Administrative Changes to AFPAM 47-103V1, *Dental Laboratory Technology-Basic Sciences, Removable Prosthodontics and Orthodontics*

OPR: 381 TRS/XWAA

References to HQ AETC/SGD should be changed to AFMOA/SGD throughout the document.

Reference address for the 381 TRS/XWAA should be changed to 2931 Harney Road, Fort Sam Houston, TX 78234 through the document.

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Dental Laboratory Technology

Basic Sciences, Removable Prosthodontics, and Orthodontics

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An Outline of Dental Materials and Their Selection, by William J. O'Brien, PhD., and Gunnar Ryge, D.D.S., M.S., published by W.B. Saunders Company, Philadelphia, 1978.

CERAMCO Technical Manual; CERAMCO Stain System; Preparation Guide; Basic Porcelain Manual; and *Basic Design for CERAMCO Restoration,* published by Ceramco, Inc., East Windsor, N.J. (Special thanks to Johnson & Johnson Dental Care Company.)

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Jig Reline and Repair Technique Booklet, published by Howmedica, Inc., Los Angeles.

Kayon Denture Stains, a registered trademark of the Kay-See Dental Manufacturing Company, Kansas City, Mo.

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Whip Mix Articulator and Quick Mount Face Bow Instruction Manual, published by Whip Mix Corporation, Louisville, Ky.

BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE PAMPHLET 47-103
VOLUME 1

15 NOVEMBER 2005

Dental

DENTAL LABORATORY TECHNOLOGY—
BASIC SCIENCES, REMOVABLE PROSTHODONTICS, AND ORTHODONTICS

OPR: 381 TRS/XWAA
(MSgt Andrea E. Bates)
Along with AFPAM 47-103, Volume 2, 15 November 2005, supersedes AFP 162-6, Volume I, 30 May 1990; Volume II, 15 December 1991; and Volume III, 15 October 1991

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(Brig Gen Thomas S. Bailey)
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This pamphlet implements AFPD 47-1, *Dental Services*. It is the first of the two volumes that form the training foundation for the Tri-Service Dental Laboratory Apprentice Course, J3ABR4Y032-005 (available at https://etca.randolph.af.mil), and the Air Force Career Development Course (4Y052). In addition, it is a working reference for all dental laboratory technicians.

This volume defines the dental laboratory specialty and its mission, presents subject knowledge necessary to deal with technical problems and work as a dental laboratory technician, introduces laboratory safety and infection control practices, and details procedures necessary to construct removable dental prostheses and orthodontic appliances. It is to be used by the Dental Corps of the Medical Service, resident dental laboratory courses, 381 TRS, and all dental laboratories in the US Air Force. Volume 2 covers basic knowledge and procedures necessary to construct fixed and special prostheses in the dental laboratory.

Send comments and recommendations for improving this publication to 381 TRS/XWAA, 917 Missile Road, Sheppard AFB TX 76311-2246. Ensure all records created as a result of processes prescribed in this publication are maintained in accordance with AFMAN 37-123, *Management of Records,* and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) (available at https://afrims.amc.af.mil/rds/index.cfm). The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

See Attachment 1 (Glossary of References and Supporting Information), Attachment 2 (Prefixes and Suffixes), Attachment 3 (Packing and Shipping Cases to Dental Laboratories), Attachment 4 (Denture Tooth Management), and Attachment 5 (Subject Index).

SUMMARY OF REVISIONS

This instruction is substantially revised and must be completely reviewed.

This volume and Volume 2 incorporate all of the material in the previous three volumes of AFP 162-6. This volume updates dental materials, infection control, laboratory-fabricated orthodontics, lingualized denture setup, the glossary, and the index. It adds information on injection mold denture processing techniques, light cured custom trays, baseplates, resin veneers for removable partial dentures (RPD), soft denture liners, denture base characterization, and RPD repairs. It deletes shellac resin base plates.

Chapter 1—DENTAL LABORATORY SPECIALTY AND LABORATORY ENVIRONMENTAL CONCERNS

Chapter 2—DENTAL MATERIALS

Chapter 1

DENTAL LABORATORY SPECIALTY AND LABORTATORY ENVIRONMENTAL CONCERNS

Section 1A—Overview of the Specialty

1.1. Dental Mission. The mission of the dental laboratory specialty is "to support the Department of Defense personnel in building the world's most respected air, land, sea, and space forces by fabricating dental prostheses and specialized products, supporting research activities, and providing consultation services to dental health care providers." The foundation of our country's national security is based on the strength and readiness of its military services. As part of the medical mission, each person assigned to the Dental Service plays a vital role in establishing and maintaining the dental health of uniformed military personnel.

1.2. Description of the Dental Laboratory Specialty. The dental laboratory specialty is an integral element of the Dental Service. It deals with the design, fabrication, and repair of dental prostheses (crowns, complete dentures, and fixed and removable partial dentures [RPD]) under the supervision of a dentist. Prosthesis is a general term that applies to any artificial replacement for a lost body part. Prosthetic dentistry (prosthodontics) is the art and science of fabricating artificial replacements for missing oral structures.

1.3. Specialty Duties. The duties and responsibilities of personnel assigned to the dental laboratory specialty increase as a person grows in knowledge, skill, and grade. These duties begin by performing routine procedures in the various areas of fixed, partial, and complete dentures. As skills and knowledge increase, more advanced procedures are learned through on-the-job training or in advanced training courses. The technician who demonstrates personal and professional maturity is expected to assume supervisory responsibilities. These duties include laboratory training, laboratory supervision, and administrative and leadership positions. A more extensive breakdown of skill and career progression is described in the Air Force Dental Laboratory Specialty Career Field Education and Training Plan.

1.4. Professional and Patient Relationships. A special standard of ethical behavior is required of all people involved in health care delivery. That is, a spirit of service and personal commitment must be the controlling factor in duty performance. Supporting patient care requires committed and responsible duty performance. Your performance affects the health of others.

1.4.1. **Dentist's Relationship to the Technician.** The dentist should treat the technician as a professional. The dentist is responsible for giving the technician very specific directions (a prescription) for each case to be fabricated, being available to answer the technician's valid questions, and providing assistance as necessary. After determining the patient can wear the prosthesis made by the technician, the dentist assumes legal responsibility for the entire procedure.

1.4.2. **Technician's Relationship to the Dentist.** As a professional, a technician must maintain knowledge and proficiency by continuing his or her education. Every restoration the technician makes must represent his or her best effort. The technician must follow the dentist's prescription exactly. In the technician's judgment, if a prescription change is indicated, the dentist must be consulted. Technicians must conduct themselves in a professional manner, especially when patients are present. Professionally oriented conversations between a technician and a dentist are privileged communications that must not be repeated to others.

1.4.3. **Technician's Relationship to the Patient:**

1.4.3.1. The technician must fabricate each prosthesis to the highest standard of which he or she is capable. The technician is responsible for any deliberate inappropriate actions resulting in failure of the prosthesis.

1.4.3.2. The technician's moral responsibility is to the patient. The technician must behave in a professional manner at all times. ***NOTE:*** Because the technician and dentist are judged on the basis of observed behavior, they must ensure their behavior is always acceptable.

1.4.3.3. The patient's dental condition and progress of treatment are privileged information; therefore, this information must not be repeated in anything other than a professional conversation. Anything the technician learns about a patient's personal life or habits is privileged information.

Section 1B—General Health Conditions

1.5. Work Positions. Improper posture can produce fatigue, pain, and discomfort. Sitting with your head lowered forward can cause a feeling of cramping in the back of your neck, and a curved spine can cause backache. General health can be impaired because poor posture could cause displacement of the internal organs. The following are proper postures for the positions in dental laboratory work:

1.5.1. **Standing Position.** Stand erect, with your legs comfortably parted. This posture ensures maximum stability. The weight is carried mainly on the balls of your feet. In this position, an imaginary line dropped from the base of the ear would pass through your shoulder, hip joint, and kneecap and just in front of your ankle.

1.5.2. **Sitting Position**. Sit erect. In this position, an imaginary line would pass through your ear, shoulder, and hip joint. Sit as far back in your chair as possible. When you work at a desk or bench, your body should bend forward from the waist without breaking the straight line previously described.

1.6. Room Illumination. The exactness of dental laboratory work demands good lighting. When possible, place the equipment so natural light comes from behind and above your shoulders. When artificial light is in front of the operation, it must be shielded so there is no glare and it should be directed onto the work being performed.

1.7. Room Ventilation:

1.7.1. Properly filtered ventilation is essential for good health and maintaining a positive working attitude. Ventilation supplies clean air at a controlled temperature so the environment is kept safe and comfortable. A controlled temperature is also essential when working with dental materials. Waxes and investments require a controlled temperature of approximately 70 - 72 degrees to achieve proper expansion for accurate-fitting restorations.

1.7.2. Ventilation should be sufficient to remove fumes, gases, and excessive heat and dust. In some areas of dental laboratories, some form of mechanical ventilation is required to remove air contaminants such as dust and fumes. This is done by using exhaust hoods located at the areas where contaminants are generated.

1.8. Noise and Vibration:

1.8.1. Prolonged exposure to noise and vibration can affect your hearing ability, general health, and working efficiency. Many noises can be eliminated at their source, while others can be guarded against by individual protective measures. Proper location and lubrication of machinery are essential.

1.8.2. The Air Force Occupational Safety and Health (AFOSH) Standard 48-19, *Hazardous Noise*

Program, enforces Occupational Safety and Health Administration (OSHA) standards and requires the use of devices (such as soft rubber earplugs when you work close to noisy equipment) and rubber mats placed under equipment and in places where people stand to operate equipment, thus reducing the effects of vibration. These measures reduce the effects of long term exposure to noise and vibration detrimental to your general health.

Section 1C—Safety in the Laboratory

1.9. Housekeeping in the Dental Laboratory. A dental laboratory must be neat and orderly at all times. Clean, orderly surroundings are conducive to the best efforts and safety of all concerned. Continuous, routine care of the laboratory is everyone's responsibility. The easiest way to maintain a neat work area is to clean the area after each procedure. When this becomes habit, only a short cleanup period is necessary each evening to prepare the laboratory for use the next day. When the day's work is completed, work benches, lathes, and bench engines must be cleaned and dusted. Sinks must be emptied and scoured, and water baths must be drained. As required by clinic policy, floors should be swept, mopped, and waxed. Instruments must be cleaned and returned to their proper storage areas.

1.10. Eye Protection. You must constantly be alert to hazards that might harm your eyes. Intense light from gas-oxygen torches, acids, corrosive fumes, and flying particles pose serious safety hazards in the laboratory. All personnel must be trained to use an approved eyewash station which should be located in the laboratory for easy access by all personnel. This station will be used to flush the eyes with cold water in the event hazardous materials get into the eyes. (For guidelines on eyewash station requirements, see AFOSH Standard 91-32, *Emergency Shower and Eyewash Units*.) Neutralizers for chemicals used in the laboratory must be available. Refer to material safety data sheets (MSDS) for specific neutralizers.

WARNING

WEAR PROTECTIVE GLASSES OR GOGGLES WHEN THE REMOTEST POSSIBILITY OF EYE DAMAGE EXISTS.

1.11. Hand Care:

1.11.1. Fingernails should be trimmed short so they do not collect dirt or become torn and cause injury to fingertips. Certain laboratory procedures require wearing rubber gloves; other procedures require wearing insulated gloves or mitts. Using hand creams frequently during cold weather helps prevent chapping.

1.11.2. Give immediate care to all scratches, cuts, burns, or bruises to lessen the risk of infection. Appliances worn by patients can harbor organisms that may cause serious infection or disease through cuts or breaks in the skin. Therefore, always wear latex or rubber gloves when pouring impressions, cleaning impression trays, or handling a prosthesis that was in the patient's mouth.

1.11.3. Keep hands clean by frequently brushing them with a handbrush, soap, and water. Remove rings and bracelets to prevent catching them in equipment.

1.12. Hair Care. Hair should be trimmed short to prevent tangling it in lathes. Long hair will almost certainly be singed or set on fire near an open flame. If the need is obvious, use hairnets or bobby pins.

1.13. Clothing. As with long hair, dangling shirttails, sleeves, and neckties can pose a problem near lathes and flames. A securely fastened, well-fitting lab coat provides protection. Use an apron over your lab coat when pouring impressions or cleaning impression trays. This clothing may be disposable or cleaned by a laundry service.

1.14. Instruments. As a general rule, sharp instruments are less dangerous than dull ones. Rather than straining to use a dull tool, you can exercise more deliberate control with a sharp one. Keep all cutting tools sharply pointed or edged, but don't carry dangerous, unshielded instruments on your person. Dispose of broken instruments and worn or broken lab blades in an appropriate "sharps" container.

1.15. Lathes and Rotary Attachments:

1.15.1. Wear protective goggles or glasses during finishing and polishing procedures. Do not leave a running lathe unattended; turn it off when it is not in use.

1.15.2. Ensure all chucks and attachments are securely mounted before starting the lathe. Do not use attachments that vibrate or do not run true. Do not adjust or replace chucks, wheels, or similar attachments while the lathe is running unless the machine is equipped with an automatic chuck. Do not attempt to stop a running lathe by grasping the attachment with your hands.

1.15.3. Adjust the glass shield of high speed lathes to an angle that deflects flying debris away from the face. Follow the manufacturer's directions for inserting attachments, starting and stopping the lathe, and releasing the attachments.

1.16. Heat Sources and Flammable Substances:

1.16.1. ALL DENTAL LABORATORY PERSONNEL MUST KNOW LOCAL PROCEDURES FOR REPORTING FIRES, WHERE THE FIRE EXTINGUISHER IS KEPT, AND HOW TO USE IT.

1.16.2. After use, turn off equipment having electric heating elements. Be aware that these units have a tendency to stay hot long after they are switched off.

1.16.3. Do not leave a Bunsen burner or blowtorch flame unattended. Turn off these flames immediately after use. Control the height of a Bunsen burner flame. (A 3-inch flame is sufficient for almost all laboratory procedures.) Close the outlet valve at once when a gas flame is accidentally extinguished. Make sure a Bunsen flame is not burning through the hose that supplies the unit.

1.16.4. Replace damaged lengths of hose immediately. Store flammables (in permissible volumes) in proper containers and inside approved storage facilities. Keep flames away from storage areas containing flammables. Avoid heating both ends of a double-ended instrument. Use care in handling hot waxes and liquids.

1.17. Airborne Dust and Fumes. Ensure all positive exhaust machinery is working properly. When working with acids or any other substance having toxic fumes, place and use these substances under a power exhaust hood. Keep all acid containers properly marked and covered when they are not in use. Position them to prevent spills. Use a proper mask to prevent inhalation of airborne dust during grinding and polishing procedures when adequate exhaust machinery is not available.

1.18. Electrical Connections. Report all electrical defects (frayed cords, loose plugs, etc.) as soon as they are discovered. Treat all electrical wires as "live" wires. Unplug all equipment not in use unless it is required to be plugged in at all times for proper function (for example, porcelain ovens).

1.19. Compressed Air:

1.19.1. Do not allow horseplay around compressed air. (***NOTE:*** Serious injuries have occurred by the entry of compressed air into the body. Laboratory air pressure is routinely 30 lb/in^2, and it is estimated that a pressure of 4 lb/in^2 will rupture intestines.)

1.19.2. Wear eye protection at all times when compressed air is being used. Do not use more than the recommended pressure in pressurized curing units or other compressed air-powered equipment. Do not use more than 30 lb/in^2 for cleaning purposes. Label each air outlet according to the air pressure available (lb/in^2).

Section 1D—Infection Control in the Laboratory

1.20. Introduction:

1.20.1. Preventing the spread of infectious disease is a factor less obvious than safety, but equally as important in maintaining the health and well-being of patients and clinic personnel. Infection control procedures reduce the spread of pathogenic microorganisms by breaking the chain of infection at critical points in the fabrication, repair, and delivery of prostheses.

1.20.2. The key concept in dental laboratory infection control is to clean and disinfect all contaminated items before they are allowed to reach the production area of the laboratory. If this is done, dental laboratory personnel and equipment will not become contaminated.

1.21. Exposure and Precautions:

1.21.1. Dental health care workers (DHCW) are routinely exposed to blood, saliva, and other potentially infectious materials. Because of the potential for cross-contamination, dental personnel must follow strict infection control precautions.

1.21.2. Dental laboratory technicians are also susceptible to infection via cross-contamination. For example, it has been documented that they are almost three times more likely to be exposed to hepatitis B than the general population. Because of this potential for exposure, dental laboratory personnel are included in the hepatitis B high-risk population.

1.21.3. Some of the other potential pathogens the dental laboratory technician may be exposed to include the human immunodeficiency virus (HIV), tubercle bacillus (tuberculous), and herpes virus (primary and secondary herpes).

1.21.4. The potential for transmission of various types of infectious microorganisms from impressions and prostheses to dental laboratory personnel is always present, and universal precautions form the foundation for the prevention of cross-contamination. As described by OSHA, "Universal Precautions" indicates all blood, saliva, and bodily fluids in the dental workplace should be treated as potentially infectious.

1.21.5. In addition, routine infection control procedures should be developed and implemented for every patient. The term Standard Universal Precautions refers to the standard precautions applied universally to all patients, regardless of the infectious status, to reduce the risk of transmission of bloodborne pathogens. (See https://www.afms.mil/afdental/almajltr/1997/970414.pdf.) Various methods have been developed to minimize exposure of dental personnel to potentially infectious microbes. For example, engineering principles, personal protective equipment, chemical disinfection, sterilization, and vaccination all play a role in minimizing exposure to pathogenic microrganisms.

1.22. Infection Control Terminology. The following terms apply to infection control:

1.22.1. **Antiseptic.** An antiseptic is a chemical agent applied to a tissue to inhibit the growth of microorganisms.

1.22.2. **Asepsis.** Asepsis is a pathogen-free condition; that is, the process of preventing the access of microrganisms.

1.22.3. **Aseptic Technique.** Proper use of dental instruments to ensure sterilized and disinfected items are not contaminated before use is the aseptic technique.

1.22.4. **Bioburden.** Bioburden is the number and type of microorganisms that must be removed via mechanical debridement to allow proper disinfection.

1.22.5. **Dental Item Classifications.** Dental items can be classified as critical, semicritical, or noncritical in their need for sterilization or various levels of disinfection. As follows, these classifications are determined by where and how the items are used:

1.22.5.1. **Critical Items.** Critical items are objects that enter the skin, mucous membrane, or vascular system and present the greatest risk of infection. CRITICAL ITEMS MUST BE STERILE PRIOR TO USE. Scalpel blades, hypodermic needles, surgical instruments, and suture needles are examples of critical items.

1.22.5.2. **Semicritical Items.** Semicritical items are objects that frequently contact mucous membranes and are often contaminated by oral secretions and blood, but they do not enter the tissue or vascular system. THESE ITEMS MUST HAVE HIGH TO INTERMEDIATE LEVEL DISINFECTION. Shade guides, facebows, jaw relationship records, impressions, and prosthetic devices are examples of semicritical items.

1.22.5.3. **Noncritical Items.** Noncritical items are objects that don't ordinarily contact mucous membranes or broken skin. THESE ITEMS SHOULD HAVE INTERMEDIATE TO LOW LEVEL DISINFECTION. Receiving areas, case pans, and articulators are examples of noncritical items. ***NOTE:*** The term "noncritical" does not imply "nonimportant."

1.22.6. **Disinfection:**

1.22.6.1. The destruction or inhibition of most pathogenic bacteria (while they are in their active growth phase) and the inactivation of some viruses are termed disinfection. In most cases, the disinfecting process does not kill spores and cannot be easily verified. In addition to their normal spectrum, disinfectants used in a dental clinic environment also need to be tuberculocidal.

1.22.6.2. The Environmental Protection Agency (EPA) is tasked with classifying sterilants and disinfectants. They classify high-level disinfectants, which are sporicidal, as sterilizing agents. Defined levels of disinfection are based on the biocidal activity of an agent against bacterial spores, tubercle bacilli, vegetative bacteria, and viruses as well as the contact time of the solution.

1.22.6.3. High-level disinfectants (sterilizing agents) are biocidal against all classes of microbes, and they are used for all critical and some semicritical items.

1.22.6.4. Intermediate-level disinfectants will not routinely kill spores, but they are biocidal against all other classes. Intermediate-level disinfectants are used for semicritical and some noncritical items.

1.22.6.5. Low-level disinfectants are not effective against tubercle bacilli, bacterial spores, or certain nonlipid viruses. Low-level disinfectants are used only for noncritical items.

1.22.7. **Personal Protective Equipment (PPE).** Specialized clothing or equipment (such as gloves, masks, protective eyeglasses, and gowns) that provide a physical barrier between the body and the source of contamination are called PPE.

1.22.8. **Sanitation.** Sanitation is the process that removes gross debris and reduces the number of microorganisms or nonliving material.

1.22.9. **Sterilization.** The process of totally destroying all forms of life within an environment, including viruses and spores, is called sterilization. Heat sterilization can be monitored and verified, but sterilization by high-level disinfectant solutions cannot easily be monitored or verified.

1.22.10. **Unit Dose.** Dispensing only those materials or supplies required for treating a single patient (or prosthesis) is the unit dose method.

1.22.11. **Standard-Universal Precautions.** DHCWs must assume all body fluids and contaminated instruments and materials are infectious and routinely use standardized infection control procedures. The use of standard-universal precautions protects both the patient and the dental team.

1.23. Laboratory Barrier System:

1.23.1. Laboratory personnel can be protected against infection by the establishment of a strict barrier system. This is usually initiated by establishing a receiving area (an engineering control) that is physically separate from the rest of the dental laboratory. If it is not possible to create a physically separate receiving area, a portion of the laboratory should be designated as the receiving area which would be considered contaminated. (The rest of the laboratory would be considered uncontaminated.)

1.23.2. All items needing disinfecting will first be processed through the receiving area (paragraph 1.24). This barrier system is essentially a series of cleaning and disinfecting procedures that removes blood, saliva, and other potentially infectious material from the impression or prosthesis. After an item has passed through the barrier system, dental laboratory personnel may safely work on the case with minimum PPE. In practice, this means sterilizing or disinfecting dental items that have had contact with the patient before and after any laboratory work is performed (paragraphs 1.25 through 1.38). After a prosthesis has been through the barrier system, it can then be processed through the laboratory.

1.24. Receiving Area Requirements. Dental personnel working in the receiving area should wear the appropriate PPE (gloves, mask, eye protection, and smocks). They should wash their hands as they enter and leave the receiving area. Dirty and clean cases must be separated. Every item with a potential for contamination must not leave the receiving area until is has been cleaned and disinfected. Rush cases should not be allowed to break the infection control barrier. The bench top must be disinfected between each case and at the end of the day with an intermediate disinfectant solution.

1.25. Disinfection of Reversible Hydrocolloid and Alginate Impressions:

1.25.1. After removal from the mouth, each impression should be carefully rinsed with running water in the dental treatment room before it is transported to the receiving area. Small amounts of dental stone may be sprinkled in the impression and gently scrubbed into the impression with a camel hair brush. This addition of the stone will aid in cleaning the impression. The impression should then be gently rinsed under running water. After rinsing, the impression will be transported to the receiving area in a plastic bag.

1.25.2. In the receiving area, the impression will be sprayed with an appropriate disinfectant solution and placed in a sealed plastic bag. Alginate impressions should be disinfected with a spray because they will absorb moisture if placed in a solution. Sealing the impression in a plastic bag creates a “charged atmosphere” which enhances disinfection. The most accurate casts have been produced when the spray and plastic bag technique was used to disinfect alginate and reversible hydrocolloid impressions. Appropriate disinfectant sprays include iodophors, sodium hypochlorite (1:10 solution), 2 percent glutaraldehyde, and chlorine dioxide products.

1.25.3. After the recommended time of disinfection, the impression will again be gently rinsed under running water and then poured in the traditional manner. Because reversible hydrocolloid and alginate impressions lose dimensional accuracy as a function of time, they should be poured within 12 minutes after removal from the mouth. A disinfectant should be selected that produces an appropriate level of disinfection in as short a time as possible.

1.26. Disinfection of Addition Silicone and Polysulfide Impressions. These impressions may be managed like the hydrocolloid impressions (paragraph 1.25), or they may be immersed in an appropriate hospital level disinfectant. (***EXCEPTION:*** These impressions should not be immersed in neutral glutaraldehyde.) Immersion with any acceptable disinfectant will not adversely affect the accuracy of the impression or the surface detail of the resulting cast. The surface detail of the cast seems to be enhanced if these impressions are immersed in a 2 percent acidic glutaraldehyde disinfectant.

1.27. Disinfection of Polyether Impressions. Polyether impressions are hydrophilic and should not be immersed in a disinfectant solution. These impressions are disinfected in the same manner as reversible hydrocolloid and alginate impressions (paragraph 1.25). A chlorine-based disinfectant with a short disinfectant time is recommended for these impressions.

1.28. Disinfection of Prostheses Entering the Laboratory:

1.28.1. Carefully rinse fixed and removable prostheses under running water after removal from the mouth. This is the precleaning step. Then scrub the prosthesis with an antimicrobial soap and rinse it. This procedure can occur in the dental treatment room, professional work area, or the receiving area. If this cleaning step is performed in the dental treatment room, place the cleaned prosthesis in a plastic bag and take it to the receiving area.

1.28.2. In the receiving area, place the prosthesis in an ultrasonic cleaner with the appropriate cleaning solution. Place the cover on the ultrasonic cleaner and clean the prosthesis according to the manufacturer's recommended time. Then immerse the prosthesis in an accepted tuberculocidal disinfectant. Examples of acceptable disinfectants are sodium hypochlorite (1:10 solution), iodophors, and gluteradehyde. The immersion time is 10 minutes or the manufacturer's specified time. Metal components of prostheses can be corroded by many disinfectants, but this is unlikely to occur if proper disinfectant times are followed.

1.28.3. After the disinfectant procedure is accomplished, the prosthesis will again be rinsed and can be processed through the laboratory. This procedure allows the laboratory technician to work on the prosthesis with minimum PPE.

1.28.4. If the prosthesis is to be shipped to another laboratory, the prosthesis will be disinfected and sealed in a plastic bag, which prevents contamination of the shipping materials. Also, a statement should be included in the shipping container stating the prosthesis has been disinfected. ***NOTE:*** Disinfectant is not added to the plastic bag containing the prosthesis because the exposure time to the disinfectant will be excessive and may damage the prosthesis.

1.29. Disinfection and Sterilization of Prosthodontic Items. Dental equipment that has minimal contact with oral fluids will be cleaned and disinfected with an acceptable disinfectant. Examples of such items are shade tabs, dental torches, case pans, articulators, facebows, spatulas, and rubber bowls. Equipment that has been placed in the patient's mouth will be sterilized. Examples of such items are the facebow's bitefork and reusable impression trays.

1.30. Dispensing the Finished Prosthesis to the Dentist. The prosthesis will be cleaned, disinfected, and placed in a plastic bag before it is returned to the dentist. A statement may be affixed to the bag stating the prosthesis has been disinfected.

1.31. Preparation of Saturated Calcium Sulfate Dihydrate Solution (SDS). Prepare the SDS from fresh set stone that has never been poured against a potentially contaminated impression.

1.32. Disinfection of the Dental Casts:

1.32.1. Ideally, an impression will be disinfected before it is poured in dental stone. If the impression was poured before disinfection, the subsequent cast will be considered contaminated. Spraying the cast with an iodophor or a chlorine disinfectant can disinfect the cast. The cast will then be placed upright and allowed to completely dry. Care must be taken not to damage the stone cast's surface.

1.32.2. Another method is to place a 0.5 percent solution of sodium hypochlorite in a solution of clear SDS and soak the cast for 30 minutes. The cast will be removed from the solution and allowed to dry completely. This solution will not damage the surface of the cast. The solution must be prepared daily to maintain its effectiveness.

1.33. Dental Laboratory Personnel and Standard Universal Precautions. As a minimum, to minimize the possibility of contamination in the workplace, (1) PPE should be used when necessary, (2) excellent personal hygiene should be maintained, (3) hepatitis B vaccination should be accomplished, (4) eating or drinking should not be permitted in the dental laboratory, and (5) the receiving and shipping area should be controlled.

1.33.1. **Rush Cases.** Do not allow rush cases to jeopardize the barrier system. If a prosthesis is adjusted or modified in the dental treatment room and additional laboratory support is required, make one of the following two choices:

1.33.1.1. Recognize that, depending on the disinfectant, up to a 20-minute turnaround time is required to protect the dental laboratory.

1.33.1.2. Establish a unit dose polishing area physically removed from the dental laboratory. In the isolated area include a polishing unit, individually wrapped wheels, abrasive points, and polishing agents. Enclose catch pans for pumice in sealed plastic bags for single patient use. Ensure all pumice and polishing wheels used on contaminated appliances are sterilized after each use.

1.33.2. **Hand Cleansing.** Personnel involved with patient care must follow the rigid handwashing regimine below:

1.33.2.1. Hands must be thoroughly washed and free of rings to remove resident bacteria and transient organisms acquired from contact with patients or contaminated surfaces.

1.33.2.2. Cleanse hands at the beginning of each duty day. Fingernails should be free of nail polish and trimmed and cleaned, using a nail cleaner. (DO NOT wear false fingernails because contamination may occur from fungal growth occurring between the false and natural nail.)

1.33.2.3. Wet hands, apply an antiseptic solution, and scrub hands and nails with a surgical sponge or brush. Rinse thoroughly because some antiseptic handcleansing agents may irritate the skin if they are not thoroughly removed. Finally, dry hands, using a clean paper towel.

1.33.2.4. Repeat handcleansing is required after working with contaminated dental items, before lunch, and before leaving the dental clinic.

1.34. Chemical Sterilization and Disinfection:

1.34.1. Although heat sterilization is the preferred method, certain instruments and many dental materials cannot be placed in a heat sterilizer. Therefore, they require chemical sterilization or disinfection. Many different chemical disinfectants are available with varying degrees of effectiveness.

1.34.2. It is important to remember that disinfectants can be rendered ineffective by soiled or heavily contaminated prostheses. Therefore, adequate debridement and cleaning are necessary for effective disinfection.

1.34.3. The American Dental Association (ADA) Council on Dental Therapeutics recommends the following five disinfectants; iodophor (paragraph 1.35), glutaraldehyde (paragraph 1.36), phenolic (paragraph 1.37), chlorine (paragraph 1.38), and formaldehyde compounds. Formaldehyde compounds are usually used as surface or immersion disinfectants in dentistry.

1.35. Iodophor. Examples include Wescodyne® and Biocide®.

1.35.1. Iodophor compounds contain 0.05 to 1.6 percent iodine and surface-active agents (usually that of detergents), which carry and release free iodine. Because the antimicrobial activity of an iodophor compound is greater than iodine alone, it can be used as a chemical disinfectant.

1.35.2. Because the vapor pressure of iodine is reduced in the iodophor, its odor is not as offensive. Also, iodophors do not stain as readily as iodine.

1.35.3. Intermediate levels of disinfection can be achieved after 10 to 30 minutes of contact when mixed with water according to the manufacturer's directions..

1.35.4. Antiseptic iodine compounds approved by the Federal Drug Administration (FDA) must not be used as disinfectants.

1.36. Glutaraldehyde:

1.36.1. **Examples.** Examples of glutaraldehyde include, Cidex®, Sporicidin®, Sterilize®, Glutarex®, and Banicide®.

1.36.2. **Chemical Sterilization:**

1.36.2.1. The types of available glutaraldehyde are alkaline, neutral, and acidic. Most formulations contain 2 percent glutaraldehyde and come in two containers. When the proper amounts from each container are mixed, the solution is activated.

1.36.2.2. Glutaraldehyde sterilization cannot be verified by using sterilization monitors. Because it is caustic to the skin, forceps or rubber gloves should be used to handle prostheses that have been immersed in glutaraldehyde. A 2-percent, room-temperature solution of alkaline or neutral glutaraldehyde should be used to sterilize heat-sensitive items. (Read the manufacturer's directions carefully because some formulations cannot be used on carbon-steel instruments.)

1.36.2.3. Immersion for 6 3/4 to 10 hours in a fresh solution of alkaline or neutral glutaraldehyde usually achieves sterilization, but metallic items cannot be left in any glutaraldehyde solution for longer than 24 hours.

1.36.2.4. After activation, the shelf life and reuse life of each solution may vary depending on the formulation. Place an expiration date on each container of fresh solution to ensure only active solutions are used. Acidic glutaraldehydes heated to 600 ^{o}C in a closed system will sterilize instruments in 1 hour. Because of the need for frequent heating and a closed system to eliminate toxic vapors, the use of acid glutaraldehyde is impractical for sterilization.

1.36.3. **Chemical Disinfection.** The types of glutaraldehydes used for disinfection are the same as for sterilization, but their usage differs. A 10-minute immersion in glutaraldehyde normally provides an intermediate level of disinfection. The label states shelf life (after activation), reuse life, and dilution factors. Glutaraldehydes are best used as immersion disinfectants. They are not practical to use as surface disinfectants because surfaces wiped down with glutaraldehydes must have the residual disinfectant film wiped off with sterile water.

1.37. Phenolic Compounds. Synthetic phenolics have been accepted as disinfectants. In high concentrations, phenolics are protoplasmic poisons; in low concentrations, they inactivate essential enzyme systems. As disinfectants, phenolics are usually combined with a detergent. Some phenolic compounds have also been shown to be bactericidal, fungicidal, virucidal, and tuberculocidal.

1.38. Chlorine. Chlorine is available as sodium hypochlorite (common household bleach) or as chlorine dioxide. If improperly used, chlorine-containing compounds can cause corrosion of dental instruments and materials.

1.38.1. **Sodium Hypochlorite.** Sodium hypochlorite is thought to oxidize microbial enzymes and cell-wall components. It is used as a chemical disinfectant. A 10-percent solution (one part bleach to nine parts water) yields 10,000 parts per million of available chlorine which achieves an intermediate level of disinfection in 30 minutes. Because a sodium hypochlorite solution tends to be unstable, a fresh solution must be prepared daily. This solution possesses a strong odor and can be harmful to eyes, skin, colored clothing, and metals.

1.38.2. **Chlorine Dioxide.** This new chemical sterilant has been approved by the EPA.

1.38.2.1. It contains no glutaraldehyde, is economical to use, and is nontoxic and nonsensitizing. It is safe to use on most nonmetal items, but very corrosive to nonstainless steel metal instruments.

1.38.2.2. It requires an immersion time of 6 hours for sterilization. After activation, it has a shelf life of 14 days, but a reuse life of only 1 day. It is biodegradable, does not stain hands or equipment, and does not have to be wiped off environmental surfaces.

1.38.2.3. If used within 24 hours of preparation, it requires an immersion time of only 1 minute to achieve an intermediate level of disinfection. However, if used 24 or more hours after its preparation, 3 minutes of immersion or wetting are required.

1.39. Ethylene Oxide. Ethylene oxide is the most reliable agent for chemical sterilization. It sterilizes objects that are heat stabile without producing rust or corrosion.

1.39.1. Like heat sterilization, it can be verified with biological spore monitors. Monitoring with the B subtilis spore should be performed with each sterilization cycle.

1.39.2. Certain disadvantages prohibit the routine use of ethylene oxide in the dental laboratory. First, it is very slow acting, taking 4 to 6 hours to complete sterilization. In addition, certain sterilized items retain ethylene oxide gas so they must be aerated for a minimum of 12 hours before they can be used in the oral cavity. Finally, there is some concern about whether ethylene oxide vapors may be mutagenic and (or) carcinogenic.

1.39.3. Ethylene oxide must be used according to OSHA standards.

Chapter 2

DENTAL MATERIALS

Section 2A—Overview

2.1. Introduction. This chapter describes the composition, properties, and use of materials in a dental laboratory. Information on the use of the materials is also discussed in those chapters dealing with specific laboratory procedures.

2.2. Knowledge of Dental Materials:

2.2.1. Almost all dental materials are obtained from a commercial manufacturer. Each manufacturer furnishes recommendations for handling and storage of its product so the desired results are consistently obtained. The dental laboratory technician must know which material is needed to do a good job, the way it is handled, how it reacts, and how it is stored to maintain its physical properties.

2.2.2. Knowledge of materials is not only necessary to routinely perform laboratory tasks successfully, but to evaluate a failure so it won't be repeated. A failure means wasted laboratory time, additional clinic time, and physical discomfort for the patient.

Section 2B—Gypsum Materials

2.3. Introduction. *Gypsum* is the common name for *calcium sulfate dihydrate*.

2.3.1. Gypsum products are more frequently used in laboratory procedures than any other group of compounds. Controlled variations in the manufacture of gypsum products yield a group of dental materials that include plaster, dental stone, die stone, casting investment, and soldering investment.

2.3.2. Each substance is a carefully formulated powder that has the particular combination of physical properties to do a specific job. When the prepared powder is mixed with the proper amount of water, the blend initially forms a fluid paste that gradually hardens into a solid. In the fluid paste state, the mixture can be poured into molds or otherwise shaped. As gypsum sets, dense masses of crystals form and heat is liberated. This liberation of heat, called an exothermic reaction, happens while all gypsum products are setting.

2.4. Physical Properties: (*NOTE:* See Table 2.1 for an analysis of the physical properties of gypsum materials.)

2.4.1. **Crushing Strength.** Crushing strength or compressive strength is the measure of the greatest amount of compressive force that can be applied to a substance without causing it to fracture. The strength of a gypsum product increases rapidly as it hardens. Because the relative amount of water left in the set material has a distinct effect on strength, the following kinds of gypsum product strengths (wet and dry) are recognized:

2.4.1.1. **Wet Strength.** This is the strength of the material with excess water still present in the set up mass.

2.4.1.2. **Dry Strength.** This is the strength of a dried gypsum specimen. Twenty-four hours after setting, the compressive strength of a gypsum specimen left to dry will double.

2.4.2. **Setting Time.** The setting tim e is the tim e required f or the m aterial to set or harden. It is divided into the following stages:

2.4.2.1. **Initial Set.** The tim e starts when the powder is m ixed with water and ends when the material becomes solid enough to remove from the tray and trim without distortion.

2.4.2.2. **Final Set.** This is the time required for full crystallization to occur. All exothermic heat dissipates and the mass reaches about half its potential crushing strength.

Table 2.1. Physical Properties of Gypsum Materials.

	A	B	C	D	E	F
				Technique		
ITEM	**Material**	**Setting Time**	**Heat Resistance**	**Normal Setting Expansion**	**Hygroscopic Expansion**	**Thermal Expansion**
1	Plaster Initial:	7 - 13 minutes Final: 45 minutes	NA	As low as possible	NA NA	
2	Stone (Hydrocal)	Initial: 8 - 15 minutes Final: 45 minutes				
3	Die Stone	Initial: 15 minutes Final: 25 - 30 minutes				
4	Soldering Investments	Initial: 8 - 12 minutes Final: 18 - 22 minutes	Matched to the melting temperature of the solder	Matched		to the expansion of the metals being soldered
5	Gold-Casting Investments	Initial: about 12 minutes Final: 35 - 45 minutes	Matched to the burnout and casting temperature of the metal being cast	Thermal Expansion Technique: Semihygroscopic and thermal expansion must compensate for gold shrinkage (about 1.4 percent)		
6				Hygroscopic Expansion Technique: Hygroscopic expansion, pattern wax expansion, and thermal expansion must total about 1.4 percent.		
7	Chrome-Nickel System Investment	Initial: 8 - 12 minutes Final: about 20 minutes	Special, gypsum-bound investment for the Ticonium® system	Combined semihygroscopic and thermal expansion must compensate for shrinkage of chrome-nickel (about 1.7 percent).		

2.4.3. **Setting Expansion.** A gypsum product enlarges in volum e as it sets. This enlargem ent is called *setting expansion* and usually amounts to a fraction of 1 percent. A gypsum material sets up in air or in contact with water. The setting expansion varies, depending on the conditions the material is exposed to (Table 2.1).

2.4.3.1. **Normal Setting Expansion.** A gypsum product expands predictably when it is allowed to solidify unconfined in a normal room temperature environment. A setting expansion that takes place under these conditions is called *normal setting expansion.*

2.4.3.2. **Hygroscopic Setting Expansion.** Hygroscopic setting expansion occurs when a gypsum material is allowed to solidify under water. A hygroscopic expansion can be expected to more than double a normal setting expansion. In some dental procedures, a gypsum product solidifies in limited contact with water. For example, an investment is sometimes made to set against a wet ring liner. This expansion is greater than the normal setting expansion, but it is not as great as a hygroscopic expansion. A setting expansion that occurs as a result of limited contact with water is called *semihygroscopic expansion.*

2.4.3.3. **Thermal Expansion.** This kind of expansion occurs as the result of a gypsum product being heated. The amount of thermal expansion is proportional to the temperature.

2.5. Effect of Selected Variables on Crushing Strength. The strength of set gypsum products can be directly affected by several variables under the control of the technician:

2.5.1. **Water-Powder Ratio.** The crushing strength lowers as more water is used in the mix. Gypsum products are porous, and the greater amount of water increases porosity because there will be fewer crystals formed per unit of volume of the material.

2.5.2. **Mechanical Mixing.** Longer and more rapid mixing, up to a maximum of 1 minute, results in greater strength. However, overmixing breaks down the forming crystals and reduces the crushing strength of the end product.

2.5.3. **Chemical Modifiers.** In general, chemical modifiers reduce crushing strength. However, borax can act to increase the surface hardness of the material.

2.6. Effect of Selected Variables on Setting Time. The setting time of a gypsum product can be affected directly by certain variables the dental technician can control. These variables must be applied with extreme care. In gaining a more desirable setting time, other physical properties, such as strength, may be adversely affected as follows:

2.6.1. **Water-Powder Ratio.** A longer setting time is required when more water is used in the mix. Conversely, the setting time is reduced when less water is used in the mix.

2.6.2. **Water Temperature.** As the temperature of the water used in the mix is raised from 32 to 85 ^{o}F, the setting time is shortened. When the water is between 85 and 120 ^{o}F, the setting time is lengthened. If boiling water is used and the mixture is maintained at about 212 ^{o}F, the material will not set at all.

2.6.3. **Mixing.** The setting time is shortened as the mixture is stirred (spatulated) either for a longer time or at a faster rate.

2.6.4. **Accelerators and Retarders:**

2.6.4.1. An *accelerator* is a substance that, when added to a gypsum product, decreases the setting time. Conversely, a *retarder* increases the setting time. The manufacturer uses these substances to standardize the setting behavior of a product. At times, accelerators or retarders may be used to alter the usual setting behavior of a product.

2.6.4.2. Potassium sulfate and common table salt are accelerators; vinegar, potassium citrate, and borax are retarders.

2.6.4.3. Unfortunately, accelerators and retarders also change properties other than setting time, and they tend to reduce both setting expansion and crushing strength. For this reason, chemical accelerators or retarders should never be used with casting or soldering investments because a predictable setting expansion is important in these materials. Manipulating the water temperature, mixing time, and mixing rate are safer ways of controlling setting time than using chemicals.

2.6.4.4. There are a few laboratory procedures where using a specific accelerator is acceptable. One outstanding example is when slurry water is used to accelerate plaster or dental stone mixes in cast mounting procedures. *Slurry water* is a concentrated suspension of gypsum particles in water made by catching the runoff from a cast trimming machine. The suspended gypsum particles are allowed to settle, and about two-thirds of the water is siphoned away. The object is to develop a more highly concentrated suspension when the sedimentary calcium sulfate dehydrate particles are reagitated. Each of these calcium sulfate dehydrate particles acts as a center of crystalline formation.

2.6.4.5. Depending on the concentration of the suspension, you can expect much shorter setting times when you use slurry water than when you use plain water.

2.7. Effect of Water-Powder Ratio and Mixing Time on Setting Expansion. The manufacturer strictly controls the setting expansion of a gypsum product by using a carefully measured amount of chemical modifiers. The manufacturer recommends standard proportioning and mixing procedures that make physical properties, including setting expansion, predictable. In the case of investments, setting expansion is such a sensitive factor that deviating from the manufacturer's directions is a questionable practice. Always be aware that a number of gypsum's properties are interdependent. For example, steps taken to change setting time can also alter setting expansion. If there is good reason to change a gypsum material's normal setting expansion, follow these guidelines:

2.7.1. Thick mixes (less water) tend to result in increased setting expansion and vice versa.

2.7.2. Long mixing times tend to increase setting expansion and vice versa.

2.8. Modeling Plaster:

2.8.1. **Manufacturing Process:**

2.8.1.1. Gypsum is converted into model plaster by grinding it into small particles and then heating it slowly in open vats to drive off the water of hydration. Under a microscope, the plaster is seen to be made up of rough irregular crystals. Each crystal contains a definite proportion of water. This is called *water of crystallization* or *water of hydration.* The amount of water eliminated by heating has a bearing on the behavior of the plaster when it is again mixed with water in the laboratory.

2.8.1.2. A special process is used to ensure plaster made for dental use has suitable working properties. These properties must always be uniform throughout a batch of material and from one batch to another.

2.8.1.3. One of the most important requirements of plaster is that it must set or harden within definite time limits. The amount of setting expansion must also be from 0.2 to 0.3 percent. A setting expansion of 0.3 percent is the maximum amount allowed by the American National Standards Institute (ANSI) of the ADA's Specification Number 25 for model plaster.

2.8.2. **Model Plaster's Uses.** Model plaster has many uses in the laboratory. It is used for constructing a matrix, flasking a denture, attaching casts to an articulator, and as an ingredient in some investments. The initial setting time for most dental plasters is from 4 to 12 minutes. The final setting time is approximately 20 to 45 minutes.

2.9. Impression Plaster. This is a plaster that has been specially compounded for making impressions of the mouth, as follows:

2.9.1. Impression plaster must behave differently than model plaster. It must be able to set much faster to reduce the time it is held in the patient's mouth. Because a plaster impression cannot spring around an undercut as it is withdrawn from the mouth, it must be broken into pieces and reassembled outside the mouth. For this reason, it must be weak and brittle.

2.9.2. Impression plasters are rarely used in dentistry today due to the availability of hydrocollids and elastomers. Impression plaster must have a very low setting expansion of 0.13 percent because an impression that changes size significantly is inaccurate. Various accelerators and retarders are added to control the setting time of plaster, and coloring agents are often added to distinguish one gypsum product from another.

2.9.3. Today, impression plaster is mainly used to obtain bite registrations for dentures or orienting a fixed partial denture in the mouth for a solder index.

2.10. Dental Stone:

2.10.1. Dental stone is medium strength plaster that is stronger and more resistant to abrasion. It is used primarily for casts (such as diagnostic casts), opposing arch casts, and complete and partial denture working casts.

2.10.2. Dental stone is made by autoclaving the gypsum under pressure and then grinding it into a hemihydrate powder. The particles are more prismatic and regular in shape. For this reason, dental stone requires less water in mixing and sets more slowly. When set, it is harder, much more dense, and has a higher crushing strength than model or impression plaster. The average setting expansion is approximately 0.12 percent.

2.10.3. The manufacturer colors dental stone to make it easy to distinguish from plaster. The initial setting time of a typical dental stone product is from 8 to 15 minutes. The final set takes approximately 45 minutes.

2.11. Die Stone (Improved Stones):

2.11.1. Improved stones are specially processed forms of gypsum products used to make crown, onlay, and inlay dies. They are harder, more dense than dental stone, and have a 0.08 to 0.18 percent setting expansion. They are also colored to distinguish them from plaster.

2.11.2. Because the amount of setting expansion is critical, it is important to use the water-to-powder ratio the manufacturer recommends. These high strength plasters are made by first boiling the gypsum in a 30-percent calcium chloride solution before autoclaving and then grinding the stone into very fine particles. Some manufacturers use a 1 percent solution of sodium succinate, or they add resin particles to increase the hardness of the stone.

2.12. Investment Materials. Investments are products used to form molds for molten metal and to relate pieces of metal to one another prior to soldering. Investments are composed of a refractory (heat-resistant) substance, like cristobalite or quartz, and a binder. Common binders are gypsum, phosphate, and silicate compounds. As a result, investments are often described as gypsum, phosphate, or silicate bound.

2.12.1. Investments with a high cristobalite content expand more than those with a high percentage of quartz. Depending on what metal is to be used, some casting investments need significant expansion to compensate for metal shrinkage, and their refractory component needs to contain a higher amount of cristobalite. When low expansion is required (such as for soldering investments), the refractory component will be high in quartz.

2.12.2. Investments are supposed to withstand heat without decomposing. Depending on the binder, they become more or less able to resist heat-induced breakdown.

2.12.3. Overheated, gypsum-bound investments liberate sulfur dioxide which makes the casting brittle. To minimize sulfur dioxide liberation, gypsum-bonded investment molds are recommended to burn out below 1300 °F. Also, molten metals thrown (cast) into those molds should have casting temperatures below 1950 °F.

2.12.4. The company that produces Ticonium chrome alloy makes a special gypsum-bound investment that withstands a 1350 °F burnout temperature and a casting temperature of 2600 °F. Barring this kind of exception, phosphate and silicate bound investments have excellent high heat resistance and are commonly used when casting or soldering temperatures exceed 1950 °F. Some more recent investments can be used as "all-purpose" investments. They have a high silicate bound makeup and use burnout temperatures of 1500 to 1600 °F.

2.13. Inlay Investment:

2.13.1. Inlay investments are usually gypsum bound. Inlay investments are commonly used for investing many different kinds of fixed restorations cast in conventional golds.

2.13.2. When molten gold alloy is cast into a mold, it cools and solidifies. As it cools, it shrinks. The amount of shrinkage is approximately 1.4 (± 0.2) percent. If nothing is done to compensate for this shrinkage, the casting will be too small. The mold space must be enlarged so the molten metal is cast into a space that is 1.4 percent oversize. As the molten metal solidifies and shrinks, the casting attains the correct size.

2.13.3. Techniques have been devised to use setting and thermal expansion characteristics of investments to compensate for cast metal shrinkage. In one technique, high heat (1290 °F) is used to produce the majority of the required expansion. In another technique, the hygroscopic expansion of the investment is responsible for most of the compensation.

2.13.4. Inlay investments tend to fall into two broad categories depending on how they are used--high heat technique investments (above 1300 °F) and low heat technique investments (1300 °F or less). One type of low heat technique is used with a high water content called a *hygroscopic technique*. This technique creates additional expansion at a lower temperature burnout.

2.14. Soldering Investment:

2.14.1. A soldering investment is similar in composition to a casting investment with a quartz refractory. An investment with a quartz refractory expands less than one having cristobalite as the heat resistant component.

2.14.2. Minimal normal setting expansion is a desirable soldering investment characteristic. A soldering investment does not expand nearly enough to compensate for the shrinkage of molten gold and should not be used for casting purposes. Like casting investments, soldering investments are made with gypsum or high heat binders. The heat resistance of the binder is matched to the anticipated soldering temperature. As a rule of thumb, a soldering procedure that takes place above 1950 °F requires an investment with a high heat binder.

2.15. Investments for Chrome Alloys:

2.15.1. **High-Heat, Chrome-Alloy Investment.** A high-heat, chrome-alloy investment is made to withstand a much higher heat than the 1300 °F normally used in eliminating wax for casting gold. Such an investment consists of a quartz powder mixed with an ethyl silicate liquid and is used with the high melting range of chrome alloys (2700 to 2800 °F).

2.15.2. **Low-Heat, Chrome-Alloy Investment:**

2.15.2.1. A low-heat, chrome-alloy investment is gypsum bound and has a silica refractory component. It is similar to the investment used for casting gold. A low-heat, chrome-alloy investment is used as part of the system for producing Ticonium chrome alloy castings. Ticonium metal is used throughout the Air Force Dental Service for RPD frameworks.

2.15.2.2. The burnout temperature of ticonium investment molds is 1350 °F, and the casting temperature of ticonium metal is 2500 to 2600 °F.

2.15.2.3. There is a sulfur dioxide liberation problem associated with gypsum bound investments at high burnout or casting temperatures. One way to combat this problem is to increase the percentage of refractory material relative to the gypsum binder in an investment formula. Ticonium metal shrinks 1.7 percent as it solidifies. The investment and burnout techniques are balanced to furnish that amount of expansion in the mold.

2.16. Investments for Ceramic Gold Alloys:

2.16.1. Gypsum-bonded investments are not adequate for casting ceramic golds. The expansion is not high enough, and the gypsum decomposes under the high temperatures. Instead, investments containing magnesium oxide and soluble phosphate should be used.

2.16.2. The dissolved phosphate reacts with magnesium oxide to form a matrix of magnesium phosphate which binds silica particles together much the same as gypsum binds low heat investments. Phosphate-bound investments are coarse in particle size, heat resistant, strong, and sometimes difficult to remove from castings. The investment is sluggish and sets rather rapidly with a working time of 3 to 4 minutes. All-purpose investments have a smaller particle size; therefore, a smoother casting can be made.

2.17. Rules for Handling Gypsum Materials:

2.17.1. **Use Clean Equipment.** Always use a clean mixing bowl and spatula. Hardened particles left in the bowl from a previous mix alter the setting time and weaken the material. As little as 0.1 percent of the hardened particles in a mix of casting investment reduces the setting time and alters the thermal or hygroscopic expansion. The best time to clean a bowl and spatula is while the plaster is still soft and easy to remove.

2.17.2. **Tumble the Contents.** Tumbling helps ensure an even distribution of the investment constituents.

2.17.3. **Add the Powder to the Water.** The powder is always added to the water; the water is never added to the powder. Place the required amount of water into the bowl and then sift the powder into the water until the powder forms an island. The powder gradually absorbs the water; consequently, the mixture is free of lumps and air. Because tap water contains contaminants, use only distilled water.

2.17.4. **Measure the Water and Weigh the Powder.** To ensure the properties of any gypsum product are maintained, an accurate water-to-powder ratio must be obtained. Weigh the powder and measure the volume of water before mixing the gypsum material.

2.17.5. **Mix Well.** Ensure all powder is spatulated into the water. As mixing proceeds, the water and powder form a mixture of creamy consistency. (To avoid excessive incorporation of air into the mix, do not whip the mix.)

2.17.6. **Vacuum-Mix the Materials.** Phosphate-bound investments release ammonia gas when mixing. Vacuum-mixing removes gas and air from the mix. Avoid gas entrapment by holding the mix under vacuum for 30 seconds. (Gas entrapment in the mold results in nodules on the casting.)

2.17.7. **Never Add to a Mix.** Adding to a mix interferes with the setting mechanism and results in a weak and distorted product. It is better to begin a new mix.

2.17.8. **Use Good Equipment.** A scarred or cracked plaster bowl allows minute particles of material to lodge in the cracks. These particles could contaminate and spoil the mix.

2.17.9. **Do Not Contaminate the Material.** Never allow water or other contaminants to fall into a bin containing gypsum material. One drop of water can adversely affect the entire batch.

2.17.10. **Know the Material.** An aged investment can ruin a piece of work. Be aware that investments have batch numbers and expiration dates stamped on them. Contact the manufacturer if any problems are suspected with your investments. Another good practice is to keep investments rotated, with the oldest packs being used first.

2.18. Storing Gypsum Materials:

2.18.1. **Improper Storage:**

2.18.1.1. When gypsum material is exposed to air, it absorbs water. The water may alter its working qualities and make it unfit for use. When plaster or stone is exposed to air for a short period of time, it sets faster than usual. If it is exposed for a longer period, it may set very slowly and be weak when it's set.

2.18.1.2. A prolonged period of storage in an unsealed container may alter the physical properties of casting investments, greatly changing the setting time, setting expansion, and reducing the crushing strength.

2.18.1.3. The setting time of casting and soldering investments is listed on the container along with the physical properties expected when the recommended powder to water ratios are used. This data is based on fresh material as it leaves the factory. It does not apply to aged batches of material that have been improperly stored.

2.18.1.4. If an investment takes an unusually long time to reach an initial set (more than 20 minutes), the entire batch must be discarded. A prolonged setting time is a warning that some or all of the desirable physical properties may have been lost or so altered as to render the investment unfit for use.

2.18.2. **Proper Storage:**

2.18.2.1. Gypsum material must be properly stored. The storage problem is more acute in a humid climate than in a dry one. All gypsum products must be stored in a sealed container in a dry room.

2.18.2.2. A systematic plan for withdrawing older stock from the supply room should be used. To minimize prolonged periods of storage, large quantities must not be stockpiled due to the danger of deterioration.

2.18.2.3. Some authorities also recommend that still another factor be taken into account when casting investments are stored. The heavier constituents (for example, quartz) settle to the bottom of the container, thereby altering the working properties of the investment. Therefore, investments should be tumbled before use, either mechanically or by hand, to make sure the powder is evenly mixed throughout.

2.19. Proper Handling of Plaster and Dental Stone Casts:

2.19.1. **Erosion of Casts:**

2.19.1.1. A well-poured cast can be ruined by contact with water because hardened stone is soluble in water in a ratio equal to or less than 1 part stone to 500 parts of water. When a stone cast is immersed in water, an erosion process begins immediately on the surface of the stone. The erosion is noticeable in as short a period as 10 minutes. This can be shown in the laboratory by suspending a stone cast in water so part of the cast is submerged, while part of it remains out of the water. In 10 minutes, the erosion of the submerged part will be evident because of its pitted appearance.

2.19.1.2. The time necessary to produce a noticeable effect depends on the mineral content of the water, temperature of the water, and density of the stone. A poured impression should never be submerged in tap water because of the harmful effect it has on stone.

2.19.2. **Saturated Calcium Sulfate Dihydrate Solution (SDS) Preparation:**

2.19.2.1. SDS is a clear, true solution of water and a maximum amount of dissolved dihydrate (set) gypsum product. Cast surfaces exposed to SDS do not erode nearly as much as cast surfaces bathed in tap water. If a cast must be soaked for more than 1 or 2 minutes, SDS should be used.

2.19.2.2. SDS is made by immersing fragments of gypsum casts in water for about 5 days. A saturated solution consists of about 0.2 grams of dehydrate in 100 cc of water.

2.19.2.3. If a slurry water suspension is left to settle out for 3 to 4 days, the clear fluid above the sediment is SDS. For use, siphon off the SDS into another container without agitating the sediment layer.

2.19.2.4. SDS can be made from plaster, dental stone, or gypsum bound investment, whichever is best suited for the kind of cast you expect to wet.

2.19.3. **Wetting Casts:**

2.19.3.1. Occasionally, casts require quick superficial wetting (for example, cleansing cast surfaces). SDS must be used instead of tap water for this purpose.

2.19.3.2. When a cast is shaped on a cast trimmer, gypsum slurry splashes onto its surface. If this slush layer is allowed to dry, it is hard to remove and cast damage could occur. As the slurry buildup accumulates, rinse the cast in a suitable container of SDS to remove the slurry. The SDS must be changed often or it will also turn into concentrated gypsum slurry.

2.19.3.3. When outright cast soaking must be done in conjunction with a laboratory procedure, the cast must not be completely submerged in SDS. Total immersion slows down the soaking process because air trapped in the cast cannot readily escape. Instead, the fluid level should be maintained below the tissue surface of the cast. A cast can be moistened in this manner in 20 to 30 minutes.

2.19.3.4. The wetting process can be seen gradually working up from the base of the cast to the tips of the teeth, much the same as oil dampens the wick in a lamp. If relief wax has been placed on the cast, there is danger of the escaping air from the cast lifting the wax from the stone. Instead of setting the cast on its base, set it on its end in the SDS.

Section 2C—Dental Waxes

2.20. General Information:

2.20.1. Wax compounds used in dentistry are mixtures of individual waxes of natural or synthetic origin. As with all other dental materials, each component in the mixture is selected to give the specific properties best suited for the procedure being performed. Depending on the purpose the wax serves, modifiers are included to change the melting range, increase or decrease stickiness, or impart a distinguishing color.

2.20.2. Dental waxes are supplied in various shapes, sizes, colors, and compositions. Become familiar with their uses and manipulation and be prepared for variations in the behavior of different waxes supplied by manufacturers.

2.20.3. See Table 2.2 for the types of waxes used in the laboratory.

Table 2.2. Types of Dental Waxes.

I	A	B	C
ITEM	Material	Use	Remarks
1	Baseplate Wax	Denture wax-ups, fill the tongue space of a lower impression, other uses miscellaneous.	Supplied in medium or hard types. Most baseplate wax sheets are about 1 mm thick (18 ga).
2	Inlay Wax	Wax patterns: inlays, onlays, crowns, and pontics; RPD frame wax-ups.	Highest requirements for accuracy of any wax. Supplied in medium and hard types.
3	Ivory Wax	For waxing acrylic resin jackets and compression-molded acrylic veneers.	Nonpigmented inlay wax.
4	Wax Forms	RPD patterns: spiral retention posts, sprues, external finish lines, etc.	Same characteristics as the softer inlay waxes.
5	Sheet-Casting Wax	Relief to create areas under RPD acrylic resin retention grids.	24 ga = 0.51 mm 26 ga = 0.40 mm 28 ga = 0.32 mm 30 ga = 0.25 mm
6	Sticky Wax	To hold broken pieces together prior to pouring an indexing cast.	Breaks with a “snap” at room temperature; shows very little flow when cool.

ITEM	A Material	B Use	C Remarks
7	Utility Wax	Beading impressions prior to boxing.	Tacky at room temperature.
8	Boxing Wax	Damming impressions for controlled pouring of casts.	Supplied in strips 1 1/2 inch wide by 12 inch long.
9	Blockout Wax	To block out undercuts in RPD fabrication.	Flows easily, sticks to a cast well, cuts cleanly.
10	Beeswax	To seal a refractory cast.	Use at around 290 ^{o}F.

2.21. Groups of Waxes. Most dental waxes fall generally into three functional groups; impression, pattern, or processing, as follows:

2.21.1. **Impression Waxes.** These waxes are used primarily by the dentist at the chair. They have low melting points and flow fairly easily at mouth temperatures. They can be distorted very easily and require extreme care in handling. Examples of impression waxes are corrective wax and jaw movement recording wax.

2.21.2. **Pattern Waxes.** These waxes are used by the dentist and laboratory technician.

2.21.2.1. They are used to form the molds in which prosthodontic restorations are made. Examples of pattern waxes are inlay wax (paragraph 2.23), baseplate wax (paragraph 2.22), wire wax (paragraph 2.25.1), preformed wax (paragraph 2.25.1), and sheet-casting wax (paragraph 2.25.3). With the notable exception of inlay wax, almost all of the pattern waxes are meant to be used in controlled thicknesses.

2.21.2.2. *Gauge* (ga) is a measure of thickness. The term is applied to the diameters of metal wires and wax forms having circular and semicircular cross sections (for example, wire wax). *Gauge* is also used when talking about sheet metal and sheet wax thicknesses.

2.21.2.3. Unfortunately, manufacturers don't always use the same gauge standard. Even if the discussion is limited to wax, the thickness of wax shapes with the same gauge number can vary between two manufacturers. Table 2.3 shows a portion of the Brown and Sharpe Gauge Scale for nonferrous (non-iron containing) sheets and wire. Notice that as gauge numbers get smaller, the thickness increases.

Table 2.3. Brown and Sharpe Gauge Scale.

ITEM	A Gauge Number	B Inches	C Millimeters
1	10 0.1019		2.59
2	12 0.0808		2.05
3	14 0.0641		1.63
4	16 0.0508		1.29
5	18 0.0403		1.02
6	20 0.0320		0.81
7	22 0.0253		0.64

ITEM	A Gauge Number	B Inches	C Millimeters
8	24 0.0201		0.51
9	26 0.0159		0.40
10	28 0.0126		0.32
11	30 0.0100		0.25
12	32 0.0080		0.20

2.21.3. **Processing Waxes.** These waxes are used primarily for fabricating prosthodontic restorations. Examples are sticky wax (paragraph 2.26), utility wax (paragraph 2.27), boxing wax (paragraph 2.28), blockout wax (paragraph 2.30), and beeswax (paragraph 2.32).

2.22. Baseplate Wax:

2.22.1. **Composition.** Baseplate wax is composed mainly of beeswax, paraffin, and coloring matter. The ingredients are melted together, cast into blocks, and then rolled into sheets. A typical baseplate wax might contain 50 parts of yellow beeswax, 6 parts of gum mastic, 3 parts of prepared chalk, and 4 parts of vermilion.

2.22.2. **Requirements.** There are several requirements for a baseplate wax. The wax must be fairly rigid at mouth temperature under biting pressure. It must be capable of holding porcelain or acrylic teeth in position, but must not be brittle. The wax should maintain a uniform consistency throughout a normal range of room temperatures as well as at mouth temperature.

2.22.3. **Types.** Baseplate wax is supplied in two types, hard and medium. The hard wax is indicated for warmer climates because it resists flow at higher temperatures. At cold temperatures, it might be too brittle and have a tendency to crack. The medium wax is indicated for low temperatures, but might exhibit too much flow in a warmer environment.

2.22.4. **Uses.** Baseplate wax is used for occlusion rims, as a boxing for matrices, for filling the tongue space of lower impressions, in complete and partial denture waxups, and for many miscellaneous purposes. Most baseplate wax sheets are about 1 millimeter (mm) (18 gauge [ga]) thick.

2.23. Inlay Wax:

2.23.1. **General Composition.** Inlay wax consists of paraffin (to make up the bulk); gum dammar (to improve the smoothness in molding and to render the wax more resistant to flaking and cracking); and carnuba (to control the softening point and hardness of the wax).

2.23.2. **Requirements for Use in Dental Procedures.** Inlay wax is one of the most carefully compounded of all the dental waxes. It should have the following qualities: high accuracy in reproducing every detail of a cavity or crown preparation; ease of carving without chipping or flaking; workable in the mouth at body temperature and in the laboratory at room temperature; dimensionally stable when transferred from one temperature environment to another; strong enough in thin areas to withstand the ordinary stresses of investing; and finally, the ability to burn out cleanly from the mold at ordinary burnout temperatures without leaving a solid residue.

2.23.3. **Types of Inlay Wax.** There are three types of inlay wax—Type A, a hard or low flow wax used in some indirect methods; Type B, for the direct technique of pattern making or intraoral use; and Type C, for the indirect technique or laboratory use.

2.24. Ivory (or White) Wax. Ivory or white wax is an inlay wax containing no color pigment. It is especially useful for waxing acrylic jacket patterns. It does not leave a colored residue in the plaster mold which might discolor the resin of the jacket crown.

2.25. Casting Waxes for Partial Dentures:

2.25.1. **Preformed Wax (Round and Half-Round Cross Section).** Preformed wax is supplied by the manufacturer in a variety of shapes and sizes suitable for use in constructing the wax pattern for a partial denture framework. Some of the round forms (wire wax) can also be used for spruing fixed prosthetic units.

2.25.2. **Inlay Wax.** When waxing frameworks, inlay wax is primarily used to free flow and carve those parts of the pattern that join preformed components to each other. Inlay wax is also used to sprue patterns.

2.25.3. **Sheet-Casting Wax.** Sheet-casting wax is very similar to baseplate wax (paragraph 2.22). At room temperature, sheet-casting wax possesses the properties of toughness and pliability and sufficient tackiness to adhere to the cast and stay where it is placed.

2.25.3.1. **Gauge.** Sheet-casting wax is manufactured in several thicknesses or gauge. The most common sizes are 24, 26, 28, and 30 gauge.

2.25.3.2. **Color.** Although manufacturers supply the wax sheets in several colors to distinguish waxes of different consistencies and handling characteristics, there is no standardization of colors among manufacturers. For example, one brand of green wax may be entirely different in working properties from the green wax of another manufacturer.

2.25.3.3. **Uses.** Sheet-casting wax can be used when a definite thickness of wax is needed. Its principal use is with RPD work to provide relief of the residual ridge on the master cast. It is often combined with one thickness of baseplate wax to produce a palate of uniform thickness in a complete denture.

2.26. Sticky Wax. Sticky wax is composed of beeswax, paraffin, and a considerable amount of natural resin. The resin gives the wax its adhesiveness and hardness. An important property of sticky wax is that it breaks under pressure instead of bending or distorting. This property makes it useful for joining the parts of a broken denture or holding together the structural parts of a wrought wire clasp while it is invested for soldering.

2.27. Utility Wax. Utility wax is an extremely pliable wax that is marketed in rope form. It is plastic and somewhat tacky at room temperature, which makes it usable without heating. Most importantly, utility wax is used for beading impressions before pouring the cast. It is sometimes used in impression techniques before pouring the cast to build up the impression tray borders.

2.28. Boxing Wax. Boxing wax is a specially prepared wax, supplied in strips 1 1/2 inches wide by 12 inches long. It is primarily used to box impressions. Most boxing waxes do not require heating; they are pliable enough at room temperature to be formed into desired shapes.

2.29. Low-Fusing Impression Wax. Low fusing impression wax is specially compounded to flow under controlled pressure in the mouth. It is melted in a water bath and painted on the tissue surface of an individual impression tray as a corrective liner for final complete and RPD impressions. Because the wax is easily distorted, low-fusing wax impressions must be handled with the utmost care. Fingers must never touch the tissue side of the impression, including the periphery. When the impression is rinsed, a *gentle* stream of room temperature water should be used. A separator is not necessary when the cast is poured.

2.30. Undercut (Blockout) Wax. Undercut wax has physical properties that allow it to be built up around an abutment tooth and then easily carved with surveying tools. Undercut wax is made by combining beeswax, resin, and kaolin. It is usually supplied in small, wide-mouthed jars. The formula for making this kind of wax is shown in Chapter 8, paragraph 8.42.1.4.1.

2.31. Disclosing Wax. Disclosing wax has a very low fusing range. It flows readily under pressure and is used to detect points of unequal pressure when seating many kinds of castings. Disclosing wax is melted on the tissue side of a casting and then held in place under pressure. It flows away from the pressure points and discloses them for corrections.

2.32. Beeswax. Refined beeswax is supplied in cakes or bars. It is used in molten form (280 to 300 ^{o}F) as a dip for sealing refractory casts. To prevent cracking, casts must be heated and dehydrated before they are dipped. Subsequent sealing of refractory casts provides a satisfactory surface for attaching wax and plastic patterns, and prevents absorption of moisture when invested for casting RPD frames.

Section 2D—Impression Materials

2.33. Introduction:

2.33.1. A variety of impressions are made in the dental clinic. Each variety requires a material of slightly different properties. In complete denture work, a material is needed that accurately registers all the denture-bearing areas. In partial denture work, there is an additional requirement. The material must be capable of registering both tooth and soft tissue undercuts. In many dental impression procedures, two materials and sometimes even three are used in sequence to take advantage of the most favorable qualities of each.

2.33.2. A useful table of impression materials is shown in Table 2.4.

Table 2.4. Types of Impression Materials.

ITEM	A Material	B Use	C Characteristics
1	Modeling Plastic	Preliminary complete denture impressions, final impressions, and final impression trays.	Rigid at room temperature, but begins to distort when it gets warm.
2	Low-Fusing Impression Wax	Specialized impressions.	Very easily distorted by warmth or pressure. Must be handled with care.
3	Zinc Oxide-Eugenol Paste	Final complete denture impressions and jaw relationship records and for stabilizing baseplates.	Holds dimensional stability well. Rigid.

ITEM	A Material	B Use	C Characteristics
4	Rubber Base (Polysulfide)	Final complete denture impressions and impressions for fixed prosthetic units.	Stains clothing badly and indelibly. Extremely accurate and durable. Can be poured twice if necessary. Elastic.
5	Hydrocolloid, Reversible	RPD and fixed prosthetic impressions. In a tougher form, it is used in the laboratory for cast duplication procedures.	Highly susceptible to drying. Should be poured within 10 minutes after the impression is made. Can be broken down and reused many times. Elastic.
6	Hydrocolloid, Alginate	Preliminary impressions for diagnostic cast and final RPD impressions. Can be used as a matrix to make temporary fixed prosthetic units.	Highly susceptible to drying. Should be poured within 10 minutes after the impression is made. Cannot be reused like the reversible type. Elastic.

2.34. Impression Compound:

2.34.1. Impression compound is a material that can be softened by heat into a soft plastic mass and then hardened by cooling it with either a stream of cold water or a blast of air. It is used in the clinic for preliminary impressions, to make custom impression trays, and to modify stock trays. Because it does not accurately spring around an undercut and return to its former shape, impression compound has very limited use in partial denture work.

2.34.2. Although impression compound is a basic material in the clinical phases of prosthetic dentistry, it is not often used in the laboratory. The laboratory technician uses it periodically to attach a cast to its mounting in an articulator.

2.34.3. Impression compound is marketed in several colors and designated by the manufacturer as high, medium, or low fusing. However, there is no uniformity among manufacturers as to exactly what constitutes high or low fusing. One brand of "high-fusing" impression compound may have about the same fusing range as another brand labeled "medium-fusing," and the two may be the same or different colors. In general, high-fusing impression compounds flow at approximately 135 to 140 ^{o}F while low-fusing types may flow at 115 ^{o}F. Several of the manufacturers make a "tray" compound which is high fusing (about 140 ^{o}F). It is almost always black in color and is the type of impression compound most suitable for a custom impression tray.

2.34.4. Impression compound is one of the few impression materials an amalgam die can be packed against. Any of the gypsum materials can be poured into a compound impression without the need of a separator. The material is supplied in the form of cakes and sticks.

2.35. Low-Fusing Impression Wax:

2.35.1. Low-fusing impression wax is specially formulated to flow under controlled pressure in the mouth. It is melted in a water bath and painted in an individual impression tray as a corrective liner for final impressions. It is also used for reline impressions for complete dentures and RPDs.

2.35.2. Low-fusing wax impressions must be handled with extreme care in the laboratory because the wax is so easily distorted. Fingers must never touch the tissue side of the impression, including the periphery. If an impression is rinsed, it should be done very carefully with room-temperature water. A separator is not necessary when a cast is poured.

2.36. Impression Paste:

2.36.1. Impression paste is usually supplied as two separate components, a base and a hardener. The base and hardener are mixed together in specific proportions to form a paste. Impression paste is rigid when it sets, and it does not spring over undercuts. Its principal ingredients are zinc oxide and eugenol or lauric acid. Impression paste is used primarily as a corrective material inside an individual impression tray.

2.36.2. One use of impression paste is to reline impressions for both complete and RPDs. Occasionally, it is used in immediate denture work as a lining for a sectional impression. It can also be used to provide a lining for a complete denture record base to make it fit the cast and the mouth more accurately. A separator is not required when the cast is poured into an impression made with this material.

2.37. Elastomeric Impression Materials. These materials are supplied as two-part systems; a base paste and an accelerator paste. Some manufacturers supply the accelerator as a liquid. When the two are mixed in the correct proportions, the resulting mixture polymerizes into a rubbery state. Elastomeric materials are not reversible and can be used only once. They are used primarily for fixed prosthodontic units (crowns or onlays), although they can also be used as corrective liners in complete denture impressions and RPD bases. Pastes and accelerators from different brands of elastomeric materials must never be cross-mixed. Materials must be carefully handled because the stains that some of them produce on contact with clothing and towels are impossible to remove. Four different types of elastomeric impression materials are available; polysulfides, silicones, polyvinylsiloxanes, and polyethers, as follows:

2.37.1. **Polysulfides.** The basic ingredient of a polysulfide impression material is polysulfide rubber with various fillers, pigments, and modifiers. The polysulfides are easily recognized because one of the two pastes is usually dark and the other paste is white in color. This material has a very characteristic odor. The polysulfides are more commonly known as *rubber base* or *polysulfide* rubber base impression material. The low viscosity of this material allows accurate registration of the soft and hard tissues. It is most often used in removable prosthodontics.

2.37.2. **Silicones (Condensation Reaction Silicones):**

2.37.2.1. Silicone impression material consists of silicone and ethyl silicate. This material exhibits significant setting shrinkage and should be used in thin consistent layers.

2.37.2.2. Silicone manufacturers were the first to offer a two-phase impression method. The dentist first makes an impression, either in the mouth or on the diagnostic cast, of the patient's arch, using a stock impression tray and a putty form of the silicone material. The resulting custom-fitted tray is used to carry a wash of the lower viscosity silicone material to the mouth for the final impression.

2.37.2.3. Silicone materials are generally lighter in color and translucent when set, and they have a much more subdued odor than the polysulfides. A disadvantage is that shrinkage occurs if the material is allowed to sit for more than 30 minutes before pouring the impression.

2.37.3. **Polyvinylsiloxanes (Addition Reaction Silicones).** Polyvinylsiloxanes are like the conventional silicones in their elastic nature, but they differ in chemical structure and reactions. Because of this, the polymerization shrinkage of polyvinylsiloxanes is well controlled, and a thin uniform thickness of the material is not so significant a requirement for accurate impressions. Polyvinylsiloxanes are also used with a two-stage impression technique. A disadvantage is the rigidity and cost of the material.

2.37.4. **Polyethers.** The base of this impression material is a polyether compound, and the accelerator is a sulfonic acid. Laboratory studies have shown that polyethers, along with polysiloxanes, are the most accurate of the elastomeric impression materials. However, when set, polyether impression material is very stiff, making it difficult to remove the impression tray from the mouth if large tooth undercuts are present. This is also a problem when trying to separate casts from the impression without breaking off stone teeth.

2.38. Special Characteristics of Elastomeric Impressions:

2.38.1. Polysulfide rubber base and condensation silicone impressions should be poured within 25 minutes of their removal from the mouth. These materials do not have long term dimensional stability. Second pours may be made from these impressions, but the resulting cast does not have the same accuracy as the cast from the first pour. Addition reaction silicone and polyether impressions show great dimensional stability. Pours of casts may be delayed up to 7 days with no significant loss of accuracy. Second pours maintain accuracy of detail and dimension comparable to first pours.

2.38.2. Polyethers are highly hydrophilic (they absorb water) and exposure to liquids must be minimized. They may not be used in die-plating procedures because water sorption leads to unwanted dimensional change. Addition reaction silicones are more difficult to pour or achieve a bubble-free cast due to their hydrophobic nature.

2.39. Impression Plaster and Soluble Impression Plaster:

2.39.1. Impression plaster is a plaster that has been specially compounded by the manufacturer for use in the mouth. It must set rapidly to reduce the time it is held in the mouth. Because plaster will not flex over an undercut as it is withdrawn from the mouth, it must be broken into pieces and reassembled outside the mouth. For this reason, it should be weak and brittle so it will fracture cleanly, and it must have a very low setting expansion to make an accurate impression.

2.39.2. Various accelerators and retarders are added to give the plaster the required properties. In addition, coloring and flavoring agents are often added. Because of the difficulty sometimes experienced in removing a plaster impression from the cast, some impression plasters are made water soluble by adding cornstarch. If a separator is used, the plaster can be dissolved off the cast with hot water. This decreases the possibility of breaking the cast when it is separated from the impression.

2.40. Hydrocolloids. In partial denture work, an impression material is needed that accurately registers both tooth and soft tissue undercuts. A hydrocolloid material elastically deforms and then returns to its original shape. The undercuts are thus accurately reproduced in the impression. There are two basic types of hydrocolloids, the *agar* type and the *alginate* type. They are chemically and physically different and require different handling, but the purposes for which they are used are very similar. They are often referred to as *reversible and irreversible,* respectively. The agar type can be softened by heat and stiffened by cooling. Because this behavior can be driven either way, it is reversible. The alginate type is a powder that, when mixed with water, hardens by gelling. Because it cannot be softened to be used again, it is irreversible.

2.40.1. **Hydrocolloid, Agar Type (Reversible).** There are two different reversible hydrocolloids. One is designed to be used in the mouth for impressions; the other is compounded for duplication use in the laboratory as follows:

2.40.1.1. **Impression Type.** Impression hydrocolloid is a gelatin-like material that is composed mainly of agar-agar and water. The material is heated in a double boiler or in a special heating syringe to soften it to a thick consistency. It is then tempered, carried to the mouth in a tray, and cooled with 70 °F water to make it set. When it has set, it is removed, and the cast is poured. Impression-type agar can be used for duplicating in the laboratory if laboratory duplicating agar is not available. Its principle use, however, is for making RPD impressions and fixed prosthodontic final impressions. A main disadvantage of this material is that an impression can only be poured one time due to the dimensional change caused by the evaporation of water.

2.40.1.2. **Laboratory Type.** Laboratory duplicating hydrocolloid is specially manufactured for laboratory use. It is stronger and, therefore, more satisfactory for duplicating than the impression type. It can be used repeatedly if it is properly handled and stored. In order to maintain a precise water balance, heat the material in a stainless steel double boiler. The double boiler has a dome-shaped lid that condenses the water and returns it to the mixture. The water balance of the hydrocolloid is critical and is maintained by the double boiler. Store any unmixed hydrocolloid in a sealed container.

2.40.2. **Hydrocolloid, Alginate Type (Irreversible):**

2.40.2.1. **General Description.** The alginate-type hydrocolloid is supplied in the form of a fine powder. The powder is mixed with a prescribed amount of water to form a mixture that, like the agar-type hydrocolloid, is capable of accurately reproducing an undercut of either a tooth or soft tissue. In general, the ingredients used to make an alginate impression material are sodium or potassium alginate, plaster, magnesium oxide, trisodium phosphate, sodium phosphate, and ditomaceous earth as a filler.

2.40.2.2. **General Uses.** Alginate is used as an impression material for partial dentures. It can be used alone or in conjunction with another material for immediate denture impression and is sometimes used for cast duplication in the laboratory. When used for duplicating, alginate is usually mixed with more than the usual amount of water (2 or 3 times more, depending on how fluid a mix is needed).

2.40.2.3. **Handling Requirements:**

2.40.2.3.1. Making an accurate cast from a hydrocolloid impression requires following certain rules. The water balance in a gelled hydrocolloid material is critical to its accuracy. When gelled hydrocolloid is exposed to water or air, it changes its dimensions quickly. This is why hydrocolloid impressions must be poured as soon as possible after they are made. (As soon as possible means *within 10 minutes after the material is set.)*

2.40.2.3.2. Reversible and irreversible hydrocolloids tend to exude a fluid that causes gypsum surfaces to be soft and chalky. Not all gypsum products are affected in the same manner. Some brands of reversible hydrocolloid material require immersing the impression in a 2 percent solution of potassium sulfate before the cast is poured. This procedure is called *fixing.* It improves the surface qualities of the cast. Of course, manufacturer's directions must be followed.

Section 2E—Denture Base Materials

2.41. Introduction:

2.41.1. A great variety of materials have been used over the years to make denture bases. Today, a plastic material is by far the most universally used. The chemical name is methyl methacrylate; the common name is acrylic resin.

2.41.2. Since it was first introduced in 1937, a considerable amount of refinement and improvement has been made in acrylic resin and in the methods of handling and processing it.

2.41.3. Manufacturers supply acrylic resin as both a powder (polymer) and a liquid (monomer) or in the form of a premixed gel. The powder and liquid form is the one most commonly used. When the material is supplied in this form, the technician adds a measured amount of powder to a specific volume of liquid to form a dough. The dough is then packed into the denture mold, and heat is used to cure (harden) the denture. Dry heat can be used, but curing in hot water is the most commonly used method. Known as *polymerization,* the cure or hardening of the acrylic resin in the mold takes place by a chemical reaction between the powder and the liquid.

2.41.4. The types of denture base materials are shown in Table 2.5.

Table 2.5. Types of Denture Base Materials.

I	A	B	C
ITEM	**Material**	**Use**	**Comment**
1	Heat-Cured Denture Resins (powder + liquid)	Complete and RPD bases.	Improper packing and/or processing result in contamination, breakage, porosity, etc. Heat is required for polymerization.
2	Heat-Cured Denture Resins (gel)	Complete and RPD bases.	Basic composition is the same as the powder and liquid varieties. Must be refrigerated to inhibit polymerization.
3	Autopolymerizing Acrylic Resins	Repairs, relines, impression trays, and baseplates.	Heat is not required to induce polymerization. Can be applied by the "sprinkle" method or used in dough form.
4	Resins for Tinting	Tinting standard pink denture base material.	Pigments may be mixed with polymer powder or packed separately.
5	Tooth-Colored Resins	Custom denture teeth, temporary fixed prostheses repairs, etc.	Fine polymer powders that come in a variety of natural tooth shades. Available in self-curing or heat-curing forms.
6	Soft-Lining Resins	Tissue-conditioning denture liners.	Polymerize to a semisoft state.
7	Vinyl Resins and Polystyrenes	Complete and RPD bases.	Special processing equipment is necessary.

2.42. Heat-Cured (Heat-Activated) Denture Resins. Heat-cured denture resins are processed in the dental laboratory, using heat and pressure to obtain a product that meets the requirements of the particular appliance being constructed. Heat-cured denture resins are bought in packages containing powder (polymer) and liquid (monomer). The monomer has an inhibitor to prevent polymerization until activated by heat. Monomer is highly flammable. It is a skin and eye irritant and is known to cause allergic reactions.

2.43. Acrylic Resin Gel. This is a premixed form of acrylic resin. The manufacturer mixes the powder and liquid at the factory and adds a substance (inhibitor) that prevents polymerization until the resin is placed in the mold and heated. The gel is more homogeneous because it is machine mixed in large quantities. It is somewhat handier and quicker to use, but its shelf life is limited so it must be refrigerated when stored.

2.44. Autopolymerizing (Chemically Activated) Resins:

2.44.1. **Composition.** Another member of the acrylic resin group used in the dental laboratory is the autocuring or self-curing resin. The basic composition of these autopolymerizing resins is the same as that of heat-cured denture acrylic. The difference is that, instead of using heat to bring about polymerization, a chemical agent (activator) is added to the liquid so the dough polymerizes in about 10 to 20 minutes at room temperature.

2.44.2. **Uses.** The self-curing acrylic resins are used for most denture repairs. In repair procedures, these resins have a decided advantage over heat-cured resins because the denture does not have to be subjected to a high-curing temperature which often causes the denture base to warp. These resins are also used for impression trays, record bases, and denture base construction. The self-curing resins can be mixed and used as a dough, or they can be applied by the sprinkle method. The liquid provided with the self-curing resins should always be well shaken before it is used because the activators are lighter than the liquid and tend to rise to the top of the bottle.

2.45. Acrylic Resins Used for Tinting. Methyl-methacrylate resins are used to modify the color of basic pink, denture base plastics. The pigments are used to more closely simulate the colors of natural gum tissue in the finished denture base. Some are applied to the desired areas of the denture mold before the resin material is packed; some are shaped into preformed patterns that are placed in the mold prior to packing.

2.46. Hard-Lining Resin. This is a slightly different type of acrylic resin which is marketed and intended for one step (clinical) denture relines. The material has been compounded specifically for clinical purposes. It does not lend itself well to laboratory use. It can be used for impression trays if a more suitable material is not available in the laboratory.

2.47. Tooth-Colored Acrylic Resin. Tooth-colored methyl-methacrylate resins are very similar to denture resin except for the color and finer particle size. Tooth-colored pigments are added to the polymer to simulate natural tooth shades. Tooth-colored acrylic resins are available in heat-curing and autopolymerizing forms. They can be used to make denture teeth, veneer crowns, and temporary restorations. These resins are extensively used to perform repairs.

2.48. Soft-Lining Resins. Some clinical conditions require a soft, cushion-like liner in the tissue side of denture bases. These soft materials are usually known as *resilient liners.* It is important for these lining materials to bond well to the denture base, resist tearing, and retain their cushion effect. There are three basic kinds of lining resins; velum acrylic, silicone, and ethyl methacrylate.

2.48.1. **Velum Acrylic Resin.** Velum resin is a form of acrylic resin that never polymerizes rigidly in the manner of ordinary resin. It is supplied as a powder and liquid. The liquid is much more viscous than regular acrylic liquid. It contains a retarder which prevents the resin from hardening. The principal use of velum resin is in cleft palate prostheses. It is occasionally used for denture reliner when a soft material is needed. Unfortunately, the ingredient that keeps the resin soft is eventually lost. Loss of this ingredient causes the liner to gradually harden. Once it hardens, it must be replaced.

2.48.2. **Silicone Resin Liners.** These soft liner materials, composed primarily of silicone gum and a liquid or paste hardener, are available as heat-cured or autopolymerizing types. These silicone liners are the most truly elastic of the soft-lining materials. However, these liners have a major disadvantage. They have poor abrasion resistance and are difficult to trim properly. Also, like velum resins, silicone liners do not remain soft indefinitely, although they harden more slowly than other lining materials.

2.48.3. **Ethyl Methacrylate (Sof Pac®, Dura Soft®).** Ethyl methacrylate is a two-component, heat-processed resilient material designed for use in the construction of long-term denture relines and maxillofacial prostheses. Ethyl methacrylate bonds to methyl methacrylate, increasing its durability in the mouth. Ethyl methacrylate is processed using standard techniques. The liner can either be used against fresh acrylic in the initial processing of a new denture, or it can be cured against an existing denture base. Ethyl methacrylate offers easy polishing and finishing. It can easily be trimmed with a carbide bur or arbor band. It is then polished to a luster using a cloth wheel, pumice, and polishing compound.

2.49. Tissue Conditioners. Until the patient's oral tissues return to a healthy state, the dentist uses tissue conditions as a temporary soft liner for dentures that require relining. Tissue conditioners must be changed at 3 to 4 day intervals. Some clinical techniques use tissue conditioning resins in a denture base as the master impression *for relining or rebasing an old denture* or *fabricating a new one.* Because these materials are very delicate and do not adhere well to the denture base, tissue conditioner impressions must be handled with great care in the laboratory.

2.50. Vinyl Resins and Polystyrenes. Vinyl and polystyrene are plastics which are chemically similar to acrylic resin but differ somewhat in their physical properties. They are formed into a denture using a method of molding known as *injection molding*. Advocates of these materials say they have superior dimensional stability over acrylic resin dentures.

2.51. Handling Acrylic Resin. Acrylic resin, with all its good qualities of excellent appearance, ample strength, lightweight, and ease of cleaning, is far from foolproof in its manipulation. Even when properly handled throughout the processing procedure, acrylic resin is subject to dimensional changes. These changes appear as minor faults in the occlusion and loss of contact of the processed resin with the master cast. The changes are more noticeable across the posterior palatal seal area of a maxillary denture. However, changes can be kept to a minimum when the technician understands the behavior and working characteristics of the material, and takes precautionary steps to avoid certain pitfalls. The errors that are most apt to occur in processing acrylic resin dentures are distortion, contamination, warpage, breakage, and porosity, as follows:

2.51.1. **Wax Distortion.** An error can be introduced during the wax-up that may alter the occlusion on the finished dentures. To minimize the effects of baseplate wax distortion, wax up one denture at a time. After the wax-up of this single unit is completed, it should be returned to the articulator and the occlusion examined. Correct any discrepancy in the occlusion before removing the other cast from the articulator for wax-up. After completing the wax-up of both upper and lower dentures, examine the occlusion and correct any changes in it before beginning flasking procedures.

2.51.2. **Acrylic Resin Contamination.** Acrylic resin is especially susceptible to contamination while it is being mixed and packed in the mold. Meticulous cleanliness must be practiced, and clean measuring containers are essential. Using a clean, stainless steel spatula, the mixing should be done in a clean jar. Hands should be gloved and kept very clean. Acrylic resin liquid is an excellent solvent capable of dissolving grease and dirt from hands. A standard precaution is to handle the resin dough with plastic gloves or sheets rather than with bare hands. The mold must be absolutely clean and dry before the resin is packed.

2.51.3. **Acrylic Resin Warpage.** During the curing phase, several dimensional changes occur in the acrylic resin. The net effect is shrinkage. A characteristic of acrylic resin is that it shrinks toward its greatest bulk. In a denture, this bulk is in the area over the alveolar ridge. From waxup to finishing, this distortion can be kept within acceptable limits if each step in the processing procedure is carefully performed as follows:

2.51.3.1. Take great care to ensure the mold has cooled to room temperature before starting to deflask a denture. Rapid cooling may create uneven internal stresses. The ideal way to cool the flask is to allow the water in the curing bath to cool down to room temperature before removing the flask from the carrier press. If faster cooling of the flask is necessary, bench-cool the flask for 1 hour and then cool it for 15 minutes in cold water.

2.51.3.2. Warpage may also result from excessive heat generated during polishing operations. Avoid excessive pressure against brushes and ragwheels because heavy pressure during polishing generates heat.

2.51.3.3. Warpage occurs from allowing the denture to dry out after it is processed. Completed acrylic resin prostheses of any kind must be stored in a container of water. If it must be mailed to another location, the denture should be sent in a sealed plastic envelope containing a small amount of water.

2.51.4. **Resin Breakage.** Most breakage of acrylic resin occurs during recovery of the denture from the mold. The breakage is often the result of careless deflasking. Deflasking cannot be hurried; take the time to do it right.

2.51.5. **Acrylic Resin Porosity.** Porosity may be due to one of the following handling errors:

2.51.5.1. **An Improper Liquid-to-Powder Ratio:**

2.51.5.1.1. The ratio of powder to liquid is important when mixing acrylic resin. A high percentage of powder in a mix speeds up the set and tends to reduce shrinkage during the cure. However, sufficient liquid must be used to wet the powder thoroughly if the chemical reaction between the two is to be completed.

2.51.5.1.2. The usual ratio is three parts of powder to one part of liquid by volume. Ten cm^3 of liquid to 30 cm^3 of powder is considered an adequate amount of material for the average denture. Measure the liquid and pour it into a clean jar. Then measure and sift enough powder to absorb all the liquid. Tap the jar on the bench top to bring any excess liquid to the surface, and then add the remaining powder. Thoroughly mix the powder and liquid with a stainless instrument. Unless the mixture is well stirred, the color tends to float to the surface of some brands of acrylic resin.

2.51.5.2. **Packing the Dough Before it is Ready:**

2.51.5.2.1. After mixing the acrylic resin, place a lid on the mixing jar and allow the resin to set for several minutes. Then remove the lid and test the mix by placing the blade of the spatula between the mix and the side of the mixing jar. When the mix no longer sticks to the side of the mixing jar, most heat-curing resins are ready to pack. First, the mixture appears sandy, then stringy, and finally doughy. When the doughy stage is reached, it is ready for the mold.

2.51.5.2.2. A further test involves making a roll of some of the material and pulling it apart. When it snaps apart cleanly, it has reached packing consistency. The test for proper packing consistency does not apply to all denture resins. Be sure to read the manufacturer's directions to ensure proper procedures are followed.

2.51.5.3. **Underpacking the Mold:**

2.51.5.3.1. The acrylic resin dough must be packed into room temperature molds. Too warm a mold may cause the dough to become too stiff too fast. When trial packing, overfill the mold slightly and apply the pressure from the flask press very slowly until the two halves of the flask are as near as possible to metal-to-metal contact. Then release the pressure, open the flask, and remove the resin flash from the land area.

2.51.5.3.2. This procedure must be repeated at least three times to ensure the mold is full and the halves of the flask meet in metal-to-metal contact. To prevent opening of the occlusal vertical dimension, additional material must never be placed in the mold before final closure.

2.51.5.4. **Curing the Acrylic Resin Too Quickly.** The resin dough starts to polymerize at around 160 ^{o}F. As this chemical reaction takes place, heat is given off. The internal temperature of the flask tends to rise above the external heat being used to make the resin polymerize. The faster the resin dough reaches curing temperature, the more rapid the polymerization reaction and the higher the internal temperature of the flask. Depending on how fast polymerization progresses, a flask's internal temperature can reach 300 ^{o}F.

2.51.5.4.1. The boiling point of the monomer component of the resin dough is about 212 ^{o}F. If the dough reaches curing temperature too quickly, the internal flask temperature exceeds 212 ^{o}F and causes the monomer to boil. A porous resin results. The thick sections of a denture base are especially susceptible to this problem.

2.51.5.4.2. A packed flask must be brought to a curing temperature at a rate that does not induce rapid polymerization. A temperature rise of 2 ^{o}F per minute is recommended. Make sure the curing bath contains enough water to dissipate the excess heat that might be generated by the polymerization reaction. The flask press should never contact the bottom of the container; it should rest on a rack.

Section 2F—Metals in Dentistry

2.52. Introduction:

2.52.1. Metals are alike in certain aspects. There is no all-inclusive definition for a metal that is entirely satisfactory. However, metals do have certain properties that distinguish them from nonmetals. They possess a metallic luster; are good conductors of heat and electricity; and, with the exception of mercury (and one other rare metal), are solids at ordinary temperatures.

2.52.2. As compared to nonmetals, some metals are malleable (can be pounded or rolled into sheets), others are ductile (can be drawn into wire), and most of them have a fairly high specific gravity (are dense and heavy as a result).

2.52.3. Metals are also different in certain other aspects. For example, each metal possesses physical properties peculiar to it alone, which distinguishes it from all other metals. It has a fixed melting point, a definite specific gravity, and a certain degree of hardness, malleability, ductility, etc. By knowing these physical properties, you can predict with a fair degree of accuracy the way a metal will behave under different conditions. In the same way, you can also predict a metal's degree of usefulness as a dental restoration or structural part of a prosthesis.

2.53. Structure of Metals:

2.53.1. **General Properties:**

2.53.1.1. Metals are crystalline in structure, and many of their physical properties depend to a large extend on the size and arrangement of the crystals. The word *grain* is a very popular name for a metallic crystal. As molten metal cools and solidifies, clusters of molecules come together from the liquid to form solid crystal nuclei. These crystallites grow into grains. The faster molten metal cools to the solid state, the smaller will be the grain size and vice versa.

2.53.1.2. Generally speaking, small grains arranged in an orderly fashion give the most desirable properties. The size and arrangement of grains can be changed markedly by the way the metal is handled in the laboratory. The amount of heat a metal is subjected to, the method by which it is heated, the rate by which it is cooled, and the way it is worked (for example, bending or swaging) all have a pronounced effect on its physical properties.

2.53.2. **Cast Metal.** A *cast metal* is a piece of metal formed by pouring or forcing molten metal into a mold and allowing it to cool and harden. As previously stated, the size of the grains in a casting depends on the rate of cooling during solidification. The shape and arrangement of the grains are also established at the same time.

2.53.3. **Wrought Metal.** When rolling, pounding, bending, or twisting changes the shape of a casting, it becomes a wrought metal. Producing changes in the shape of a metal at normal room temperature is called *cold-working.* Working a metal changes its grain structure and has a marked (and sometimes detrimental) influence on the physical properties of the material. You must have a thorough understanding of the changes taking place in the worked metal to control and, if necessary, correct the changes (paragraph 2.56.2).

2.53.4. **Metal Alloys:**

2.53.4.1. **Nature of Alloys.** Some of the properties of a given metal might be ideal for a specific use while other properties of the same metal might be less desirable or even detrimental. By combining several metals in the correct proportions, it is possible to produce a compound in which the desirable properties of each metal are retained, while the less desirable ones are nullified or entirely eliminated. This is known as *alloying,* and the combination of metals thus formed is a metal *alloy.* The physical properties of an alloy cannot be accurately predicted solely by knowing the properties of the constituent metals. For example, two metals of extreme hardness, when combined, might yield an alloy of only moderate hardness, rather than one as hard as (or harder than) the individual component metals.

2.53.4.2. **Knowledge Requirement.** With few exceptions, metals used in dentistry are alloys. You should have an understanding of the structure and physical properties of dental alloys. This will enable you to accomplish the following:

2.53.4.2.1. Determine the combination of physical properties required in an alloy to be used for a prosthesis.

2.53.4.2.2. Understand the proper manipulation and heat-handling procedures to be followed with the selected alloy in order to retain and make the most of its desirable properties.

2.54. Physical Properties of Metals. The physical properties of metals are described in definite, precise terms. A familiarity with the meaning of these terms is basic to an understanding of the characteristic traits or the way a metal behaves under different conditions. Moreover, the suitability of a particular metal for a specific purpose can be determined only by someone who fully understands the terms used to describe its qualities. These qualities are explained in paragraphs 2.54.1 through 2.54.12.

2.54.1. **Hardness:**

2.54.1.1. This is a measure of the resistance of a metal to an indentation or scratch. It is an indication of the strength and wearability of the metal. Due to the varied functions the different types of dental prostheses must perform, *hardness* is a highly significant property of dental alloys.

2.54.1.2. For example, different types of restorations call for varying degrees of hardness. An onlay casting, which is to be subjected to heavy occlusal wear, should be harder than a casting made for the facial surface of a tooth. On the other hand, a metal might be too hard. The amount an inlay or crown can be burnished (adapted) to a tooth is directly dependent on the hardness of the metal. Harder metals are more difficult to burnish.

2.54.1.3. Several methods are used for measuring the hardness of metals. When an alloy has been tested for hardness, it is given an index number. Depending on the method used to test the alloy, it is then said to have a certain *Brinell, Vickers,* or *Rockwell* hardness (or another index). Regardless of the scale used, the higher the index number, the harder the metal. Figure 2.1 lists the comparative hardness of some common metals.

Figure 2.1. Comparative Hardness of Selected Metals.

Very Hard	Medium Hard	Soft
Chromium Manganese	Cobalt Nickel Copper Iron Platinum Silver Magnesium	Gold Aluminum Cadmium Tin Lead

2.54.1.4. Brinell hardness is determined by pressing a steel ball into a dental gold alloy under a measured load. The amount of surface indentation is computed according to the load.

2.54.1.5. The Vickers test uses a diamond in the shape of a square-based pyramid. The test is more suitable for determining the hardness of a wider variety of materials. Recently, the Vickers test replaced the Brinell test for testing dental gold alloys.

2.54.1.6. The Rockwell hardness is a standard measure of the hardness of an alloy. It is similar to the other tests, but with a different range of numbers. It is often used to measure the hardness of chrome alloys.

2.54.2. **Ductility.** Ductility is the property of a metal that permits it to be drawn into a thin wire without breaking. A study of the tables of hardness and ductility indicates that ductility decreases as hardness increases. Figure 2.2 lists the relative ductility of several metals.

2.54.3. **Malleability.** Malleability is an indication of the amount of extension the metal can sustain in all directions without breaking. The pressure might be applied by hammering, rolling, or burnishing. *Malleability* makes it possible to burnish the margin of a gold restoration to the tooth's surface and minimize the chance of leakage between the two. Gold is the most malleable of all metals. One grain of gold can be rolled and beaten into a leaf that is 6 square feet. A more brittle metal is less malleable. Figure 2.3 compares the malleability of several metals.

Figure 2.2. Comparative Ductility of Selected Metals.

High Ductility	Medium Ductility	Low Ductility
Gold Silver Platinum Copper Aluminum Nickel Cobalt	Palladium Cadmium Zinc Tin Lead	Manganese Beryllium Antimony Chronium

Figure 2.3. Comparative Malleability of Selected Metals.

High Malleability	Medium Malleability	Low Malleability
Gold Silver Copper Tin Platinum Lead	Zinc Iron Nickel Cobalt Molybdenum	Chromium Manganese Antimony Bismuth

2.54.4. **Specific Gravity and Density:**

2.54.4.1. Specific gravity is the weight of a unit of metal compared with an equal volume of water at the same temperature. Specific gravity is sometimes a factor in planning the design of a cast partial denture. The design selected for a dental prosthesis in which one of the heavier alloys is to be used might differ from one employing an alloy of a lighter weight.

2.54.4.2. The specific gravity of water is *one,* which is the standard of comparison. Thus, a metal that has a specific gravity of *two* is exactly twice the weight of an equal volume of water. Table 2.6 lists the specific gravity of some of the metals.

2.54.5. **Elasticity, Flexibility, and Resiliency.** Complete and technically accurate definitions of the terms elasticity, flexibility, and resiliency are quite complex. For laboratory purposes, they refer to the characteristic of an alloy that enables it to bend under pressure and then return to its former shape when the pressure is removed. This is an important property in a RPD clasp because the clasp must spring on and off an abutment tooth without exerting harmful pressure on the supporting structures of a tooth.

2.54.6. **Elastic Limit, Proportional Limit, and Yield Strength.** These three terms have subtly different definitions. However, for practical purposes, the terms will be used interchangeably in this pamphlet. A gross definition for all three would be the maximum amount of stress that can be applied to a metal without permanently deforming the metal.

Table 2.6. Relative Specific Gravity of Metals.

ITEM	A	B
	Metal	**Specific Gravity**
1	Calcium	1.54
2	Magnesium	1.70
3	Beryllium	1.84
4	Aluminum	2.70
5	Antimony	6.68
6	Chromium	6.92
7	Zinc	7.19
8	Tin	7.30
9	Manganese	7.42
10	Iron	7.85
11	Nickel	8.60
12	Cobalt	8.70
13	Copper	8.90
14	Bismuth	9.78
15	Molybdenum 10.20	
16	Silver 10.50	
17	Lead 11.34	
18	Palladium 11.90	
19	Mercury 13.59	
20	Gold 19.32	
21	Platinum 21.37	
22	Osmium 22.48	

2.54.7. **Percentage Elongation.** Elongation is a measure of the amount an alloy can be deformed without breaking. The percentage of elongation of an alloy has much to do with its suitability for making appliances that must be bent or burnished into shape. The elongation should be as high as possible, consistent with strength requirements.

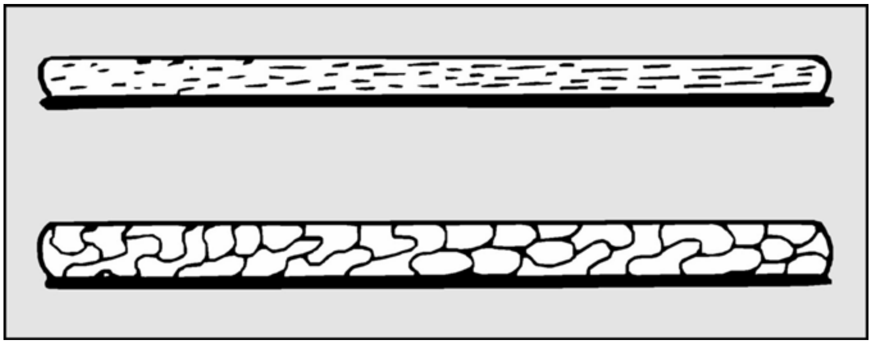
2.54.8. **Grain Size:**

2.54.8.1. When metal is heated and allowed to cool, the rate of cooling affects the grain size. Slow cooling results in a comparatively large grain size. Fast cooling produces a finer grain structure. A metal with a fine grain structure is stronger than a coarse-grained one.

2.54.8.2. The metal rod at the top of Figure 2.4 was cast and solidified rapidly, which resulted in a fine grain structure. The rod in the lower part of the figure cooled slowly, which resulted in a larger grain size.

2.54.9. **Grain Growth.** Prolonged heating below a metal's melting temperature may cause grain growth; that is, small grains merging to form larger ones. This grain growth causes the metal to be brittle. Malleability and ductility can sometimes be restored in a metal that has become brittle by heat-treating it. It is far better, however, to handle the metal in such a way that it never *becomes* brittle.

Figure 2.4. Differences in Grain Size.



2.54.10. **Color of Heated Metals:**

2.54.10.1. When gold alloys are heated, definite color changes occur. The temperature of the metal can be estimated by the color it radiates as listed in Howe's Color Scale (Table 2.7). As metal is heated, colors are observed in the following sequence: dull red, brighter red, orange, and finally, white as the temperature progressively increases.

Table 2.7. Howe's Color Scale.

I T E M	A Color	B Approximate Temperature Range
1	Dull red	1020 - 1150 °F
2	Cherry red	1300 °F
3	Light red	1560 °F
4	Orange 1650	°F
5	Yellow	1740 - 1920 °F
6	White 2100	°F or above

2.54.10.2. Temperatures associated with the colors are only approximations because color determinations differ from person to person. Another variable in appraising the color of a heated metal is the light under which it is examined. The metal may appear black in bright sunlight, but may look red when viewed in a shadow. When the color of a heated metal is evaluated, it should be viewed in as near normal light as possible.

2.54.11. **Melting Range:**

2.54.11.1. Pure metals melt suddenly at definite places or *points* on a temperature scale (Table 2.8). Dental alloys do not melt abruptly at precise temperatures because they contain a number of metals with different melting points. When a high enough temperature is reached, an alloy first softens and becomes mush. As the heat is increased, the alloy gradually becomes more fluid until it finally behaves much like a thick liquid.

Table 2.8. Melting Points of Pure Metals.

ITEM	A Metal	B Melting Point
1	Aluminum 1218	^{o}F
2	Beryllium 2332	^{o}F
3	Bismuth	520 ^{o}F
4	Cadmium	610 ^{o}F
5	Chromium 3434	^{o}F
6	Cobalt 2723	^{o}F
7	Copper 1981	^{o}F
8	Gold 1945	^{o}F
9	Iron 2795	^{o}F
10	Lead	621 ^{o}F
11	Manganese 2246	^{o}F
12	Molybdenum 4748	^{o}F
13	Nickel 2651	^{o}F
14	Palladium 2820	^{o}F
15	Platinum 3190	^{o}F
16	Silver 1761	^{o}F
17	Tin	450 ^{o}F
18	Tungsten 6098	^{o}F
19	Zinc	787 ^{o}F

2.54.11.2. This gradual softening takes place over a spread of temperature known as the *melting range.* The lower limit of this range, known as the *solidus,* is the temperature at which the metal first begins to soften. The higher limit, called the *liquidus,* is the temperature at which the metal is completely molten. The spread of the melting range for most dental gold casting alloys varies from 75 to 150 ^{o}F.

2.54.12. **Fusion Temperature.** The manufacturer does not provide the melting range of a casting alloy. Very often the *fusion temperature* is provided instead. The fusion temperature is slightly above the lower limit of the melting range. It should never be exceeded when a metal is being soldered. The fusion temperature is provided to aid in selecting solder that has a melting range safely below the fusion temperature of the parent metal. This minimizes the possibility of overheating the parent metal during a soldering operation.

2.55. Deformation of Metal:

2.55.1. When an external force (load) is applied to a metal, it is opposed and resisted by the internal force of the material's otherwise regularly spaced atoms (stress). If the load is great enough, a change results in the distance between the atoms in the areas where the load is applied (strain) and a degree of distortion (deformation) occurs which is directly related to the amount of the load and the direction in which it is applied.

2.55.2. A distortion that disappears when the load is removed is called an *elastic deformation.* When the stresses are removed, the atoms return to their original position. A distortion that does not disappear when the load is removed is called a *permanent deformation.* (The metal is said to have exceeded its elastic limit or proportional limit or yield strength.) The stresses are not relieved and the affected groups of atoms slip along a plane to new positions within the boundaries of their particular grains.

2.55.3. If a piece of metal is flattened by pounding or rolling, the individual grains are also flattened. As a pulling force is exerted on the metal, like drawing it through a die plate to form a wire, each grain is elongated to assume a fiber-like appearance.

2.56. Strain-Hardening of Metal:

2.56.1. **Strain-Hardening or Cold-Working.** When a metal is permanently deformed repeatedly, the metal becomes stiffer and harder. This process is called *strain-hardening* or *cold-working.* Continued application of a deforming load results in more and more atoms or grains slipping within the metal until the metal fractures. This is what happens when a paper clip is bent back and forth. Up to a point, it becomes stiffer and harder. Then it breaks.

2.56.2. **Annealing or Heat Treatment:**

2.56.2.1. Annealing is the process of heat-treating a metal to remove the stresses introduced by cold working and to prevent the metal's fracture. For example, there is a considerable amount of cold-working to bend or contour a wire to form a clasp to fit on the surface of a tooth.

2.56.2.2. The strain hardness built up in the metal can be removed and the original properties restored by heating it to the proper temperature (for example, cherry red) and then cooling it rapidly by quenching in cold water. The cold-working can then proceed because the regular arrangement of the slipped atoms has been restored and the stresses and strains have been relieved. The grains retain the changed shape caused by the cold-working. Thus, ductility and malleability increase, but all other physical properties decrease. The metal is in its softest state so a crown or inlay is most burnishable and a partial denture clasp is most adjustable.

2.57. Effect of Constituent Metals. The exact role of a metal varies with the particular alloy system the metal is added to. For example, copper is included in many of the high palladium alloys to help form an oxide layer for porcelain bonding. However, copper is added to the medium silver-palladium alloys to effectively lower their melting range and permit the use of gypsum-bonded investments. The following elements are frequently used in the traditional gold-base alloys: (***NOTE:*** Their descriptions are generalized.)

2.57.1. **Aluminum (Al).** Aluminum is added to lower the melting range of the alloy. It is also a hardening agent and influences oxide formation.

2.57.2. **Beryllium (Be).** Like aluminum, beryllium lowers the melting range, improves castability, serves as a hardener, and influences oxide formation. Reportedly, it improves polishability by acting as a lubricant for polishing agents, thus permitting them to work more effectively. Electrolytic "etching" of nickel-chromium-beryllium alloys removes a nickel-beryllium phase to create microretention for the etched-metal resin-bonded retainers (Maryland Bridges).

2.57.3. **Boron (B).** Boron is a deoxidizer, hardening agent, and element that reduces the surface tension of an alloy and thereby improves castability. In the nickel chromium alloys, boron acts to reduce ductility and to increase hardness.

2.57.4. **Chromium (Cr).** Chromium acts as a solid solution hardening agent and ensures corrosion resistance by its passivating nature.

2.57.5. **Cobalt (Co).** Cobalt-base alloys are an alternate to the nickel-base types, but are more difficult to cast.

2.57.6. **Copper (Cu).** Copper serves as a hardening and strengthening agent, lowers the melting range, and interacts with platinum, palladium, and silver (if present) to provide a heat-treating capability. It helps form oxides for porcelain bonding, lowers the density slightly, and can also enhance passivity.

2.57.7. **Gold (Au).** Gold provides a high level of resistance to corrosion and tarnish (no associated passivity) and slightly increases the melting range as well as workability and burnishability. Gold imparts an esthetically pleasing color to the alloy while markedly increasing density.

2.57.8. **Indium (In).** Indium serves as a less volatile scavenging agent, tends to lower the melting range (gold-base alloys), helps form an oxide layer for ceramic alloys, and lowers the density. Reportedly, an indium content of 20 percent can adversely affect the corrosion resistance of silver-base alloys.

2.57.9. **Iridium (Ir) and Ruthenium (Ru).** These two elements serve as grain refiners to improve the mechanical properties and tarnish resistance.

2.57.10. **Iron (Fe).** Iron is usually added to gold-base ceramic alloys to harden the alloy and aid in the production of oxides for porcelain bonding.

2.57.11. **Manganese (Mn).** Like silicon, manganese acts as an oxide scavenger to prevent the oxidation of other elements when the alloy is melted. It is also a hardening agent.

2.57.12. **Molybdenum (Mo).** Molybdenum is added to adjust the coefficient of thermal expansion and improve corrosion resistance. It also influences the oxides produced for porcelain bonding.

2.57.13. **Nickel (Ni).** Nickel has been selected as the base for alloys because its coefficient of thermal expansion is close to that of gold and because it possesses a resistance to corrosion. It is easier to cast than the cobalt-base alloys.

2.57.14. **Palladium (Pd).** Palladium is added to increase the strength, hardness (with copper), corrosion, and tarnish resistance of an alloy. It increases the melting range and improves the sag-resistance of a ceramic alloy. Palladium has a strong whitening effect, which renders metals as white alloys. It has a high affinity for hydrogen, and it lowers the density of the alloy slightly.

2.57.15. **Platinum (Pt).** Platinum increases the strength, melting range, and hardness while it improves the corrosion, tarnish, and sag-resistance of an alloy. It whitens the alloy and increases its density.

2.57.16. **Silicon (Si).** Silicon serves as an oxide scavenger to prevent the oxidation of other elements during the melt. It is also a hardening agent.

2.57.17. **Silver (Ag).** Silver imparts a moderate increase in the strength and hardness of an alloy (with copper), tends to tarnish in the presence of sulfur, possesses a rather high affinity for oxygen absorption, and lowers the density of the alloy. In ceramic alloys, silver lowers the melting range by counteracting the influence of palladium. Ceramic alloys with a high silver content may produce discoloration (green or brown) in many porcelains.

2.57.18. **Tin (Sn).** Tin serves as a hardening agent, tends to decrease the melting range of the alloy, and helps produce an oxide layer in ceramic systems.

2.57.19. **Titanium (Ti).** Titanium is added to lower the melting range and improve castability. It also acts as a hardener and influences oxide formation.

2.57.20. **Zinc (Zn).** Zinc helps lower the melting range and acts as a deoxidizer or scavenger to combine with any oxides present. It improves the castability of an alloy and, when combined with palladium, contributes to its hardness. Zinc is commonly included in gold alloy solders.

2.58. Classification System:

2.58.1. The ADA classifies alloys according to the percentage of *noble* metals present. Noble metals include gold and the six members of the platinum-palladium group; ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os), iridium (Ir), and platinum (Pt). The ADA classification system is identified in Table 2.9.

Table 2.9. ADA Classification System.

I	A	B
ITEM	**Classification**	**Au and Pt Group**
1	High Noble	Greater than or equal to 90 percent
2	Medium Noble	Less than 90 percent; greater than or equal to 70 percent
3	Low Noble	Less than 70 percent
4	Base Metal	0 percent

2.58.2. Table 2.10 contains specifications of dental alloys.

Table 2.10. Essential Specifications of Dental Alloys.

I	A	B	C	D	E	F
ITEM	**Alloy**	**Purpose**	**ADA Specification**	**Brinell Number**	**Melting Range**	**Heat Treatment**
1	Soft Inlays	subject to little stress	A minium of 83 percent of the gold-platinum group of metals	40 to 75	1740 to 1920 ^{o}F	Not subject to heat treatment
2	Medium	Inlays of any kind	A minimum of 78 percent of the gold-platinum group of metals	70 to 100	1650 to 1780 ^{o}F	Bench cool for 5 minutes after casting and quenching

I	A	B	C	D	E	F
ITEM	Alloy	Purpose	ADA Specification	Brinell Number	Melting Range	Heat Treatment
3	Hard Single	onlays, crowns, and fixed partial retainers	A minimum of 78 percent of the gold-platinum group of metals	90 to 140	1650 to 1760 °F	Softening heat treatment: heat to 1292 °F and quench; hardening heat treatment: heat to 840 °F; drop temperature to 480 °F; quench
4	Extra Hard	RPD frameworks	A minimum of 75 percent noble metal content	130 +	1600 to 1800 °F	NA
5	Ceramic Gold Alloys	Porcelain veneer fusion	Enough noble metal to provide corrosion resistance	160 to 200	2200 to 2400 °F	
6	RPD Alloys	RPD frameworks	No less than 85 percent chromium, cobalt, and nickel	431	2300 to 2500 °F	

2.59. Dental Alloy Terminology. There are so many different metal-ceramic alloys for porcelain bonding, each with its own peculiar handling characteristics. For that reason, it is often difficult to accurately communicate with others about these alloys. For example, Olympia is the brand name of a metal-ceramic alloy that can be called either a *precious alloy,* a *high noble alloy,* or a *gold-palladium alloy.* It is easy to see why there is so much confusion associated with describing a particular alloy. The most accurate description of an alloy can only be made by listing its major constituents and any minor metal considered important for its functional use.

2.60. Conventional Dental Gold Alloys (Nonceramic). Conventional gold alloys are used to fabricate and repair inlays, onlays, crowns, and fixed partial dentures. These gold-base alloys can be organized into three categories; casting gold, gold solder, and gold foil. Each is formulated and marketed in a form best suited to its intended use.

2.60.1. **Dental Casting Golds:**

2.60.1.1. Casting golds are alloyed and made into ingots suitable for melting and casting into a mold. Different types of restorations require alloys with slightly different physical properties. An alloy used for an inlay must have somewhat different capabilities than an alloy used for a crown or fixed partial denture.

2.60.1.2. The physical property *hardness* is regarded as a useful indicator of the strength of an alloy. Therefore, restorations such as inlays are made using a *soft* or *medium* gold alloy (formerly Type I and II). Similarly, a crown or fixed partial denture requires a much harder casting alloy. On occasion, even RPD frameworks are made of extra hard gold for patients who may be allergic to chrome alloys. The dentist selects the type of casting alloy according to the needs of the particular case, personal preference, and availability.

2.60.1.3. Elements most commonly found in gold-base casting alloys are gold, silver, copper, platinum, palladium, and zinc. Table 2.11 shows typical compositions of conventional gold casting alloys according to hardness.

2.60.1.4. The increased use of silver in medium and hard alloys is intended to lighten the color of the alloy, not affect the hardness. As the copper content of gold alloys is increased, the color of the alloy is darkened unless it is offset by silver. Most people consider this darker color less attractive.

Table 2.11. Typical Composition of Conventional Gold-Casting Alloys.

I	A	B	C	D	E	F	G
ITEM	**Alloy**	**Gold**	**Silver**	**Copper**	**Platinum**	**Palladium**	**Zinc**
1	Soft	85	10	4	0 - 0.5		0.5
2	Medium 76		12	8	1	2.5	0.5
3	Hard	72	12	9	3	3	1 to 2
4	Extra Hard	66	12	12	3.5	3	1 to 5

2.60.1.5. The zinc in these alloys is present to prevent the loss of copper by oxidizing the molten metal. As a result, when the copper is increased, the zinc content is also increased. Zinc lowers the melting range of the finished alloy and makes the material more fluid and easier to cast.

2.60.1.6. Heat treatment of wrought and cast golds is an integral part of all fabrication procedures in which they are used. Careless heat handling is responsible for much of the breakage of cast and wrought wire prosthetic appliances. When gold alloys are properly heat treated, their desirable properties are appreciably increased.

2.60.1.7. In general, when gold alloys are heated to 1292 ^{o}F (cherry red) for 10 minutes and then quenched in water, the metal is in its softest state (annealing). Ductility and malleability increase, all other physical properties show decreased values. Wrought gold is most bendable and cast gold is more burnishable (adaptable) after being subjected to softening heat treatment.

2.60.1.8. Gold restorations that are to be subjected to heavy chewing loads or other mechanical pressures in the mouth cannot be used in a heat-softened condition because they would deform too easily. These restorations must be treated by a process of controlled heating and cooling to restore hardness called *tempering*. For example, certain gold alloys are hardened by heating to 840 ^{o}F, allowed to cool slowly over a 15-minute period to 480 ^{o}F, and then quenched in water. Gold alloy destined for heat hardening should first be heat softened. Any strain hardening is relieved, and the heat hardening process yields more predictable results.

2.60.1.9. There are two ways of expressing the gold content of an alloy. One is in terms of its *carat* and the other is its *fineness*. By definition, a carat is a unit of measure that indicates purity of formulation. A 24-carat rating means that a metal is solid gold with nothing else added. A metal having an 18-carat rating is automatically an alloy, 18 parts of which are gold. The six remaining parts are other metals. The concept of *fineness* is similar to carat only it deals with 1,000 parts instead of 24. Pure gold is said to be 1,000 fine. Therefore, if an alloy is

75 percent gold, it is 750 fine. An easy way to convert fineness to carat and vice versa is to insert the known number into the following formula and solve for the unknown:

$$\frac{\text{Cara}}{24} = \frac{\text{Fineness}}{1000}$$

2.60.2. **Gold Solders.** Gold solders are primarily used to join units of fixed partial dentures. They are also used in repairs of all kinds--everything from plugging holes in castings to adding proximal contacts on restorations. Solders are supplied in many forms. Wires and strips are the most common.

2.60.2.1. **Physical Properties of Gold Solders:**

2.60.2.1.1. **Melting Range.** Dental gold solders are designed to melt and flow within precise temperatures called a melting range. A melting range is the temperature range from the time an alloy begins to melt until it is completely molten. A precise melting range is necessary to prevent overheating and melting the parts to be joined (that is, the parent metal). Solders should melt at a temperature 100 ^{o}F below the fusion temperature of the parent metal. Tin and zinc are added to solder formulas to provide a fusion temperature lower than the fusion temperature of the parent metal. The melting range of a typical, conventional gold solder is 1375 to 1445 ^{o}F.

2.60.2.1.2. **Tarnish Resistance.** After a soldered prosthesis has been in the patient's mouth for a period of time, the solder should show a degree of tarnish resistance that is very close to the parent metal.

2.60.2.1.3. **Color Compatibility.** The color of the solder should match the parent metal as closely as possible.

2.60.2.1.4. **Strength Requirement.** As the fineness of solder increases, its strength decreases. Solders with fineness ratings in excess of 650 should not be used to unite fixed partial denture units that are subject to a lot of stress.

2.60.2.2. **Choosing a Solder:**

2.60.2.2.1. **When the Properties of the Parent Metal are Known.** Several rules of thumb can be used in selecting a solder if either the carat, fineness, or the fusion temperature of the parent metal or metals is known. The primary objective is to pick a solder with a fusion temperature about 100 to 150 ^{o}F lower. Solder with carat ratings that are two values lower or fineness ratings that are 100 units lower than the parent metal are assumed to have fusion temperatures at least 100 ^{o}F lower than the parts to be joined.

2.60.2.2.2. **When the Properties of the Parent Metal can be Guessed.** Fixed prosthesis castings that are not porcelain veneered are made with conventional Type II or Type III golds. The minimum fusion temperature for these kinds of golds is around 1650 ^{o}F; therefore, a solder should be selected accordingly. A problem arises when the mass of gold alloy used to make a casting already contains some solder (for example, a reclaimed fixed partial denture). The presence of the solder acts to lower the fusion temperature of the mass. If a technician tries to solder castings with this kind of unknown composition, success is doubtful. If old, previously used gold is recycled, the solder must be ground off. Ceramic golds have melting ranges in excess of 2100 ^{o}F.

2.60.2.3. **Supplemental Remarks.** The 650-fine solder is widely used for soldering fixed prosthetic restorations made out of conventional casting golds. As fineness increases above

650, tarnish resistance increases, but strength drops off. Below 650 fine, the solder gets stronger but may descend below acceptable tarnish resistance limits. If ceramic casting golds are soldered *before* porcelain fusion, use special solders that melt at around 2000 °F. *After* porcelain fusion, they can be soldered with materials used on conventional casting golds (for example, a 650-fine solder).

2.60.3. **Gold Foil.** Foil is used in repairs such as repairing a hole in a gold crown with solder. It is fabricated at the refinery by rolling gold into sheets of various thickness.

2.61. Alternatives to Gold-Base Alloys (Nonceramic). There are *precious* nongold-base alloys and *nonprecious* chrome alloys which are offered as alternatives to conventional gold-casting alloys. The nonprecious alloys, nickel-chromium and cobalt-chromium, are less desirable alternatives and, as such, are not discussed here. The remaining precious alloy group can be subdivided into the following three subgroups:

2.61.1. **High Silver-Palladium Group.** Alloys in this group contain roughly 70 to 71 percent silver and 25 percent palladium. They require the use of phosphate-bonded casting investments and generally possess gold-base alloy handling characteristics. These alloys cost less than gold-base alloys.

2.61.2. **Medium Silver-Palladium Group.** This second group of silver-palladium alloys was developed to provide a less expensive casting alloy that could be used with conventional gold techniques. These alloys contain between 58 to 68 percent silver, 25 to 26 percent palladium, and 10 to 15 percent copper. Adding copper to this system lowers the melting range and permits the use of gypsum-bonded investments. Several of these alloys possess properties similar to extra hard casting golds, while others are marketed as hard casting gold alternatives. Some alloy brands can be cast into gypsum-bonded investments, while others require phosphate-bonded casting investments. Consult the manufacturer's directions regarding information on their use.

2.61.3. **Silver-Palladium-Gold Group.** By lowering the silver content of the silver-palladium system and replacing copper with gold, manufacturers produce a more tarnish-resistant alloy. The increase in noble metal content of this system makes this alloy more expensive, but it is still cheaper than conventional gold-base alloys. Phosphate-bonded investments are indicated with these alloys and processing is similar to the high silver-palladium group.

2.62. Metal-Ceramic Alloys. These high-melting range alloys are blended for porcelain application. They retain both form and physical properties when porcelain is applied and fused to them. The alloy's coefficient of thermal expansion is slightly more than porcelain, placing the porcelain veneer under compression when the alloy cools. The porcelain is most likely to remain attached to the alloy in this condition. The titles of the following subparagraphs show the classification of the metal-ceramic alloy in parenthesis beside each alloy topic:

2.62.1. **Gold-Platinum-Palladium (High Noble):**

2.62.1.1. **Alloy Contents.** Gold-platinum-palladium alloys contain mostly gold. Platinum and palladium are added to raise the melting temperature, reduce the coefficient of thermal expansion, and strengthen the alloy. Small portions of base metals, such as indium, zinc, and tin, are included to produce a thin oxide film on the surface of the gold alloy which provides the chemical means for bonding between the metal and porcelain.

2.62.1.2. **Advantages.** The bond strength of gold-platinum-palladium alloys is excellent. They also cast easily, finish and polish easily, and produce fine, burnishable margins.

2.62.1.3. **Disadvantages.** The only reasons for replacing gold-platinum-palladium alloys are cost and mechanical strength. To maintain its strength, this alloy must be used in fairly thick sections in areas such as connectors. One of the other alloys might be a better choice for a long span fixed partial denture subject to increased occlusal loading.

2.62.2. **Gold-Palladium-Silver (Medium Noble):**

2.62.2.1. **Alloy Contents.** The elimination of platinum and the addition of silver are the principal differences between this alloy and the gold-platinum-palladium alloy described above. Silver tarnishes and is, therefore, not a noble metal.

2.62.2.2. **Advantages.** These newer "white golds" or "semiprecious" alloys have gained in popularity, probably due to their lower cost and increased mechanical strength. Because these alloys are higher in yield strength than the high gold content alloys, they are useful for long-span restorations. They are easy to cast, finish, and polish.

2.62.2.3. **Disadvantages.** The silver present in these alloys may cause *greening* of the fired porcelain and contamination of the muffle within the porcelain furnace. Also, the high palladium content can increase the risk of hydrogen gas absorption during casting. During the porcelain processing step, the release of hydrogen gas from the metal can create gas bubbles in the porcelain veneer. Although, the porcelain bond is not as good as the gold-platinum-palladium alloy, it is adequate.

2.62.3. **Palladium-Silver (Low Noble).** More recently, an effort has been made to eliminate gold from metal-ceramic alloys completely by substituting palladium and silver.

2.62.3.1. **Alloy Contents.** The manufacturer must achieve a careful balance between the amount of palladium and silver in the alloy because increasing the palladium content raises the melting range and lowers the coefficient of expansion, whereas silver has the opposite effect.

2.62.3.2. **Advantages.** Due to the lower density of palladium-silver alloys combined with their low intrinsic cost, these alloys have a substantial decrease in total metal cost compared to the gold-containing alloy systems. A further advantage is that their handling characteristics and physical properties are comparable.

2.62.3.3. **Disadvantages.** The disadvantages associated with the use of palladium and silver are the same as in paragraph 2.62.2.3. Additionally, the increase in palladium makes casting more difficult because of the hydrogen gas absorption. The gas and oxygen pressure of casting torches requires critical adjustment to produce the correct flame for melting. Using carbon-free investments is also a must because residual carbon can affect the grain structure of the alloy.

2.62.4. **Palladium (High Noble).** Although palladium-silver alloys were in great demand because of the low intrinsic cost, the dental profession wanted alloys that did not cause greening problems. Research led to alloy systems which reverted back to silver-free systems. In place of silver, more palladium was added.

2.62.4.1. **Advantages.** Increasing the palladium content imparts greater hardness, toughness, and strength to the alloys. With silver completely eliminated from the alloys, greening of the porcelain veneer is not a problem.

2.62.4.2. **Disadvantages.** High palladium alloys are more difficult to cast. For example, more casting pressure is needed because of the lower density, and care must be taken not to induce excessive amounts of hydrogen, oxygen, or carbon into the melt. The torch flame must have just the right balance of gas and oxygen. Carbon contamination can appear from such sources as carbon-containing investments, waxes, plastic patterns, carbon crucibles, or liners.

2.62.5. **Base Metal.** Base metal alloys (or nonprecious alloys, as they have been called) are similar in composition to the alloys used in RPDs. ***NOTE:*** The other elements contained in base metal alloys could be molybdenum, manganese, magnesium, aluminum, silicon, beryllium, carbon, iron, titanium, or copper. Although beryllium is often omitted from some alloys because of its toxicity, it hardens the alloy and improves castability. Cobalt-chromium alloys are rarely used in porcelain bonding.

2.62.5.1. **Advantages.** The properties of base metal alloys are considerably different from the noble metal alloy systems. In general, the base metal alloys are much stiffer and harder, requiring high-speed equipment to finish and polish the alloy. Because of this strength, base metal alloys for porcelain bonding are useful where long-span, thin substructures are necessary. They are also the only metal alloys that can be used in the acid etch technique of making resin-bonded FPDs. Low cost has probably been the single most important consideration in selecting base metal alloys over noble alloy materials.

2.62.5.2. **Disadvantages.** Specialized casting and finishing equipment is recommended when working with base metal alloys. Because these alloys do not contain noble metals, they readily oxidize when heated. In addition, they may develop too many oxides, causing the bond between the porcelain and metal to fail. Because of the high oxidizing tendency, the techniques for metal preparation and porcelain additions are different from those used with noble alloys. There has also been controversy over the allergenic and carcinogenic potentials of nickel used in nickel-chromium alloys (mostly with RPDs). In addition, alloys containing beryllium are becoming more suspect because of beryllium's toxic and unstable character.

2.62.6. **Metal Ceramic Alloy Composition.** Table 2.12 shows typical compositions of metal-ceramic alloys.

Table 2.12. Typical Compositions of Noble Metal Alloys for Metal-Ceramic Restorations.

	A	B	C	D	E	F	G	H
ITEM	**Composition**	**Metal-Ceramic Alloys (note)**						
		Gold (Au)	**Platinum (Pt)**	**Palladium (Pd)**	**Silver (Ag)**	**Indium and Tin (In-Sn)**	**Galium (Ga)**	**Copper (Cu)**
1	Au-Pt-Pd	84	10	2 3 1				
2	Au-Pd-Ag 50			30	12	8		
3	Au-Pd	52 38				8.5	1.5	
4	Pd-Ag	55 to 60			25 to 30	10 to 20		
5	Pd			74		5		14.5

NOTE: All figures are percentages.

2.63. RPD Casting Alloys:

2.63.1. **Basic Content:**

2.63.1.1. The ADA specification for cast chromium containing alloys says "... the alloy contains a total of no less than 85 percent by weight of chromium, cobalt, and nickel." This allows a lot of latitude for putting an alloy formula together.

2.63.1.2. When the formulas for the different brands of chrome alloy are reviewed for constituents common to all of them, they contain roughly 20 to 30 percent chromium and highly variable amounts of nickel and cobalt. As an example, Ticonium® Premium 100 alloy contains about 25 percent chrome and 60 percent nickel, with no cobalt present.

2.63.1.3. Other brands of alloys have much less nickel and proportionally more cobalt. According to the ADA's *Guide to Dental Materials and Devices,* a chrome alloy with a high nickel content is reported to have a lower melting range and less thermal contraction than a chrome alloy with a high percentage of cobalt. In contrast to nickel-chrome alloy, the cobalt-chrome family of alloys cast at temperatures that require a high-heat investment with a silicate or phosphate binder. Smaller amounts of several other metals such as molybdenum, tungsten, beryllium, iron, manganese, and aluminum are frequently a part of chrome alloy formulas. Table 2.13 gives a general idea of chrome alloy composition. ***CAUTION:*** Prolonged exposure to beryllium is harmful. Proper dust-collecting apparatus must be used when finishing alloys that contain this metal.

Table 2.13. Approximate Proportions of Metals in Various Chrome Alloys.

I	A	B
ITEM	**Metal**	**Proportions (Percentages)**
1	Aluminum	0 to 0.7
2	Beryllium	0 to 1.8
3	Carbon	0.2 to 0.4
4	Chromium	20 to 30
5	Cobalt	0 to 60
6	Iron	0 to 5
7	Manganese	0 to 0.5
8	Molybdenum	4.6 to 18.5
9	Nickel	5 to 60
10	Silicon	0.7 to 0.4
11	Tungsten	0 to 4

2.63.2. **Properties of Chrome Alloys.** These alloys are considerably harder than the gold alloys and have much higher melting ranges. The specific gravity of these alloys is only about half that of the gold alloys. This factor makes possible a reduction in weight of the RPD casting over one made from a gold alloy. Special equipment is required for casting and finishing the chrome alloys. Due to the differences in hardness and melting temperatures of chrome alloys, equipment used for gold alloys is not suitable.

2.64. Wrought Alloys. Wrought alloys are made through a process of rolling, annealing, and drawing into the various forms. This processing gives the alloys certain physical properties that are of interest to the dentist. The elastic and flexible nature of the alloy is of particular importance. It allows a wrought wire clasp to *spring into* an undercut area. Due to their increased tensile and yield strength, wrought alloys do not deform as easily.

2.64.1. **Base Metal Alloys:**

2.64.1.1. **Forms of Wrought Base Metal Alloys.** Wrought base metal alloys are available in the form of wires and bond materials. Nickel-chromium and cobalt-chromium are the two main types of wrought alloys presently used. These alloys are commonly referred to as *stainless steels.*

2.64.1.2. **Rules for Handling.** Certain procedures must be followed if the desired properties of wrought alloys are to be maintained. When working with wrought wires, avoid making bends too quickly. Do not make bends that are too large or too sharp and do not nick or dent wires because it causes them to break when stress is applied. Also, if repeated bending and shaping is necessary, heat-soften the wire to relieve the stress effects of cold-working caused by bending and shaping. For best results, follow the manufacturer's instructions for heat-softening. When soldering stainless steel wires, take special care to prevent overheating the wire. A prolonged exposure to temperature in excess of 1300 ^{o}F softens the wire and reduces corrosion resistance.

2.64.2. **Gold Alloys:**

2.64.2.1. **Forms of Wrought Gold Alloys.** Wrought gold is made in the form of wires and bars that can be used to make individual, wrought gold clasps or an entire RPD framework. The gold is alloyed to give it the properties needed so it can be bent and shaped into a desired form and so several different units can be joined by dental solder.

2.64.2.2. **Grain Structure.** Because of its method of manufacture, dental wrought gold has a different grain structure than cast gold. Because of its grain structure, it is considerably tougher than cast gold and has a higher yield strength and proportional limit.

2.64.2.3. **Sizes of Wrought Gold Wire.** The manufacturer makes wrought gold from gold alloy that is rolled, swaged, and drawn through the die plates into the desired shape and gauge. The gauge is a measure of the thickness or diameter of the wire. The numbers used are the standard Brown and Sharpe gauge numbers used by machinists. The larger the gauge number, the smaller the diameter. A comparison of the gauge number and the equivalent measurement in inches and millimeters is shown in Table 2.14.

Table 2.14. Brown and Sharpe Wrought Wire Gauge Conversion.

ITEM	A Gauge Number	B Inches	C Millimeters
1	12 0.0808		2.052
2	14 0.0641		1.628
3	16 0.0508		1.290
4	18 0.0403		1.024
5	20 0.0320		0.813
6	22 0.0253		0.643
7	24 0.0201		0.511

2.64.2.4. **Composition of Wrought Gold Wire.** Dental wrought gold wires must have high fusion temperatures so the different parts of the clasp can be assembled by soldering without the danger of overheating the wire. For this reason, platinum and palladium are added in much greater amounts than those used in the casting alloys. The following formula is typical although some wrought wires presently marketed might contain considerably more platinum and palladium, and correspondingly less gold. Wrought wires are usually silver-colored, due to their high percentages of platinum and palladium. A typical formula includes zinc (1 percent), palladium (5 percent), silver (8 percent), copper (13 percent), platinum (15 percent), and gold (58 percent).

2.64.3. **Gold Wire.** Wrought gold wire is used to make RPD clasps. Wrought gold bars are used as lingual and palatal bars. Clasps and bars can be assembled into a complete RPD framework by using dental gold solder.

2.65. Technique Alloys. Technique alloys are used mainly for making demonstration models and for student practice. They resemble gold in appearance although they differ markedly in physical properties. They have an extremely low tarnish resistance and oxidize rapidly at ordinary temperatures. A typical formula for one such alloy is 12 parts silver, 68 parts copper, and 20 parts zinc.

2.66. Low-Fusing Alloys:

2.66.1. Several low-fusing alloys are marketed for dental laboratory use. They are often used to pour the tooth portions of an opposing cast in the construction of a complete denture against natural teeth. They are also used to remount fixed prosthodontic castings in an articulator for occlusal adjustments. (See AFPAM 47-103, Volume 2, *Dental Laboratory Technology, Fixed and Special Prosthodontics,* Chapter 1.)

2.66.2. Low-fusing alloys melt at such low temperatures they can be poured into any elastomeric impression material as well as into alginate or agar impressions without damaging them. These alloys are marketed with a variety of trade names. All of the formulas are made using different proportions of the following low-fusing metals: bismuth (520 ^{o}F), cadmium (610 ^{o}F), indium (314 ^{o}F), lead (621 ^{o}F), and tin (450 ^{o}F), (Table 2.15). The manufacturer strives to produce an alloy with a minimum of dimensional change as it is heated and cooled. ***NOTE:*** Cadmium fumes are toxic. A good way to beat the cadmium vapor problem is to melt cadmium-containing alloys under hot water.

Table 2.15. Typical Low-Fusing Alloys.

I	A	B	C	D	E	F	G
T		Percent by Weight					
E							
M	Name	Bismuth	Cadmium	Indium	Lead	Tin	Melting Point
1	Cerrelow® 136	49.0	0.0	21.0	18.0	12.0	136 ^{o}F
2	Cerrelow® 147	48.0	9.6	4.0	25.6	12.8	142 to 149 ^{o}F
3	Melotte's® 50.0				18.7	31.3	205 ^{o}F

2.66.3. For convenient use, all of the low-fusing alloys mentioned can be melted and poured off into disposable plastic, 60 cm^3 syringes. When metal is needed, heat it in the syringe under hot water and dispense it directly from the syringe as required.

2.67. Platinum Foil:

2.67.1. Platinum foil is manufactured by rolling platinum metal into thin sheets, the appropriate gauge of tinfoil. Pure platinum has a strong affinity for molten gold which makes it a very useful metal in the dental laboratory. Platinum is used in gold, wrought-wire clasp construction as a matrix on which to flow the solder for the occlusal rest. It can be used for all types of gold and chrome alloy repair procedures.

2.67.2. Platinum foil is used in porcelain jacket work as a matrix upon which the porcelain is formed and fired. Because of its high melting point (3190 ^{o}F) and low thermal expansion, platinum foil is not affected appreciably by the heat of the furnace.

Section 2G—Dental Porcelains

2.68. Introduction:

2.68.1. Highly glazed porcelain is one of the materials most compatible with oral tissues and one of the most esthetically pleasing of the dental materials. It is used for denture teeth, facings, complete crowns, and veneered fixed prosthodontic units.

2.68.2. Porcelain does not have the crushing or shear strength of cast metal, but when it is used in the proper bulk and with adequate support, it is very satisfactory for dental restorations. Dental porcelains are classified according to fusion temperature. High-fusing temperatures (2350 to 2500 ^{o}F) are used for denture teeth; medium-fusing temperatures (2000 to 2300 ^{o}F) are used for porcelain facings; and low-fusing temperatures (1200 to 1950 ^{o}F) are used for crowns and veneers.

2.68.3. All of the dental porcelains used to fabricate porcelain veneers or complete porcelain crowns fall into the low temperature range and are thus classified as low-fusing porcelain.

2.69. Manufacturing Dental Porcelain:

2.69.1. **Glass Properties.** Dental porcelain is basically glass. When heated, it can be shaped and molded into a variety of things. Glass is physically a supercooled liquid rather than a solid. However, ordinary glass must be modified and carefully compounded before it can be called *dental porcelain*. The composition of porcelain is carefully controlled to modify the physical properties of the glass both in the molten and solid form. These properties include viscosity, melting temperature, chemical durability, thermal expansion, and resistance to devitrification.

2.69.2. **Vitrification and Devitrification.** Vitrification is the development of porcelain that resembles glass. It is important to know what vitreous (mature) porcelain looks like. Mature porcelain exhibits maximum shrinkage. The surface is completely sealed, and the surface detail is slightly rounded. Devitrification occurs when the firing sequence is interrupted. When this occurs, the porcelain tends to crystallize, making it difficult to form a glazed surface.

2.69.3. **Fritting:**

2.69.3.1. Before this process begins, the natural feldspar and glass fluxes are mixed together in powdered form. Then the raw minerals are mixed together in a refractory crucible and heated to a temperature well above the firing temperatures used in the laboratory. The minerals all melt together to form a molten glass which is quenched in water. The mass cracks and fractures, and it is from this *frit* that the porcelain powders are made.

2.69.3.2. The process of blending, melting, and quenching the glass components is called *fritting*. Each time this is done, more of the undissolved particles are converted to glass. The particles become so small they merely fuse together when they are heated. By prefiring in this manner, the manufacturer can control the maturing temperature and translucency of the porcelain.

2.69.4. **Sintering.** This term more accurately describes the firing process. As the porcelain powders are heated, they partially fuse together to form a compact, noncrystalline solid. Unlike metals with crystalline structures, glass is comparatively weak because the atoms are arranged in an irregular pattern.

2.70. Basic Composition. Low-fusing dental porcelains can be divided into two groups, feldspathic and aluminous porcelain (paragraph 2.71). Although different in their specific makeup, they share a common feldspathic glass frit. Paragraph 2.69.3 describes the fritting process and its effect on the porcelain. Specific ingredients comprise dental porcelain. The following ingredients and their use provide valuable insight into the physical properties of dental porcelain:

2.70.1. **Glass Formation.** The principle element in all glasses is oxygen (O_2), which forms a stable bond with silicon (Si) to produce SiO_4 tetrahedra. SiO_4 is called a silicate, commonly known by another name--sand. Silicon is the major glass-forming oxide in dental porcelain, but *boron* and *alumina* may also be used.

2.70.2. **Fluxes or Alkali:**

2.70.2.1. Fluxes are added to the basic silicon-oxygen network to lower the softening temperature and increase the thermal expansion of a glass. *Potassium, sodium, and calcium oxide* are the glass modifiers used as fluxes. The manufacturer has to control the use of these fluxes because they have a drastic effect on the viscosity (fluidness) of the glass and its thermal expansion. For example, the soda content is increased in metal-bonding porcelains to raise the thermal expansion of the porcelain to that of the metal alloys. This addition has an adverse effect on the porcelain because it is now more susceptible to devitrification (a problem associated with metal porcelains).

2.70.2.2. Lower viscosity is another problem caused by adding fluxes, but it can be corrected using intermediate oxides.

2.70.3. **Intermediate Oxides.** *Aluminum oxide* is the most common intermediate oxide used to increase the hardness and viscosity of porcelain. Dental porcelains must maintain their shape and not slump when heated. Fluxes used to be added to lower the softening temperature, but they also lowered the viscosity. Now, intermediate oxides are added to produce glasses with high viscosity as well as low-firing temperatures.

2.70.4. **Coloring and Opacifying Agents.** Presently, the porcelain frit lacks the color to simulate the denture and enamel shades of teeth. It may appear opalescent or assume a gray-blue translucency similar to natural incisal enamel. Another problem is the slightly greenish hue exhibited by all glasses. In order to dampen down this effect and to produce life-like dentin and enamel colors, the basic dental porcelain frit must be colored as follows:

2.70.4.1. **Color Pigments.** The dental porcelain frit is usually colored by adding concentrated glasses. These glasses are metallic oxides fritted with the basic glass used to modify the uncolored porcelain powder. The metallic oxides used to color dental porcelain appear in Table 2.16. The dental porcelain now has color, but is far too translucent. Therefore, certain oxides must be added to opacify the porcelain, particularly the dentine shade.

2.70.4.2. **Opacifying Agents.** An opacifying agent generally consists of a metallic oxide ground to a very fine particle size. Common oxides are *cerium oxide, titanium oxide, and zirconium oxide* (Table 2.16). In the enamel porcelains, very little opacifier is used because this porcelain requires more translucency. The formation of dental porcelain is now complete.

Table 2.16. Metallic Oxides Used in Coloring and Opacifying Dental Porcelains.

ITEM	A Color/Effect	B Metallic Oxide Responsible
1	Pink	Chromium-tin or chrome alumina are useful in eliminating the greenish hue in the glass and adding a warm tone to the porcelain.
2	Yellow	Indium or praesodymium are the most stable for producing the ivory shades.
3	Green	Chromium oxide is green and the characteristic color of glass. This color should be avoided.
4	Gray	Iron oxide (black) or platinum (gray) are useful in making enamels or for dentines in the gray section of the shade guide. They can also give an effect of translucency.
5	Opacity	Cerium oxide, titanium oxide, and zirconium oxide.

2.71. Low-Fusing Porcelain Systems. The basic types of porcelain systems are feldspathic porcelain (used in veneering metal substructures), aluminous porcelain (used in making porcelain jacket crowns), and leucite porcelain (used with pressable porcelains).

2.71.1. **Feldspathic Porcelain.** Natural feldspar is any group of minerals, principally alumina silicates of potassium, sodium, and calcium. Natural feldspar contains most of the elements needed for glassmaking. Glass fluxes such as boric oxide are added to lower the softening temperature of the glass. This mixture can be fritted at a specific temperature to obtain the desired porcelain frit. Feldspathic porcelains are used in metal ceramic crowns. They have a firing range of 900 to 960 ^{o}C.

2.71.2. **Aluminous Porcelain:**

2.71.2.1. The addition of pure alumina (Al_2O_3) to the feldspar-flux mass greatly strengthens the porcelain. Alumina is the only true crystalline ceramic used in dentistry. It is the hardest and probably strongest oxide known.

2.71.2.2. Aluminous porcelain is three times stronger than feldspathic porcelain and it has six times its crushing strength. Unfortunately, added alumina also decreases translucency.

2.71.2.3. The three main types of aluminous porcelain include a high-strength core material containing as much as 50 percent pure alumina crystals, dentine (containing 5 to 10 percent alumina crystals), and enamel veneer powders. The core buildup strengthens the all ceramic crown much the same as a metal substructure, but to a lesser degree.

2.71.3. **Leucite Porcelain**. Leucite-reinforced ceramic powders are pressed to form ingots which are the basis for an all-ceramic restoration. This system uses the lost-wax technique associated with conventional metal-ceramic restorations. After burnout, the ceramic ingot is heated to a softened state and pressed into the mold. Leucite-reinforced restorations give a very esthetically pleasing result with necessary strength for veneers, single crowns, and onlays.

2.72. Porcelain Components:

2.72.1. **Porcelain Powders.** The manufacturer supplies feldspathic porcelain powders in the following four basic forms:

2.72.1.1. **Opaque Porcelain.** This porcelain contains a larger percentage of opacifying agent (zirconium and tin oxide) and is quite opaque. It is used to mask out the color of the underlying metal.

2.72.1.2. **Dentin or Body Porcelain.** This porcelain matches the gingival two-thirds of a tooth.

2.72.1.3. **Enamel or Incisal Porcelain.** This porcelain is very translucent and is used to overlay the dentin porcelain and match the incisal shade of a tooth. In addition to the different porcelain powders, each manufacturer supplies a multitude of tooth shades. Even then, it is extremely difficult to make a complete match without the aid of stains or color modifiers.

2.72.1.4. **Shoulder Porcelain.** This porcelain is used in the facial margin area to provide an esthetically pleasing alternative to the metal collar. It is available in different porcelain shades to match the dentin and enamel components.

2.72.2. **Stains and Color Modifiers.** The stains and color modifiers supplied in a kit of dental porcelain are made in the same way as the concentrated color frits used to color the porcelain powders. A *color modifier* is used intrinsically (internally) to obtain gingival effects or to highlight body colors. A *stain* is more concentrated than a color modifier and is used for extrinsic (external) coloration. Because stains are applied to the surface of fired porcelain, they are usually mixed with low-fusing, air-fired porcelain. This mixing allows the stain to fuse to the porcelain at a lower temperature. Stains are used to color correct (alter shades) and characterize porcelain restorations.

2.72.3. **Glazes and Add-On Porcelains.** Technicians face many challenges in making porcelain restorations. Either they cannot get a crown to glaze (self-glazing) or they may need to make a simple correction to a contact area. For just this purpose, the manufacturer supplies various correction powders as follows:

2.72.3.1. **Dental Glazes.** Dental glazes are clear, low-fusing porcelains which can be applied to the surface of a fired crown to produce a glossy surface. Glaze powders are difficult to apply evenly and are often used to seal off a poorly *baked* restoration. An autogeneous (self-produced glaze) is preferred over the glass powders. Applied glazes must have a coefficient of thermal expansion that matches porcelain. Otherwise, the glass (glaze) will craze on the surface of the veneer.

2.72.3.2. **Add-on Porcelains.** Except for the addition of opacifiers and coloring pigment, add-on porcelains are similar to glaze porcelains. They may be marketed as correction powders which are normally air-fired porcelains. Add-on porcelains enable minor corrections to be made without the risk of high temperatures and the vacuum cycle.

2.73. Condensation. When porcelain is fired, the particles fuse, replacing some of the formerly water-filled spaces with viscous glass and leaving some spaces filled with air. With fewer air spaces, the porcelain is stronger and more translucent. Various methods are used to condense the particles and reduce the number of air spaces before firing as follows:

2.73.1. Manufacturing the powders with various sizes of particles.

2.73.2. Closely packing the particles when making the restorations.

2.73.3. Controlling the atmosphere in which the porcelain is sintered (vacuum firing).

2.73.4. Eliminating the vehicles used to suspend the particles.

2.74. Various Methods of Condensation:

2.74.1. Condensation is the process of removing water and air from the powder-water mixture as it is applied to a matrix or frame. This is desirable because water and air can produce voids in the fired porcelain. Various methods such as vibration, capillary action, pressure-packing, and whipping are used:

2.74.1.1. *Vibration* is applied by serrating or tapping with an instrument. It will eliminate large air bubbles or spaces, but is hard to control and may unintentionally create minute cracks in the buildup.

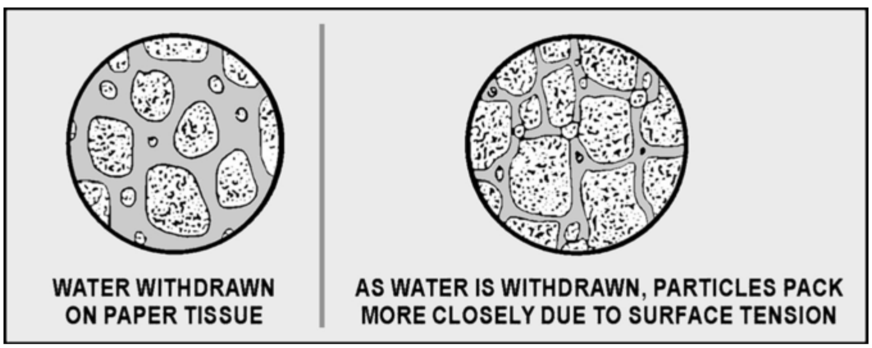
2.74.1.2. *Capillary action* occurs when you blot, usually from the lingual surface. In this way, the flow of moisture from the facial to the lingual draws the particles close together.

2.74.1.3. *Pressure packing* occurs when you smooth with a spatula or press with a clean tissue.

2.74.1.4. *Whipping* or brushing the surface with a large soft brush fills in surface voids and removes loose particles.

2.74.2. The net effect of these four methods increases the amount of surface tension within the porcelain buildup (Figure 2.5). Surface tension is the actual driving force that tightly binds the mass together. Therefore, never allow the porcelain mass to dry out during application. If the porcelain is dry, it cannot be condensed. Also, it is difficult to rewet the buildup once it has been allowed to dry out.

Figure 2.5. Effect of Surface Tension on Condensing Porcelain.



Section 2H—Separating Materials

2.75. Introduction. Two materials are brought together in many laboratory procedures, but they must be prevented from sticking to each other. Therefore, a separating medium is applied to the surface of one of the materials before the two are brought into contact.

2.76. Separating One Gypsum Product From Another. When one gypsum product is poured on another, the materials tend to stick or unite. Use the following separators to prevent union of gypsum products:

2.76.1. **Commercial Separators.** Commercially available separators are formulated to provide effective separation. However, what is equally important is that the film thicknesses they create are almost nonexistent. If these separators are not available, liquid soap or floor wax should be used.

2.76.2. **Liquid Soap.** Ordinary soap is an effective separator and is often used in flasking operations. Brush it on evenly to avoid creating foam or bubbles.

2.76.3. **Liquid Floor Wax.** Ordinary liquid floor wax is an effective separator for both plaster and stone. Apply it to a gypsum surface as a thin layer with a brush or a cotton pellet.

2.76.4. **Petrolatum (Petroleum Jelly).** The film left by petroleum jelly is too thick. Petroleum jelly shouldn't be used where maximum accuracy is essential (for example, cast mounting procedures, index fabrication, etc.). Dentists and technicians dedicated to accuracy as a work standard contend that petrolatum has no place in the dental laboratory. However, petrolatum is sometimes used in denture-flasking procedures. If petrolatum must be used as a separator, spread the material in the thinnest film possible.

2.77. Separating Gypsum Products From Acrylic Resins. Both plaster and dental stone are quite porous. They are not suitable surfaces to cure acrylic resins against. A substance is needed to line the mold that seals off the pores. *Tinfoil and alginate separating mediums* are the best materials for this purpose.

2.77.1. **Tinfoil:**

2.77.1.1. Tin is a soft, white metal which is mined as an ore. When refined and processed into foil, it is extremely malleable. It is manufactured by rolling it into thin sheets for dental laboratory use.

2.77.1.2. A thickness of 0.001 inch is used to cover the stone cast in denture flasking. A thickness of 0.003 inch is recommended for covering the waxed-up denture. The foil should be cut into pieces of suitable size and shape and the pieces burnished to the wax or on the stone cast with a blunt instrument and cotton roll.

2.77.1.3. A thin layer of petrolatum applied to the foil helps hold it in place on the wax denture or stone cast as it is being burnished.

2.77.2. **Alginate-Separating Mediums (Tinfoil Substitute):**

2.77.2.1. Alginate-separating mediums are liquids consisting essentially of sodium or potassium alginate in distilled water. Glycerin and coloring matter are often added. Because they are affected by moisture, ensure surfaces coated with alginate separating medium are not brought into contact with water.

2.77.2.2. Use a soft brush to paint the liquid in one or two layers on the cast and in the mold. Ensure the first coat is dry before applying the next one. Once applied, the film is quite fragile and easily scuffed. If a part of the film lifts off the stone, remove the entire film and paint the stone again. Pack the resin in the mold within an hour after applying the alginate because the film tends to deteriorate if allowed to stand for a longer period.

2.77.2.3. Care must be exercised when a tinfoil substitute is used. If gypsum particles get into the bottle of liquid, it is ruined as a separator. Do not work directly from a bulk bottle; instead, pour what is needed into a smaller container. Traces of tinfoil substitute allowed to remain on the necks of plastic teeth prevent bonding of the teeth to the resin of a denture base.

2.78. Lubricant Separators. When waxing a pattern on a die, use a separator to prevent the wax from sticking to the die material. A lubricant must neither block out the fine details on the die nor affect the physical properties of the wax. The lubricants most frequently used are commercial preparations or substances like glycerol or mineral oil. If possible, use commercial separators to meet the high demands for accuracy in waxing and casting patterns.

2.79. Miscellaneous Separating Materials:

2.79.1. **Talc (Talcum).** Talc is a very fine, powdered soapstone. When sprinkled onto a cast and rubbed into its pores, talc is a very effective separator against heated shellac baseplate material.

2.79.2. **Plastic Sheets (Film).** Place plastic sheets between the halves of the flask so the resin does not stick to the bottom of the flask during trail packing.

Section 2I—Fluxes and Antifluxes

2.80. Fluxes. Fluxes are substances that are applied to a metal to prevent the formation of an oxide film or to remove an already formed oxide film. Borax (sodium tetraborate), combined with charcoal and silica, are the principal constituents of most borax fluxes. Except for containing fluoride salts, fluoride fluxes are similar in composition to borax fluxes. Fluorides dissolve chromium oxide and are excellent fluxes for soldering base metal alloys. Fluxes are used in the dental laboratory in three different forms; paste, powder, and liquid:

2.80.1. **Paste Flux.** Paste flux is powdered flux that has been combined with petrolatum. In this form, it is especially useful in soldering procedures. You must cut the solder into small pieces and dip them in the paste before you place them on the joint. If required, additional flux can be placed in the joint with a small instrument.

2.80.2. **Powdered Flux.** Powdered flux is the flux best suited for casting procedures. Keep it in a container with a perforated lid, such as a salt shaker, and apply it to the metal in the casting crucible as needed.

2.80.3. **Liquid Flux.** To form a liquid flux, mix powdered flux with either water or alcohol. This form is particularly suited for soldering with an electric soldering unit. Dip the solder in the liquid flux before placing it on the joint. When soldering, more liquid may be added by picking up a few drops between the beaks of the soldering tweezers and placing the drops on the joint as needed.

2.81. Antifluxes. Some soldering operations require the solder to be confined to a very definite area. An example of this type of soldering is in building up the contact on the proximal surface of an onlay. It could be disastrous if the solder is permitted to flow onto the margin. Substances used for this purpose are called *antifluxes.* Ordinary pencil lead (graphite or carbon) is a good antiflux. Another antiflux can be made with chloroform or alcohol and rouge. Shave a small amount of rouge into a dappen dish and then add enough solvent to make a thin *paint.* Apply the paint to the metal in the desired area with a camel's hair brush.

Section 2J—Alcohols

2.82. Types of Alcohol. Alcohol is used in the dental laboratory as a solvent and as a fuel for the alcohol lamp and hand torch. There are several types of alcohol. Some are suitable for laboratory use and some are not. The physical characteristics of the more commonly used alcohols are indicated in paragraphs 2.83 through 2.86.

2.83. Grain Alcohol (Ethyl Alcohol, Ethanol). This is a colorless liquid with a highly distinctive odor. It burns with a bluish flame and is a very satisfactory fuel for an alcohol torch.

2.84. Wood Alcohol (Methyl Alcohol, Methanol). This is a colorless liquid with a pleasant odor. It is made either synthetically from carbon monoxide and hydrogen or by the distillation of wood. It is highly poisonous and burns in an alcohol lamp with a reddish-yellow, flickering flame. When air is applied from the bellow in the hand torch, the flame becomes slightly purple. The yellow flame has the advantage of being easy to see in ordinary daylight. Although the flame is not as hot as the one produced by ethyl alcohol, it is satisfactory as a fuel for either the torch or lamp.

2.85. Denatured Alcohol. Denatured alcohol is a mixture of ethyl alcohol and certain poisonous materials which are added to prevent its use as a beverage. Methyl alcohol, acetone, benzene, and ether are some of the common denaturing agents used. As a fuel in the alcohol torch, it may burn easily, poorly, or not at all, depending on the volume and type of denaturing agent used. Because of the uncertainty of its behavior, ethyl or methyl alcohol is a better fuel for the alcohol torch.

2.86. Isopropyl Alcohol. Isopropyl alcohol resembles ethyl alcohol very closely. It burns in an alcohol torch with a slightly more yellow and a somewhat more vigorous flame than either ethyl or methyl alcohol. Under pressure from the bellows of the hand torch, isopropyl alcohol produces a blue flame, but tends to smoke badly when applied to wax. For this reason, it is not recommended for most laboratory or clinical uses.

Section 2K—Acids (Pickling Solutions)

2.87. Introduction:

2.87.1. Acids are of interest to the laboratory technician because they are used in procedures to remove surface oxidation from the metal immediately after the castings have been recovered from the mold. When they are used for this purpose, acids are called *pickling solutions*.

2.87.2. Acids must be handled with great care since they produce blisters and burns on the skin, ruin clothing, and corrode equipment. Baking soda is the antidote for acid burns. It should be applied to the affected area immediately after contact. If an antidote is not available, the affected area must be flushed with a lot of water.

2.87.3. Generally, acids are not used full strength in the dental laboratory, but are diluted with water. When making up a pickling solution, always pour the acid into the water-- *never* pour the water into the acid. Failure to observe this rule may result in severe burns.

2.87.4. All pickling solutions except hydrofluoric acid should be kept in glass containers with glass stoppers and should be clearly labeled. One acid must never be mixed with another.

2.88. Hydrochloric Acid:

2.88.1. Hydrochloric acid is a colorless, very corrosive acid. The fumes attack and corrode equipment, instruments, and fixtures. As a pickling solution, it should be diluted with an equal part of water. On rare occasions, hydrochloric acid may be used full strength to remove sulfur deposits caused by an overheated mold.

2.88.2. Hydrochloric acid slowly dissolves both platinum and palladium. For this reason, gold alloys should never be allowed to remain for more than a few minutes in acid. United States Pharmacopeia (U.S.P.) hydrochloric acid is 37 percent strength by weight.

2.89. Muriatic Acid. Muriatic acid is another name for commercial hydrochloric acid. It may often contain impurities and may be slightly yellow. Like the U.S.P. grade, muriatic acid is supplied in a 37 percent solution by weight. It makes a very satisfactory pickling solution when diluted to half strength with water.

2.90. Sulfuric Acid. Sulfuric acid is a dense, oily liquid. It is an excellent pickling solution for gold in a solution of one part water to one part acid. It has an advantage over hydrochloric acid--it produces no objectionable fumes. It is a more effective pickling agent when it is warm.

2.91. Nitric Acid:

2.91.1. Nitric acid is a colorless liquid that may turn brown if it is stored for a long period of time. The discoloration does not change the properties of the acid. It is seldom used in the laboratory because it dissolves gold alloys of high palladium content.

2.91.2. Nitric acid is sometimes used when a casting contaminated with copper deposits from an unclean pickling solution cannot be cleaned with either hydrochloric or sulfuric acid. The solution used for this purpose is one part nitric acid to two parts water.

2.91.3. Never leave gold in nitric acid for more than a few minutes.

2.92. Phosphoric Acid. This acid rapidly dissolves dental cement and is very useful for removing facings or tube teeth from metal. It does not attack any of the commonly used dental alloys.

2.93. Hydrofluoric Acid. This acid should not be used except for dissolving porcelain veneers off metals. The fumes are dangerous if inhaled, and it is difficult to neutralize when it comes in contact with the skin. Magnesium oxide ointment should be kept close by for burns if the acid is used. There are commercial hydrofluoric acid substitutes on the market that are much less hazardous (for example NO-SAN®, Triodent, Inc., Union NJ).

2.94. Aqua Regia. This is a concentrated solution made of three parts hydrochloric acid to one part nitric acid. Aqua regia dissolves both gold and platinum. It is infrequently used to etch the inner surface of a gold inlay or crown to control the fit of the casting.

Section 2L—Wetting Agents

2.95. Overview:

2.95.1. When water balls up on a wax surface, it is exhibiting a property called *surface tension.* If a wax pattern is invested, the surface tension of the water in the investment must be broken down in some manner. Otherwise, the casting will very likely have nodules on its surface because the investment has failed to adhere closely to the wax.

2.95.2. A wetting agent (debubblizer) is a liquid with a soapy feel used to lower the investment's surface tension. When a wax pattern is properly prepared with a wetting agent, the investment flows evenly across the surface and into the small crevices of the wax. The resultant casting is free from nodules. In a similar manner, a wetting agent added to the water to flush out a denture mold lowers the surface tension of the solution and enables it to clean the mold more effectively.

2.96. Types of Wetting Agents:

2.96.1. **Commercial Brand Name Preparations.** Commercially produced wetting agents should be used whenever possible. Their performance characteristics are very reliable. A technician has to have particular confidence in debubblizers for wax patterns.

2.96.2. **Hydrogen Peroxide and Green Soap.** An especially good wetting agent for inlay and crown wax patterns is a mixture of equal parts of hydrogen peroxide and green soap. The hydrogen peroxide, as it is received from the pharmacy, is diluted with an equal part of tincture of green soap. This solution can be stored in a dental cement bottle and used repeatedly. The sprued pattern can be placed on the crucible former and the crucible former inverted onto the mouth of the bottle so the pattern is immersed in the solution.

2.96.3. **Household Detergent.** Research done by dental investigators at the Bureau of Standards has established that ordinary household detergent is highly effective when it is added to the water used to clean denture molds. The mold should be thoroughly rinsed with clean, hot water after cleansing because detergent residue may contaminate the denture resin.

Section 2M—Wax Solvents

2.97. Introduction. Even though a substance may be able to dissolve wax, it may not be used for that purpose in dental laboratory technology.

2.98. Wax-Dissolving Substances:

2.98.1. **Acetone.** This is a colorless liquid with a particular odor. In the dental laboratory, it is used in making *tacky liquid,* which is used to hold partial denture patterns to the investment cast. To prepare tacky liquid, dissolve plastic forms in acetone, making a liquid just slightly more viscous than water. Apply this liquid with a small brush to the exact area of the cast to which the pattern is to be applied.

2.98.2. **Commercial Wax Solvents.** These are commercially available preparations formulated to dissolve wax. They are not toxic, flammable, or harmful to acrylic resin. They are very effective and much safer to use than many chemicals. Their use is *strongly recommended.*

Section 2N—Abrasives (Polishing Agents)

2.99. Introduction:

2.99.1. *Abrasives* are substances that wear away the surfaces of softer objects. The speed of their action depends on the relative hardness of the two materials.

2.99.2. Abrasives are made into powders by crushing and sifting them to produce the desired particle size. In dentistry, they are used as powders, cemented to the surface of paper and cloth in the form of discs, and bonded with binders to form grinding stones of various shapes.

2.99.3. Abrasive materials can be classified according to their hardness using a scale known as the *Mohs scale.* The Mohs scale is a comparative scale and a good indicator of the relative abrasive power of several materials used to smooth and polish in the dental laboratory

2.99.4. See Table 2.17 for a comparison of several commonly used dental abrasives with the Mohs number of those classified on the scale. This table also shows the relative hardness and uses of abrasives.

Table 2.17. Types of Abrasives (Hardness and Use).

ITEM	A Material	B Mohs Number	C Use	D Manner of Use
1	Chalk	Unknown, extremely fine	To impart a high luster to acrylic resin or porcelain surfaces.	A powder is mixed with water to form paste. Applied with a muslin buffing wheel.
2	Rouge	Unknown; very fine	To give metal a high luster.	In stick form, applied with a chamois or rag wheel on a lathe.

I T E M	A Material	B Mohs Number	C Use	D Manner of Use
3	Cuttlefish	Unknown, fine	To finish gold.	Discs are mounted on a mandrel and gripped by a handpiece or lathe.
4	Emery	Unknown	To trim acrylic resin denture bases and various kinds of baseplates.	Arbor band mounted in a handpiece or lathe.
5	Tripoli	Relatively fine, 5	To smooth metal or acrylic resin.	Powder together with a binder solid in stick or cake form. Applied with a rag or brush wheel.
6	Pumice	5 1/2	To smooth acrylic resin or metal.	Three grits; flour, medium, and coarse. Applied with a rag or brush wheel.
7	Quartz	7	As a whetstone to sharpen instruments or as sandpaper to smooth metal.	Discs are mounted on a mandrel and gripped by a handpiece or lathe. Used as an Arkansas stone.
8	Garnet	6 1/2 to 7 1/2	To smooth metal.	Discs are mandrel mounted.
9	Carborundum	9 1/2	To smooth metal.	Incorporated into points, stones, or discs, then mandrel mounted and gripped by hand piece or lathe.
10	Diamond	10	To prepare natural teeth and to cut porcelain.	Points, discs, and wheels used in a handpiece.

2.100. Types of Abrasives (Polishing Agents):

2.100.1. **Chalk.** Chalk is a soft, nongritty form of calcium carbonate. A small quantity, made into a paste with water, is an effective high-shine compound for both gold alloys and acrylic resin.

2.100.2. **Rouge.** Rouge is a polishing agent used to impart a high luster to gold. It can be used to polish an acrylic resin denture, but it tends to collect in the crevices around the denture teeth. It is not recommend for acrylic resin. Rouge consists of finely ground particles of iron oxide incorporated in an inert binder. Mixed with alcohol or chloroform, it is a very good antiflux.

2.100.3. **Cuttlefish.** Cuttlefish is an abrasive used to coat discs used for finishing gold. It is finely ground cuttlebone that comes from the internal shell of the cuttlefish.

2.100.4. **Emery.** Emery is an impure form of aluminum oxide found in nature as corundum. It is cemented to the surface of heavy paper, and the paper is cut into discs which are used in the laboratory for smoothing and polishing. Emery is also used as the coating on the arbor bands used for trimming baseplates.

2.100.5. **Tripoli.** Tripoli material is obtained from a porous rock ground to a fine particle size and incorporated in a binder. It is supplied in stick form and is excellent for smoothing both metal and acrylic resin. Tripoli is applied with muslin buffing or brush wheels mounted on a polishing lathe.

2.100.6. **Pumice:**

2.100.6.1. Pumice is a form of sand or silica which is used in the form of a finely ground powder. Pumice is supplied by the manufacturer in several grades. Flour of pumice is extremely fine in particle size. Coarse, medium, and fine grits are routinely used for a wide variety of smoothing and polishing tasks.

2.100.6.2. Pumice is usually mixed with water to form a thick paste. The paste is then applied to the work as it is held against a rapidly revolving muslin buffing or brush wheel.

2.100.7. **Quartz.** Quartz is a crystallized form of silica. It is used in a variety of grits for many types of abrasives. A compact variety of quartz is made into whetstone (or Arkansas stone) which is used to sharpen dental cutting instruments. In the form of powdered glass, quartz is glued to cloth and paper and used as a sandpaper disc.

2.100.8. **Garnet.** Garnet is a crystalline mineral abrasive used to coat discs for smoothing and finishing operations.

2.100.9. **Carborundum.** Carborundum is a trade name for *silicon carbide*. Many of the stones, mounted points, and discs used in the laboratory are made with silicon carbide. It is composed of extremely hard, blue and black crystals that closely resemble diamonds in shape. These particles are pressed with a plastic binder to form stones and points, or they are cemented to the surface of heavy paper to make discs. Stones and discs are used for smoothing and polishing.

2.100.10. **Diamond.** Many times harder than silicon carbide, the diamond is the hardest abrasive known. Diamond particles are bonded together and used in dentistry to make mounted stones of various shapes. They are also cemented to the surface of metal to make discs, wheels, and points.

Section 2O—Laboratory Gases

2.101. Introduction. Several kinds of gases are used for heating and melting operations. Some, such as oxygen and acetylene, are stored in highly pressurized containers with safety caps over the outlets. When the containers are moved or handled, the caps must be securely attached. If the outlets are broken away from the tanks, the high pressures propel the tank like a high speed missile. Therefore, the tanks must be secured to prevent their movement while they are in use.

2.102. Types of Gases:

2.102.1. **Natural Gas (City Gas).** When organic matter decomposes, it forms natural gas which is found in the ground in regions that produce oil. Natural gas is used in Bunsen burners and blowpipes for operations requiring heat. When it is mixed with compressed air, natural gas produces a flame of approximately 2200 ^{o}F. This temperature is sufficient to melt most dental gold alloys, but not hot enough to melt chrome alloys. If an unusually large amount (more than 1 ounce) of gold must be melted, a hotter flame might be necessary (for example, natural gas-oxygen).

2.102.2. **Acetylene.** Acetylene is a colorless gas with a garlic-like odor. Manufactured by the action of water on calcium carbide, it is marketed in pressurized tanks that provide the torch operator the assurance of constant line pressure. Acetylene gas is used with specially constructed blowpipes for casting and soldering. When acetylene burns in air, it produces a flame of approximately 3000 ^{o}F. This is hotter than the temperature produced by a mixture of natural gas and air.

2.102.3. **Propane.** Propane occurs naturally in petroleum. Huge quantities of propane are produced when crude oil is refined. Propane stored in pressurized tanks assumes a liquid state. As the pressure is reduced, the propane converts to a gas. Propane and air produce a flame greater in temperature than the flame produced by natural gas and air, but less than the flame produced by acetylene and air. Propane is a cleaner fuel than acetylene, and its use is recommended over acetylene.

2.102.4. **Oxygen.** The oxygen used in the laboratory is a pure form of the oxygen that is found in the atmosphere. It is used to support the combustion of other gases. Oxygen comes in highly pressurized containers, and proper safety precautions must be taken. If a leak occurs when oxygen is stored in the laboratory, the concentrated oxygen intensifies the burning process. Therefore, the oxygen container must be stored outside the laboratory in a specially prepared, isolated area. When pressurized oxygen is mixed with natural gas or with acetylene, it produces a flame of a much higher temperature than the flame produced in combustion of those gases supported by pressurized air.

2.102.4.1. **Natural Gas-Oxygen.** Natural gas-oxygen flames are used to melt large volumes of conventional gold or to melt ceramometals. Metals suitable for porcelain fusion have higher casting temperatures than conventional golds.

2.102.4.2. **Acetylene-Oxygen.** Acetylene-compressed air or an oxyacetylene flame may be used to melt a chrome alloy. Most chrome alloys have melting ranges in excess of 2600 °F. An oxyacetylene flame reaches temperatures of approximately 6000 °F. Special torches are used to burn acetylene. Acetylene flames must not be used on ceramic alloy because the flames might change the alloy's makeup which is precisely balanced for creating porcelain bonds.

2.102.4.3. **Propane-Oxygen.** Propane-oxygen can be used to melt large volumes of conventional golds, ceramometals, or chrome alloys. Propane is cleaner and less hazardous than acetylene. Due to the risk of carbonizing the alloy, propane is recommended over acetylene, even when melting a base metal alloy. A propane and oxygen mixture produces a flame temperature of approximately 5500 °F.

Section 2P—Miscellaneous Laboratory Materials

2.103. Articulating Paper and Articulating Film. Articulating paper and articulating film are impregnated with a colored dye that is easily transferred upon contact. Both are used for marking interocclusal contacts when adjusting the occlusion of a fixed or removable prosthesis.

2.104. Modeling Clay. Modeling clay is pure kaolin (aluminum silicate) that has been mixed with glycerin to form moldable dough. In the laboratory, modeling clay is used to block out large tissue undercuts before a master cast is duplicated. It is also used to hold casts in position when they are mounted in an articulator. Because it shapes and molds easily, modeling clay is suitable for many other uses.

2.105. Cast Spray. Cast spray is used for coating the refractory cast to make a sealed surface to place wax or plastic patterns against. (Although the exact constituents are a trade secret, these sprays probably contain polystyrene plastic in a solution.)

2.106. Mouth Protectors (Mouth Guards). Custom mouth protectors (mouth guards) are made from polyvinyl acetate-ethylene blanks and preforms. This thermoplastic resin is molded over a cast, using a vacuum-forming machine. Mouth protectors are worn during sports participation to reduce injuries to the oral tissues, head, and neck.

2.107. Plastic Patterns. Plastic patterns are plastic resin forms shaped as clasp arms, lingual bars, retention forms, etc. They are used to make patterns for cast RPDs. Because they are soft and pliable at room temperature, plastic patterns can be easily adapted to the designed outline on the refractory cast. They are made of ethyl and methyl methacrylate with added plasticizers. (The exact composition of the plastics is a trade secret.) They must be stored in a cool place to prevent deterioration.

2.108. Ceramic Fiber Paper and Ring Liner (Formerly Asbestos Strip):

2.108.1. Except under highly controlled conditions, the use of asbestos is being discontinued in many industries. *Ceramic fiber paper* is a commercially available substitute for conventional asbestos stripping. Terms such as Nobestos®, Kaoliner® (both commercial brand names), and “asbestos substitute” are used to describe this material. Because this material is used to line the investment ring in fixed denture and RPD investing procedures, the term *ring liner* is befitting.

2.108.2. Asbestos substitutes are stiffer materials and generally nonabsorbent, compared to asbestos. Therefore, their use in the dental laboratory is limited to investing procedures only. Other materials are now used to replace asbestos for blocking out undercuts, lining crucibles, and insulating acrylic parts during soldering.

2.109. Quick-Setting Epoxy and Cyanoacrylate Adhesives:

2.109.1. The strengths of these products are so high and their film thickness is so low that they are gaining increasing acceptance in dental laboratory technology. Epoxy and cyanoacrylate glues are used to reunite gypsum cast fragments.

2.109.2. Epoxy glue contains enough body to be used as a blockout substance on fixed prosthesis dies. Painted on in a thin film, cyanoacrylate cement is an excellent die hardener and wax pattern spacer.

Chapter 3

ANATOMY OF FACIAL AND ORAL STRUCTURES

Section 3A—Overview of Anatomy

3.1. Introduction. The study of anatomy has a language all its own, and its terms have evolved over many centuries. Many anatomical terms are difficult to remember and pronounce. In order to communicate with other dental professionals, you must learn and understand the language and structures of oral and dental anatomy.

3.2. General Reference Terms:

3.2.1. *Anterior* and *posterior* describe the front-to-back relationship of one part of the body to another. Anterior is toward the front; posterior is toward the back. For example, the ear is posterior to (in back of) the eye; the nose is anterior to (in front of) the ear, etc.

3.2.2. The words *internal* and *medial* are synonyms as are *external* and *lateral.* These terms describe the sideways relationship of one part of the body to another, using the midsagittal plane (paragraph 3.3) as a reference. For example the ear is external (or lateral) to the eye because the ear is further from the midsagittal plane. The eye is internal (or medial) to the ear because it is closer to the midsagittal plane.

3.2.3. The *long axis* is the longitudinal center line of the body or any of its parts.

3.3. Body Planes. The study of geometry shows that a plane is perfectly flat, is infinitely long and wide, and has no depth. For the purpose of this text, a plane is a real or imaginary slice made completely through a body. In anatomy, the slice is made to study the details of the cut surfaces. The cut surfaces are called sections or views. Planes can pass through a body in an infinite number of ways. Common planes that produce standard views include sagittal, frontal, and transverse planes (Figures 3.1 and 3.2).

3.3.1. The sagittal plane parallels the long axis and divides a body into right and left parts (Figure 3.1). A midsagittal plane divides bodies into *equal* right and left sides.

3.3.2. The frontal plane parallels the long axis and divides a body into anterior and posterior parts (Figure 3.1).

3.3.3. The transverse (horizontal) plane divides a body into upper and lower parts (Figure 3.2). More specifically, it is a slice that passes through a body at right angles (90 degrees) to the sagittal and frontal planes.

3.4. Bony Elevations:

3.4.1. Tubercle, eminence, and tuberosity all describe rather small, somewhat circular areas raised above the general level of the surrounding bone. The person who originally described these areas specifically labeled an elevation of bone falling in this category as an eminence, tuberosity, or tubercle. As far as relative shape and size are concerned, there is little to distinguish among these kinds of elevations. They just have to be memorized according to the names they carry.

3.4.2. A ridge is a liner elevation on the surface of a bone or tooth. A *mylohyoid ridge* is one example.

3.4.3. A process is a very prominent projection from the central mass of a bone; for example, *zygomatic process*.

3.4.4. A condyle is a rounded, convex, smooth surface on one of the bones that forms a movable joint. The condyle of the mandible is discussed in depth in paragraph 3.18.

Figure 3.1. Sagittal and Frontal Planes.

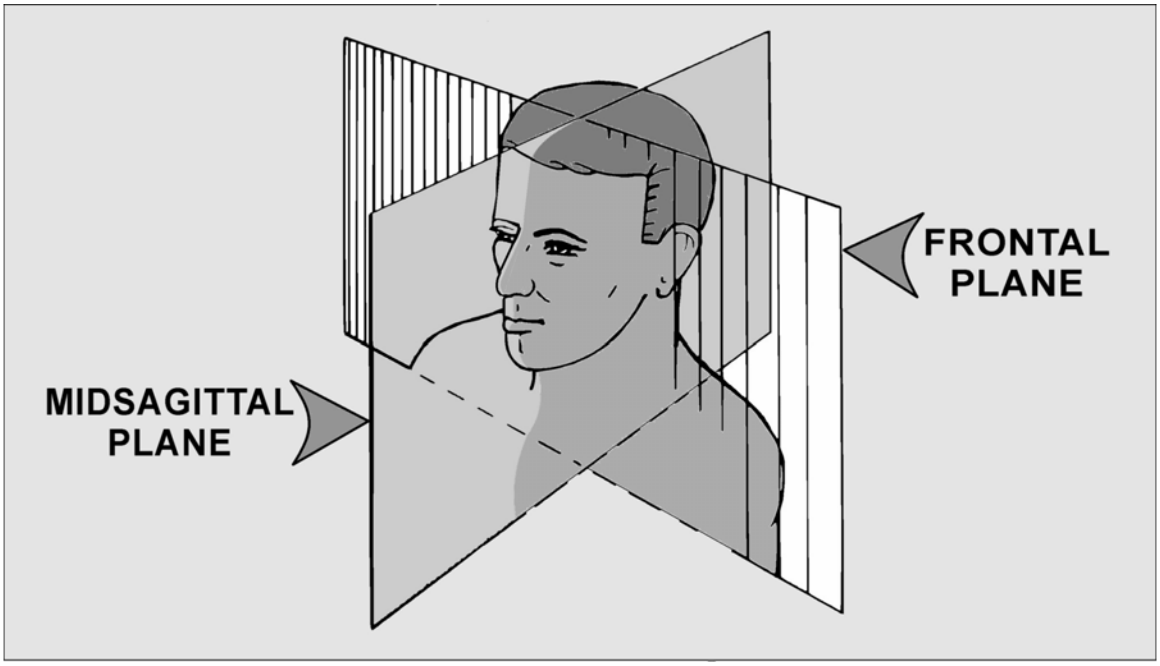
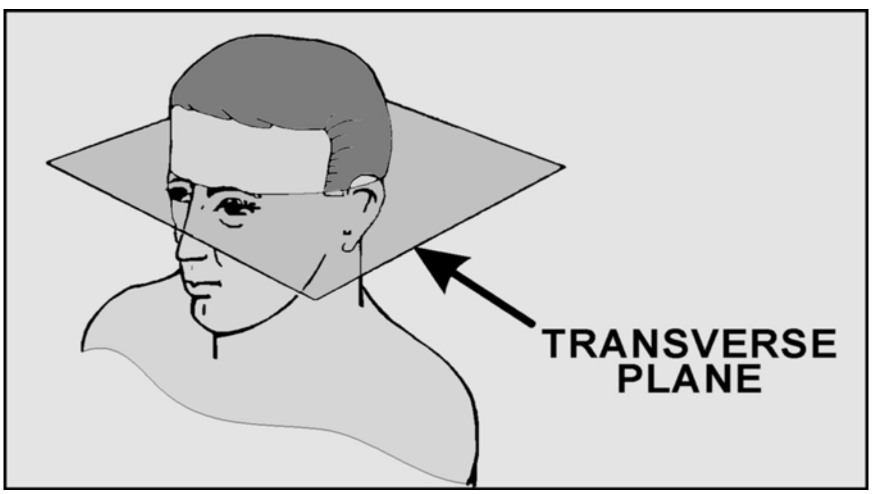


Figure 3.2. Transverse Plane.



3.5. Bone Depressions and Channels:

3.5.1. A fovea is shallow, cup-shaped depression or pit. An example of this is the palatine fovea.

3.5.2. A fossa is a more or less longitudinal, rounded depression in the surface of a bone.

3.5.3. A canal is a tubular channel through bone. The channel has at least one entrance and one exit hole. A canal's entrance or exit hole is called a *foramen*.

3.6. Joints. Joints can be classified in a number of ways. One of the ways is the kind of movement the structure of the joint allows. The three kinds of joints found in the human skull are as follows:

3.6.1. **Synarthrosis or Immovable Joint.** Most skull bones are joined together along highly irregular, jigsaw puzzle-like lines called sutures. A suture joint is classified as a synarthrosis. Bones joined along suture lines in the skull are not totally immobile. Movement occurs, but it is very limited.

3.6.2. **Ginglymodiarthrodial Joint.** Literally defined, this is a freely movable, gliding, hinge joint. This relationship of one bone to another allows the greatest range of movement of any joint type. The term ginglymodiarthrodial specifically describes the *temporomandibular joint* that unites the lower jaw with the rest of the skull.

3.6.3. **Ellipsoidal Joint.** This is the type of joint existing between the occipital bone of the skull and the first vertebra of the spinal column. There are two axes of motion at right angles to each other in this joint, and both axes pass through the same bone. This arrangement enables you to nod your head and rotate it from side to side.

Section 3B—Bony Anatomy of the Head (Skull)

3.7. Introduction. The skull is that portion of the human skeleton that makes up the bony framework of the head. For descriptive purposes, the skull is divided into an upper, dome-shaped, cranial portion; and a lower or facial portion composed of the eye sockets, nasal cavities, and both jaws (Figure 3.3). The adult skull is composed of 22 bones (8 cranial and 14 facial).

3.8. Cranial Bones. The eight bones of the cranium are the frontal, parietal (right and left), occipital, temporal (right and left), sphenoid, and ethmoid. ***NOTE:*** The shape and arrangement of these eight bones form a bony shell (cranium) that has a central cavity containing the brain. The arched roof of the cranial cavity is called the *vault*, and the floor of the cavity is called the *base*.

3.9. Facial Bones. The 14 bones in the facial portion of the skull are the maxilla, palatine, zygoma, lacrimal, nasal, inferior concha, vomer, and mandible. ***NOTE:*** There is only one vomer and one mandible in a skull; however, the other facial bones are paired.

Section 3C—Cranial and Facial Bones of Primary Interest

3.10. Overview:

3.10.1. Artificial replacements for missing natural teeth (dental prostheses) must be made to fit jaw contours and work in harmony with muscle activity. Therefore, this discussion will center on those facial bones that give shape to soft tissues within the mouth and serve as anchorage sites for muscles that move the lower jaw and give shape to the lower one-half of the face.

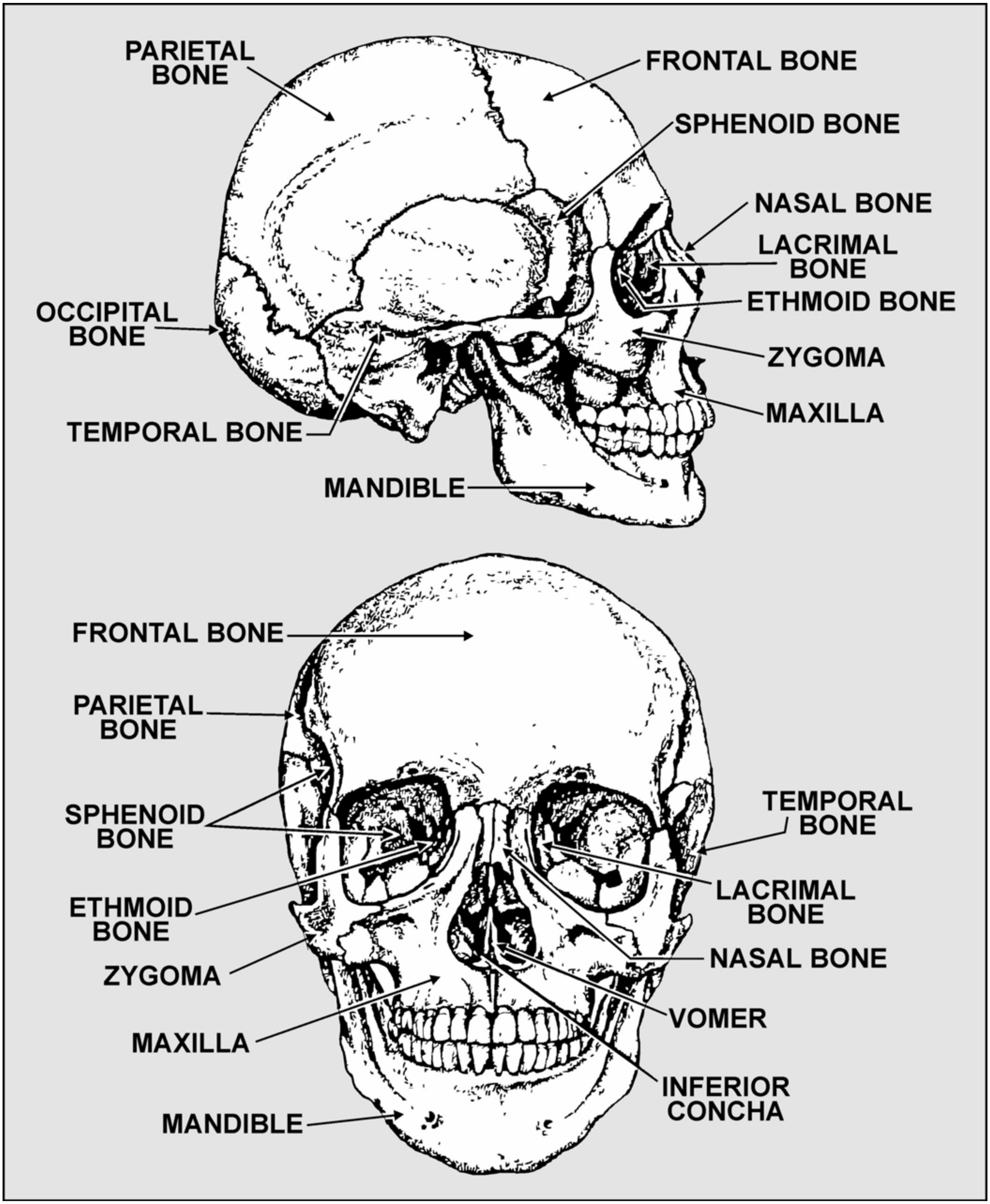
3.10.2. Cranial bones of primary interest are the frontal, parietal, temporal, and sphenoid.

3.10.3. Facial bones of primary interest are the maxilla, palatine, zygoma, and mandible. ***NOTE:*** It is important to remember the particular features of these bones for subsequent reference in this publication and, in fact, for your entire technical career.

3.10.4. Paragraph 3.11 through 3.14 highlight the particular features of cranial and facial bones.

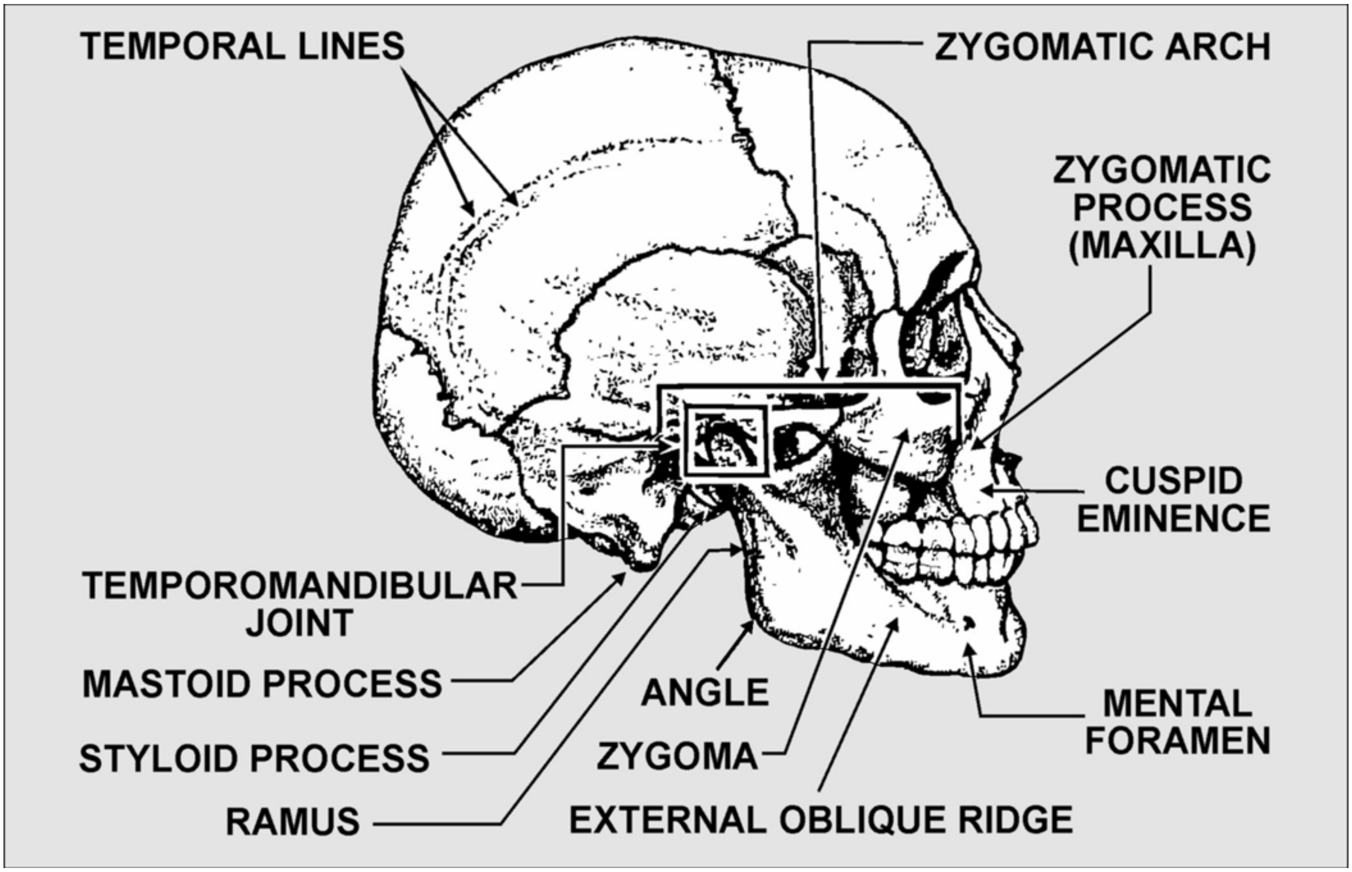
3.11. Frontal Bone. The frontal bone is a single bone forming the anterior of the cranial vault, the roof of the eye sockets, and a small portion of the nasal cavity. A *temporal line* can be found on both lateral surfaces of the frontal bone. The line begins in the region of the eye socket and proceeds posteriorly, often dividing into superior and inferior temporal lines near the posterior border of the frontal bone (Figure 3.4).

Figure 3.3. Bones of the Skull.



3.12. Parietal Bones. Parietal bones are located between the occipital and frontal bones to form the largest portion of the top and sides of the cranium. The paired parietal bones are marked by two semicircular bony ridges, the *superior* and *inferior temporal lines*, which are the posterior continuation of the frontal bone's temporal line. The superior and inferior temporal lines rim the area of origin of the temporalis muscle (Figure 3.4).

Figure 3.4. Lateral View of the Skull (Selected Structures).



3.13. Temporal Bones. Temporal bones are the paired bones forming a portion of the right and left sides of the skull below the parietal bones. The temporal bones extend down onto the under surface of the cranium and contribute to the formation of the cranial base. Each temporal bone articulates with the parietal above, the sphenoid in front, and the occipital bone behind (Figures 3.3, 3.4, and 3.5). The significant features of the temporal bone are the mastoid process, styloid process, zygomatic process, glenoid fossa, articular eminence, and auditory canal or external auditory meatus as follows:

3.13.1. The *mastoid process* is a rounded, downward projection on the posterior part of the temporal bone. This process presents a roughened exterior surface for attaching several muscles of the neck.

3.13.2. The *styloid process* is a slender, tapering spur of bone projecting downward from the under surface of the temporal bone. This process has sites of attachment for multiple muscles and ligaments, which then go to the mandible, hyoid bone, throat, and tongue.

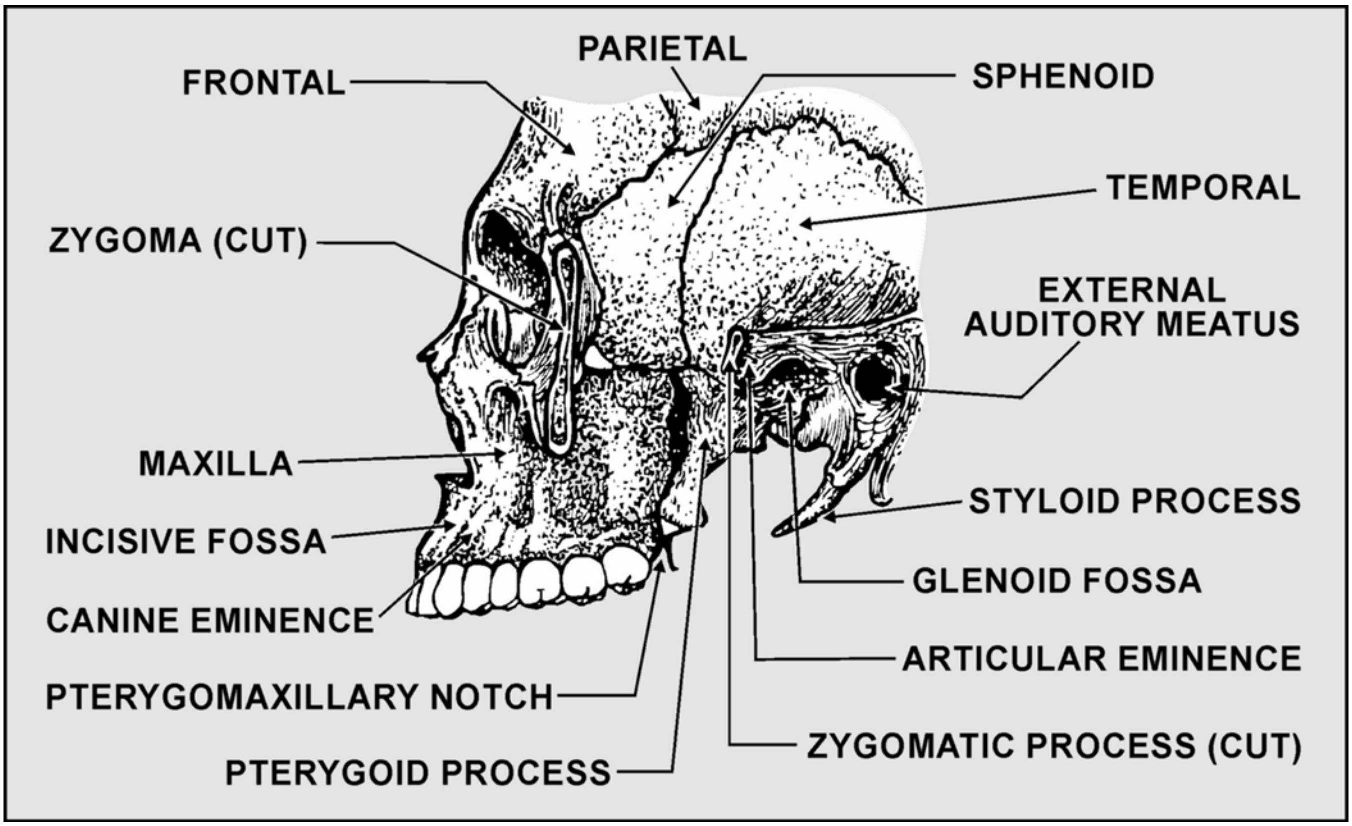
3.13.3. The *zygomatic process* is a projection from the approximate center of each temporal bone extending forward to form a part of the zygomatic arch or cheek bone. This arch (or so-called cheekbone) is not one continuous bone, but is made up of a number of parts. The zygomatic process of the temporal bone forms the posterior part.

3.13.4. The *glenoid fossa (mandiular fossa)* is a deep hollow on the under surface of the base of the zygomatic process. The base of the zygomatic process is the place where the process originates from the central mass of the temporal bone.

3.13.5. The *articular eminence* is a ramp-shaped prominence extending forward and downward from the anterior boundary of the glenoid fossa.

3.13.6. The *auditory canal* or *external auditory meatus* is a hole in the bone found posterior to the glenoid fossa. It leads from the outside surface of the base of the zygomatic process to the inner portions of the ear.

Figure 3.5. Lateral View of the Skull (Selected Features).



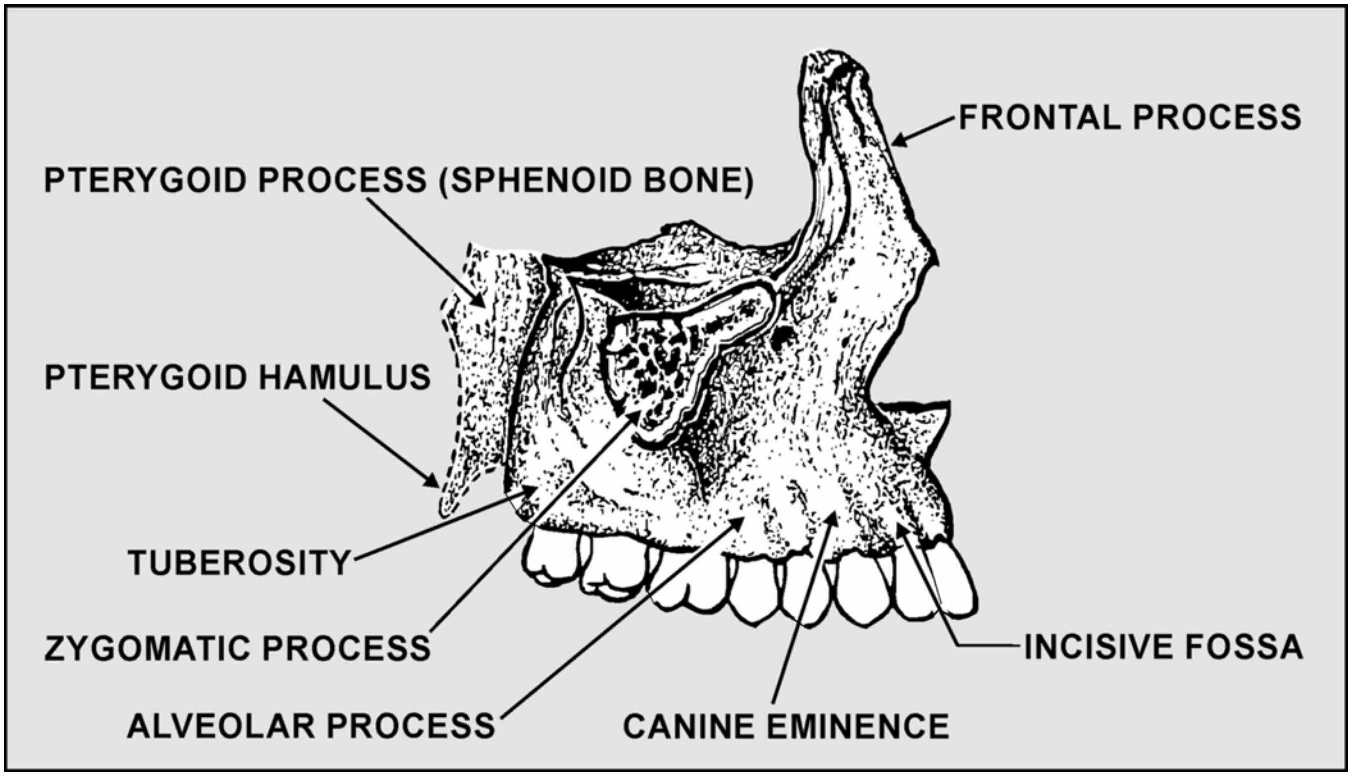
3.14. Sphenoid Bone. The sphenoid bone resembles a bat with wings extended. It consists of a central portion or body which is situated in the middle of the base of the skull and three pairs of processes: two laterally extended greater wings, two downward projecting pterygoid processes, and two lesser wings. The features of the sphenoid bone we will discuss are the greater wings, spine of the sphenoid, and pterygoid processes.

3.14.1. A greater wing (Figure 3.5) forms part of the surface contour of the cranium anterior to the temporal bone, and it also forms part of the eye socket.

3.14.2. The spine of the sphenoid is just inferior to the lateral, posterior, inferior border of the greater wing of the sphenoid bone. The spine of the sphenoid is the site of attachment of the sphenomandibular ligament.

3.14.3. The pterygoid process (Figures 3.5, 3.6, and 3.7) extends downward from the junction of the body and greater wing of the sphenoid on the right and left side. The pterygoid process is formed by the union of two bony plates. The depression between the two plates is called the pterygoid fossa. The pterygoid process is a site of origin for the medial and lateral pterygoid muscles.

Figure 3.6. Lateral View of the Maxilla.



3.15. Maxillae. Maxillae or upper jawbones are paired bones that unite in the midline. They give shape to the middle face, form a portion of the floor of the eye socket and lateral wall of the nose, form the anterior two-thirds of the hard palate, and support the natural teeth in bony sockets (Figures 3.6, 3.7, and 3.8). Each maxilla (singular) is irregularly shaped. It is made up of a body and four processes called the nasal process, zygomatic process, alveolar process, and palatine process as follows:

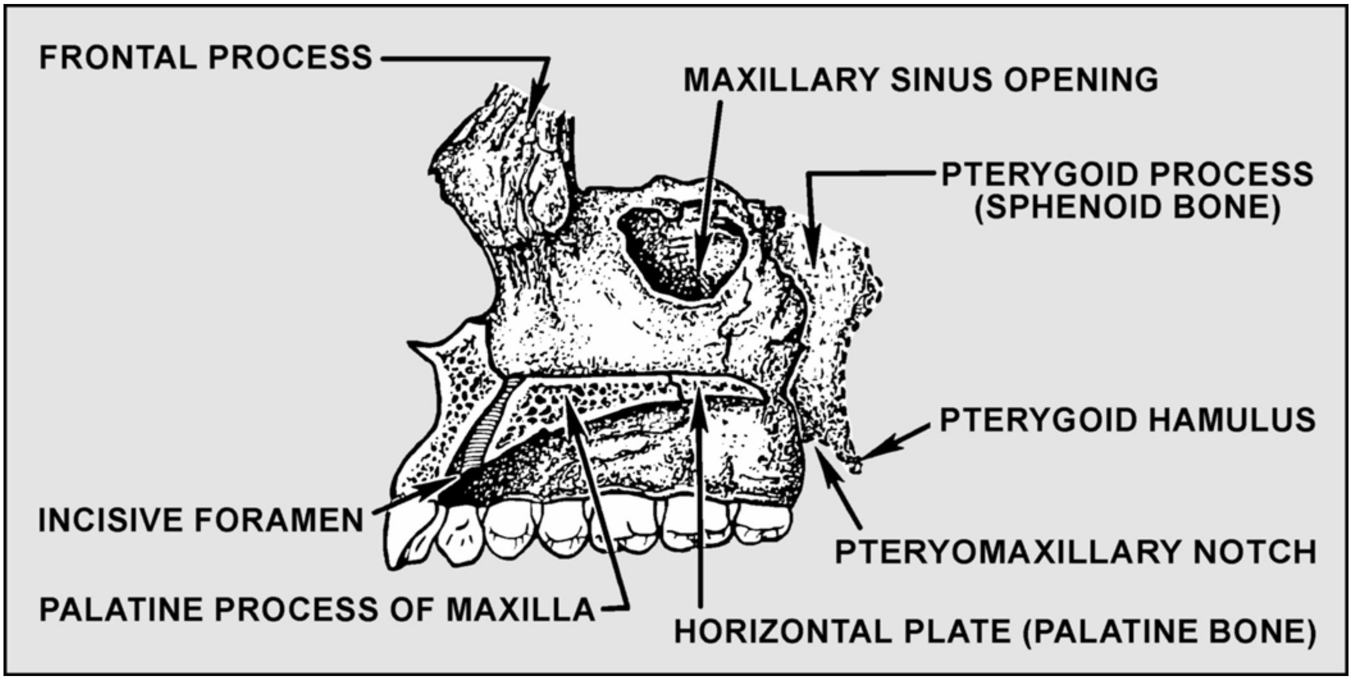
3.15.1. The *nasal process* forms a portion of the lateral wall of the nose. Another name for the nasal process is the frontal process.

3.15.2. The *zygomatic process* of the maxilla joins with the zygoma which, in turn, unites with the zygomatic process of the temporal bone to form the zygomatic arch (or cheekbone). Although popular, the term "cheekbone" is incorrect because this so-called single bone is actually made up of three parts.

3.15.3. The *alveolar process* surrounds the roots of the maxillary teeth, and the alveolar processes of both maxillae unite to form the maxillary arch. A maxillary tuberosity is found on both of the distal ends of the maxillary arch. Proceeding even further posteriorly, the maxillary tuberosities abruptly rise into deep depressions called the *pterygomaxillary notches* (hamular notches). The pterygoid process of the sphenoid bone joins with the posterior aspect of a maxilla to form a pterygomaxillary notch. The labial portion of the alveolar bone follows the contours of the natural tooth roots. This is, when a root is large and prominent, the labial alveolar bone over the root is raised in comparison to an alveolar area between roots. The labial alveolar bone covering the root of the maxillary canine stands out so much it has a specific name--the canine eminence.

3.15.4. The *palatine processes* of the maxillae join in the midline to form the anterior two-thirds of the hard palate. The midline junction of the right and left palatine processes is called the *median palatine suture*. An *incisive foramen* is found in the suture line immediately behind the central incisors. The foramen is an exit hole for nerves and blood vessels that supply palatal tissue (Figure 3.8).

Figure 3.7. Medial View of the Maxilla and Selected Adjacent Bones.



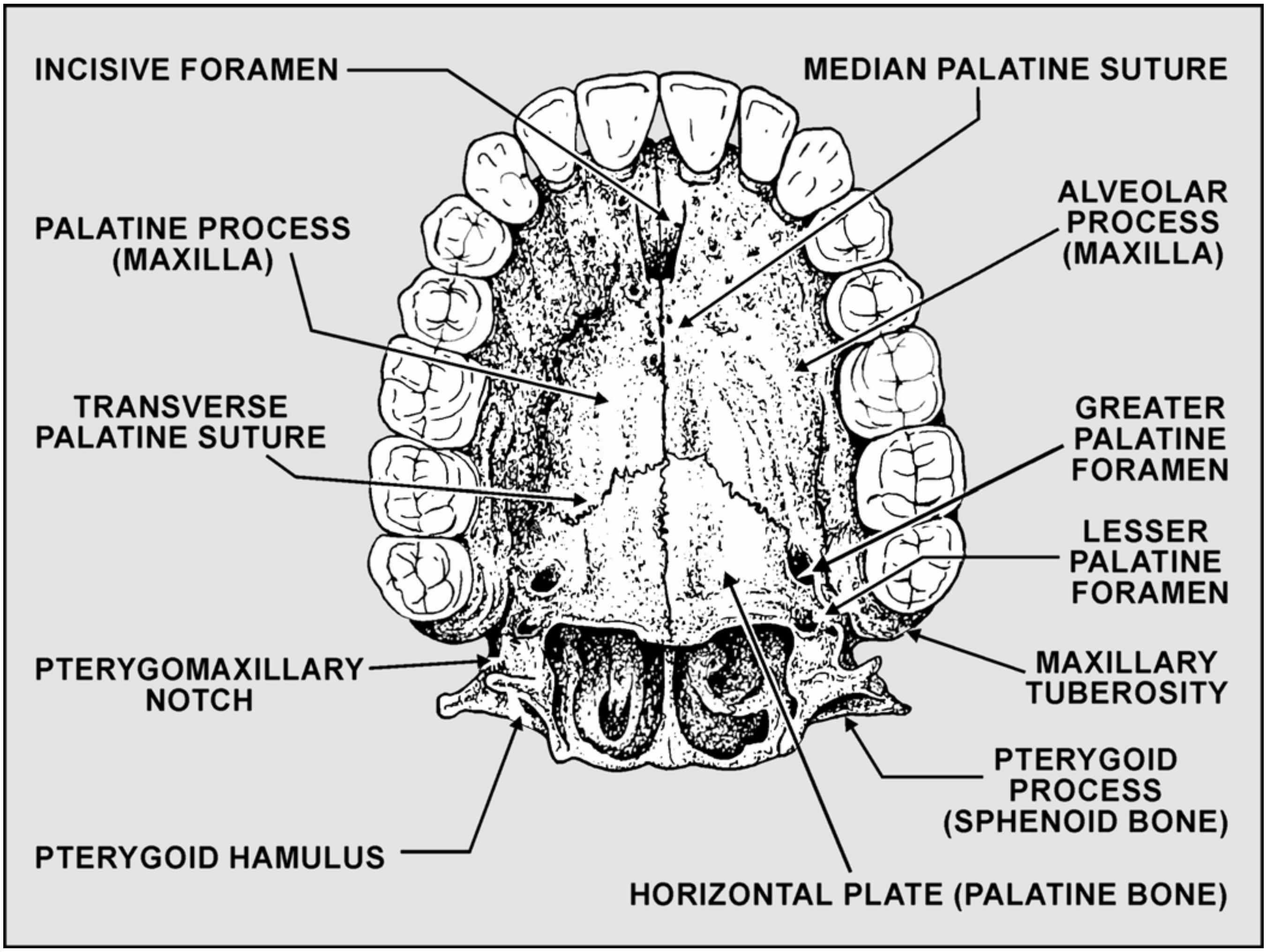
3.16. Palatine Bones:

3.16.1. The palatine bones are paired, U-shaped bones located between the maxillae and the sphenoid bone (Figures 3.7 and 3.8). A palatine bone forms parts of the floor and outer wall of the nasal cavity, the floor of an eye socket, and the hard palate.

3.16.2. The horizontal plates of the palatine bones unite in the midline as the posterior continuation of the medial palatine suture. *The anterior border of the horizontal plates of the palatine bones join with the posterior border of the palatine processes of the maxillae to form the transverse palatine suture.* As discussed previously, the palatine processes of the maxillae form the anterior two-thirds of the hard palate, and the horizontal plates of the palatine bones make up the remaining posterior one-third.

3.17. Zygoma. The zygoma is situated laterally to the maxilla. When the zygomatic process of the maxilla, the zygoma, and the zygomatic process of the temporal bone are considered as a unit, the combination is called the zygomatic arch (Figure 3.4).

Figure 3.8. Occlusal View of the Maxilla.



3.18. Mandible:

3.18.1. The mandible (Figure 3.9) or lower jaw is one of the few movable bones of the skull. This bone gives shape to the lower portion of the face, provides sites of attachment for the muscles that make it move, forms the framework for the floor of the mouth, and supports the lower natural teeth.

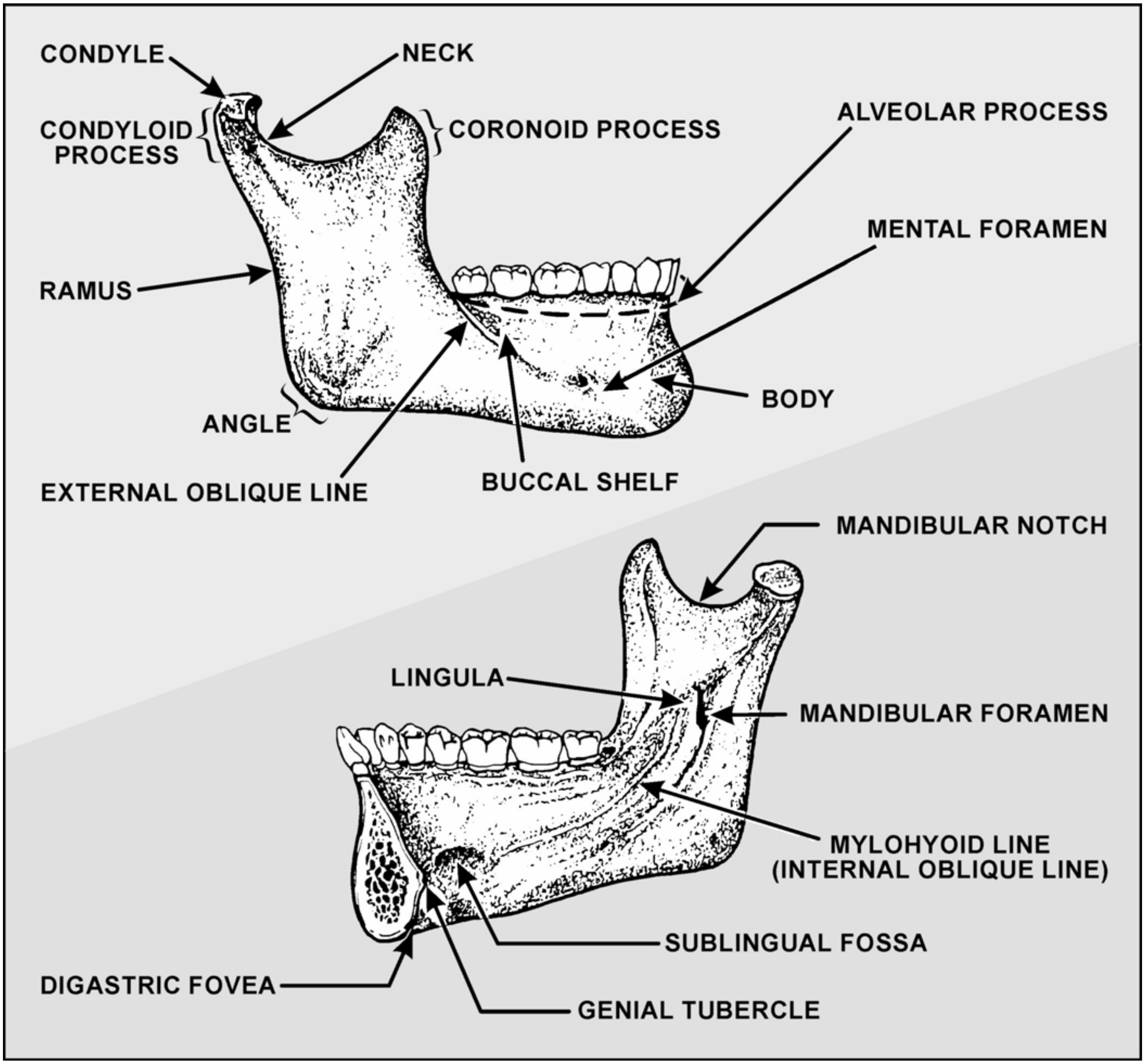
3.18.2. The mandible is connected to the skull by the right and left *temporomandibular joints*. Within each joint, the condyle of the mandible fits into the glenoid fossa on the underside of the temporal bone. In its movements, the condyle also travels onto the temporal bone's articular eminence.

3.18.3. The articular eminence projects downward and forward from the anterior border of the glenoid fossa. (See Section 3F for a detailed description of the temporomandibular joint.)

3.18.4. The most prominent features of the mandible are its horizontal body and two vertical projections known as *rami* (one projection = ramus). The body is curved (somewhat like a horseshoe) at the posterior limits of the body, and the bone turns upward and slightly backward to form the ramus.

3.18.5. As the inferior edge of the mandible is traced from anterior to posterior, the sudden transition between the horizontal body and relatively vertical ramus is known as the *mandibular angle* (angle of the mandible).

Figure 3.9. Lateral and Medial Views of the Mandible.



3.18.6. Three processes are readily identifiable. The body of the mandible carries the *alveolar process*, which surrounds the root structure of individual teeth. The right and left alveolar processes combine to form the mandibular arch. Each ramus ends in two processes, an anteriorly positioned *coronoid process* and the more posterior *condyloid process*. The deep, U-shaped concavity between the two processes is called the mandibular notch. A condyloid process can be divided into a *condyle* and a *neck*. The top part of the condyle articulates with the glenoid fossa and articular eminence of the temporal bone to form the temporomandibular joint.

3.18.7. The external surface landmarks of the mandible are as follows:

3.18.7.1. The mental protuberance—a roughly triangular prominence occurring in the midline near the inferior border of the mandible (chin point).

3.18.7.2. The mental foramen—the anterior opening of the mandibular canal. The foramen is usually found between and slightly below the first and second premolar root tips. The inferior alveolar nerve passes within the mandibular canal and exits onto the exterior surface of the mandible through the mental foramen to become the mental nerve. Compression of the mental nerve by artificial dental replacements must be avoided because it will cause a feeling of pain or numbness.

3.18.7.3. The external oblique ridge (line)—which extends at an oblique angle across the external surface of the body of the mandible. This ridge begins at the lower anterior edge of the ramus, continues onto the body, and progressively thins out to end near the mental foramen. The external oblique ridge is most prominent in the molar area and forms a distinct ledge with relation to the base of the alveolar process. This ledge is called the *buccal shelf.*

3.18.8. Internal surface landmarks of the mandible are as follows:

3.18.8.1. The mylohyoid ridge—located on the internal surface of the mandible and occupying a position similar to the external oblique ridge on the external surface. The mylohyoid ridge passes forward and downward from the internal aspects of the ramus onto the body of the mandible and fades out near the midline. This ridge serves as the lateral line of origin for the mylohyoid muscle (the mylohyoid muscle forms the major portion of the floor of the mouth).

3.18.8.2. The genial tubercles—located slightly above the lower border of the mandible in the midline. These provide an attachment site for the geniohyoid muscle.

3.18.8.3. The sublingual fossa—a shallow concavity housing a portion of the sublingual gland. This depression occurs just above the anterior part of the mylohyoid ridge.

3.18.8.4. The mandibular foramen—located in almost the exact center of the inner surface of the mandibular ramus. It opens into the mandibular canal.

3.18.8.5. The lingula—a bony prominence on the anterior border of the mandibular foramen.

3.18.8.6. The digastric fovea—a depression found on both sides of the midline near the inferior lingual border of the mandible.

3.19. Hyoid Bone:

3.19.1. Any discussion of muscles that move the lower jaw and their points of anchorage must include the hyoid bone. The hyoid is a U-shaped bone located anterior to the spinal column between the mandible and the larynx (voice box).

3.19.2. *There is no joint-like union between the hyoid and any other bone*. It is suspended between the mandible above and the clavicle (collar bone) below by suprahyoid (above the hyoid) and infrahyoid (below the hyoid) muscle groups. Some of the suprahyoid muscles act to depress the lower jaw. Those suprahyoid muscles that act to depress the mandible are described in Section 3D.

Section 3D—Muscles of Mastication and Depressors of the Mandible

3.20. Muscle Fibers and Movements:

3.20.1. A person's ability to move part of the body depends on a group of specialized cells called muscle fibers. Muscle fibers have the ability to contract or shorten when stimulated by nerve impulses. A typical muscle consists of a mass of muscle fibers bound together by connective tissue.

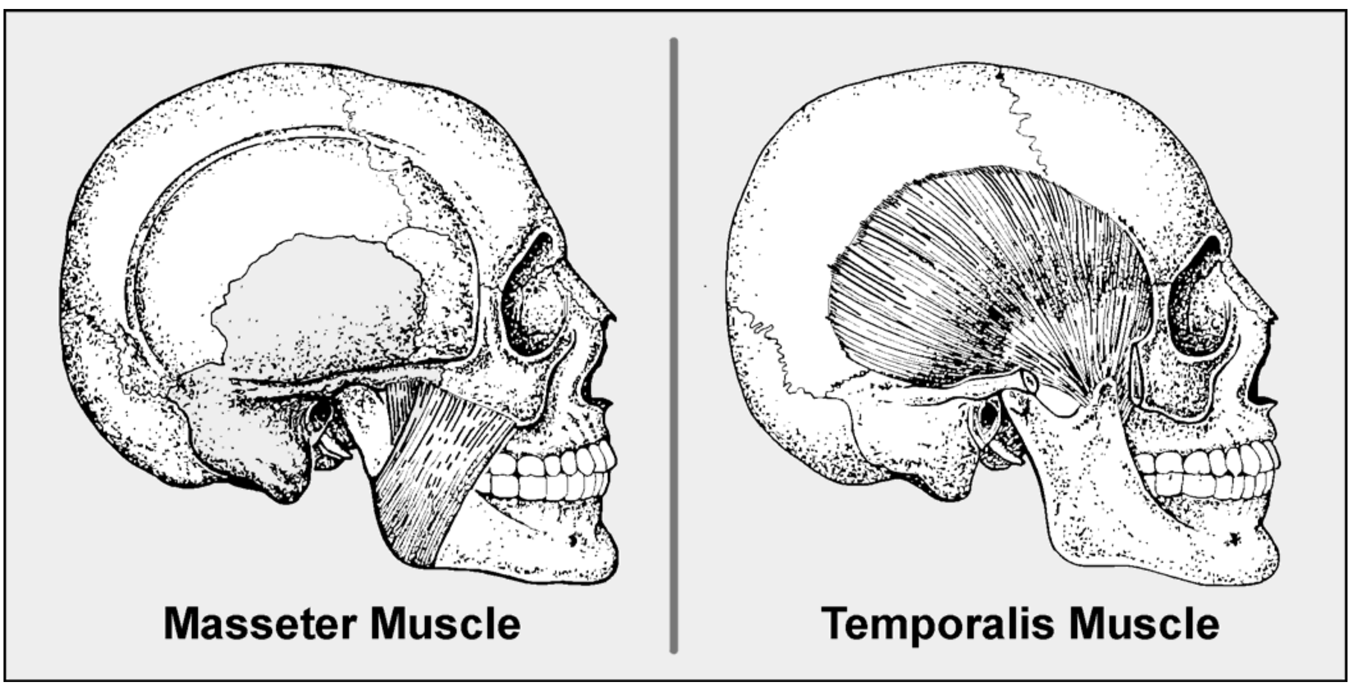
3.20.2. A muscle can generate varying degrees of power. This variation in power is directly proportional to the number and type of fibers within the muscle that are contracting at any given time. Muscles can also stretch, but only because a muscle located elsewhere has contracted and forced the extension. This performance of an action by one muscle that is opposed by the action of another muscle is called *antagonism.* The simplest way to express this is that muscles can only pull; they cannot push.

3.20.3. The two ends of a voluntary muscle usually attach to different bones. In some instances, one end of a muscle may attach in soft tissue such as skin. Some of the very small muscles that give expression to the face have both ends attached to soft tissue. In any case, the muscle attachment site that remains relatively stationary when the muscle contracts is known as the *origin*. The muscle attachment site having the greater movement during the contraction is called the *insertion*. A description of the movements, which take place as a result of muscle contraction, is called the *action*.

3.20.4. Two muscle groups are responsible for executing the movements the mandible is capable of making--the muscles of mastication and the depressor muscles of the mandible. The muscles of mastication enable the lower jaw to make closing, opening, protrusive, and retrusive movements along with movements to the right and left sides. The depressors of the mandible act to open the lower jaw wide--a function the muscles of mastication cannot perform.

3.21. Muscles of Mastication. There are four paired muscles of mastication; masseters (Figure 3.10), temporalis (Figure 3.10), medial pterygoids (Figure 3.11), and lateral pterygoids (Figure 3.12).

Figure 3.10. Masseter and Temporalis Muscles.



3.21.1. **Masseter:**

3.21.1.1. **Origin.** The origin is the zygomatic arch.

3.21.1.2. **Insertion.** The masseter muscle inserts on the lateral surface of the ramus of the mandible (Figure 3.10).

3.21.1.3. **Action.** The primary function of the masseter is to elevate the mandible. The masseter may also aid in the protruding of the mandible.

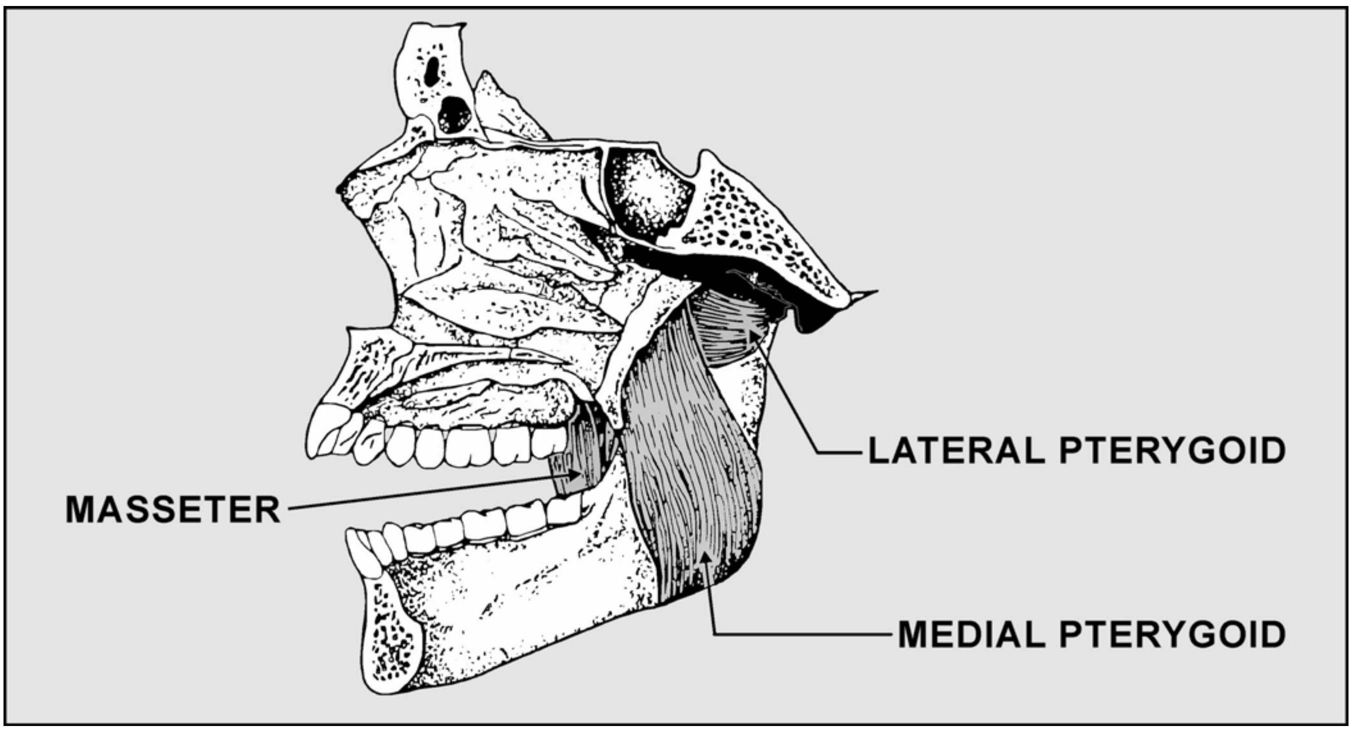
3.21.2. **Temporalis:**

3.21.2.1. **Origin.** The origin of this muscle is broadly spread out (fan-shaped) on the side of the skull (Figure 3.10). It covers the majority of the temporal bone and lesser portions of the frontal and parietal bones. The upper margin of the muscle follows the superior temporal line.

3.21.2.2. **Insertion.** The temporalis muscle inserts on the coronoid process of the mandible.

3.21.2.3. **Action.** The temporalis muscle acts in unison with the masseter and medial pterygoid muscles to close the jaws. Very importantly, it also helps to retrude or pull back the mandible.

Figure 3.11. Medial View of the Medial Pterygoid Muscle.



3.21.3. **Medial Pterygoid:**

3.21.3.1. **Origin.** The origin of this muscle is the palatine bone and pterygoid process of the sphenoid bone (Figure 3.11).

3.21.3.2. **Insertion.** The medial pterygoid inserts on the medial (internal) surface of the ramus of the mandible.

3.21.3.3. **Action.** The medial pterygoid acts with the masseter and temporalis muscles to close the lower jaw. Some authors claim that when one medial pterygoid muscle contracts independently of its paired mate, it helps move the mandible sideways.

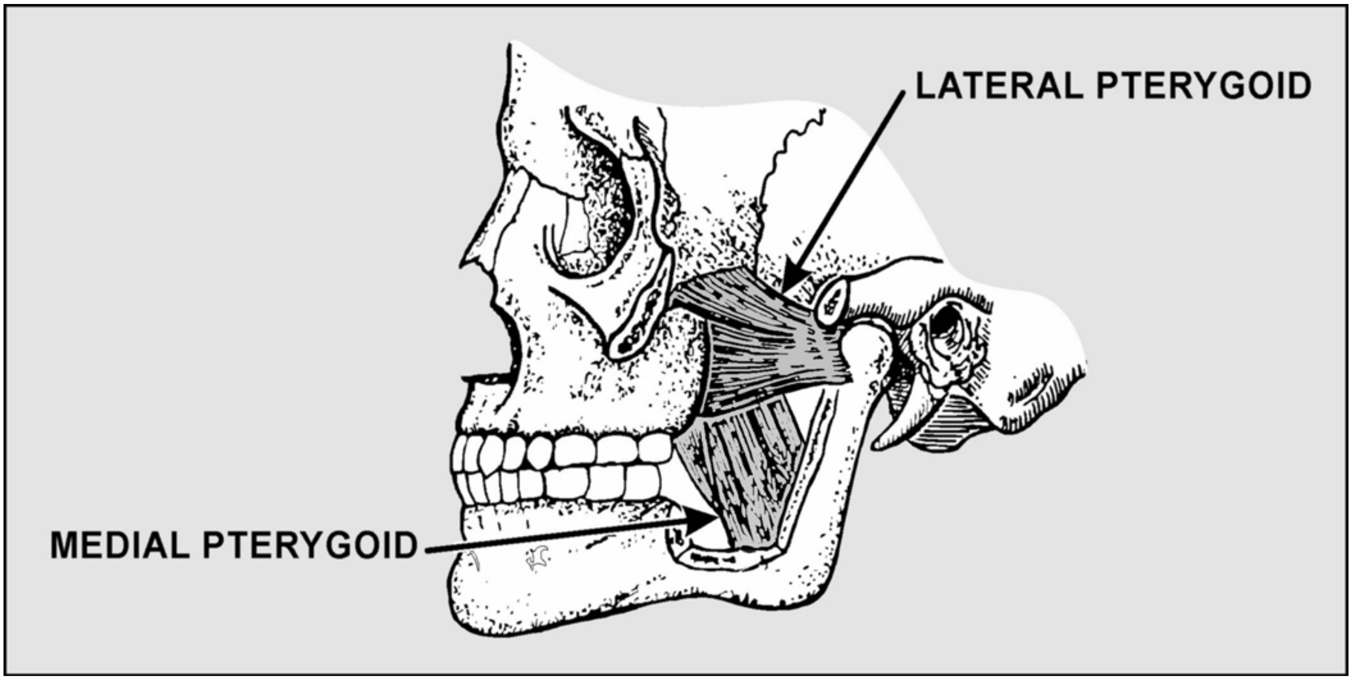
3.21.4. **Lateral Pterygoid:**

3.21.4.1. **Origin.** The origin of this muscle is the pterygoid process and greater wing of the sphenoid (Figure 3.12).

3.21.4.2. **Insertion.** This muscle inserts into the neck of the condyloid process of the mandible.

3.21.4.3. **Action.** When both lateral pterygoid muscles contract together, the mandible is pulled forward into protrusion. (Coincident with a protrusive movement, the mandible opens slightly.) When one muscle contracts independently of the other, the mandible pivots and shifts to the opposite side (lateral excursion).

Figure 3.12. Lateral View of the Lateral Pterygoid Muscle.



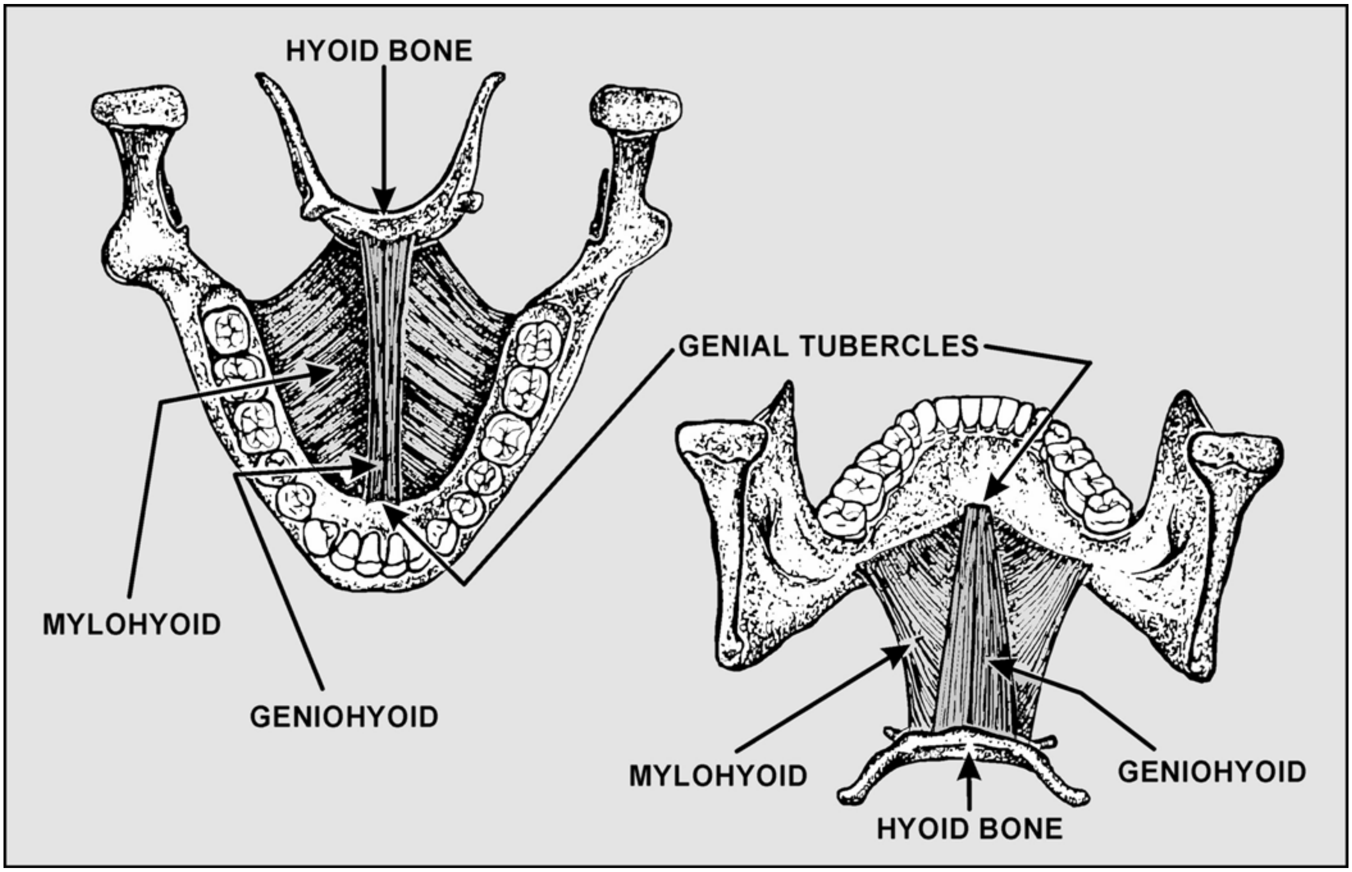
3.22. Depressor Muscles. The depressor muscles of the mandible all have the hyoid bone in common as an attachment site. When the hyoid bone is immobilized by a contraction of the muscles below it, the contraction of the depressor muscles located between the hyoid bone and the mandible pulls the mandible downward (opening the mouth). The suprahyoid depressors of the mandible are the mylohyoid (Figure 3.13), geniohyoid (Figure 3.13), and digastric muscles (Figure 3.14).

3.22.1. **Mylohyoid Muscle Attachment Sites.** The paired mylohyoid muscles are attached to the mylohyoid lines on the internal surfaces of the mandible, *the right and left mylohyoid muscles join in the midline to form the floor of the mouth*, and the posterior end of this midline junction attaches to the hyoid bone (Figure 3.13).

3.22.2. **Geniohyoid Muscle Attachment Sites.** The two geniohyoid muscles are found next to each other on each side of the midline and directly on top of the mylohyoid muscles. The sites of the attachment are the genial tubercles and the hyoid bone (Figure 3.13).

3.22.3. **Digastric Muscle Attachment Sites.** The digastric muscle bundle is divided into an anterior belly and a posterior belly by a short tendon. This intermediate tendon passes through a loop of fibrous tissue secured to the body of the hyoid bone. The end of the anterior belly attaches to the digastric fovea and the posterior belly fastens onto the mastoid process of the temporal bone (Figure 3.14).

Figure 3.13. Mylohyoid and Geniohyoid Muscles.



Section 3E—Facial Expression Muscles

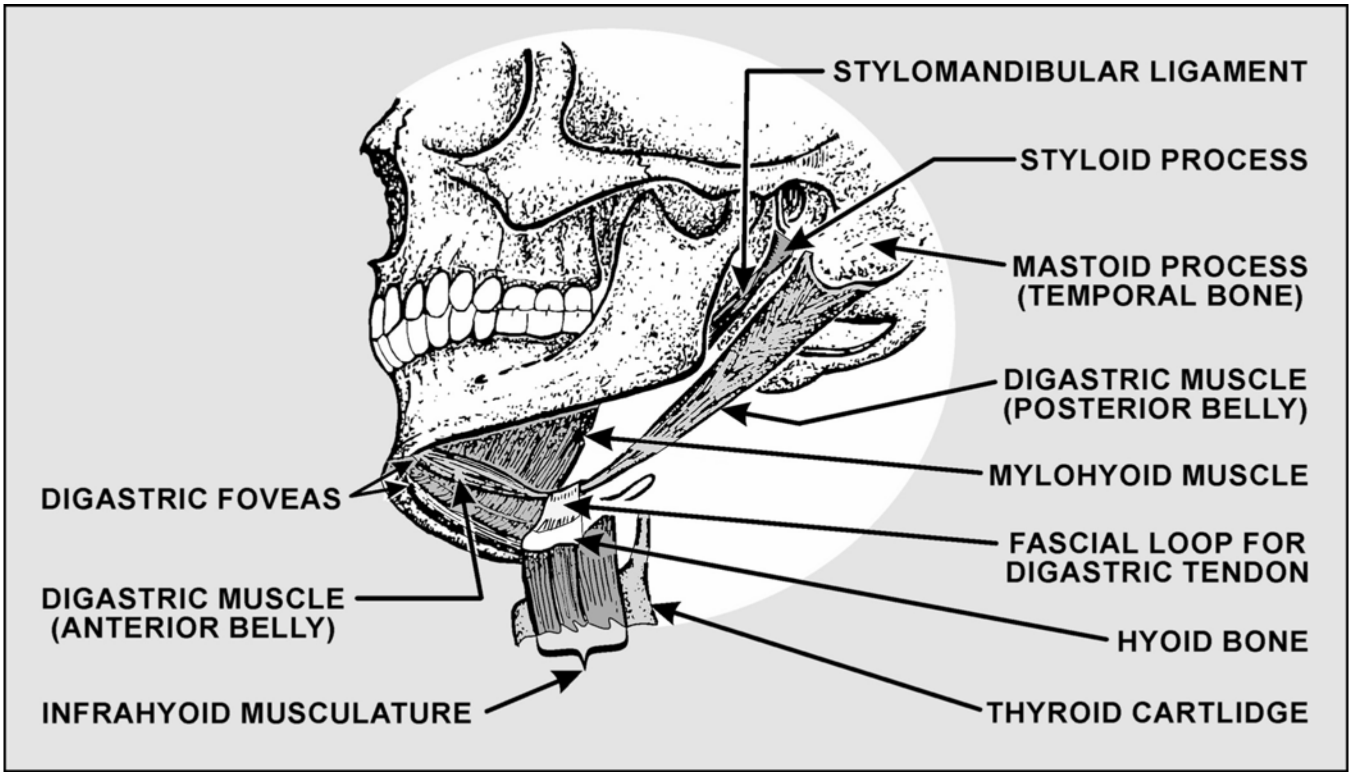
3.23. Maintaining Facial Muscle Support:

3.23.1. Eight paired muscles of expression in coordination with the single *orbicularis oris* muscle, control the movements of the lips and cheeks (Figure 3.15). The teeth and alveolar processes of the jaws support this group of muscles against collapse into the oral cavity. When natural teeth are extracted, facial muscle support must be maintained by replacing the missing teeth.

3.23.2. A person's appearance can be dramatically affected by the position of the artificial teeth. Inadequate support makes people look older; excessive support distorts a person's features by making them appear stretched. The muscles of facial expression also play an important part in forming the anterior and lateral portions of maxillary and mandibular impression borders. This is because all of these muscles can alter the depth of vestibular sulci in one way or another. (See paragraphs 3.37.12 and 3.38.6.)

3.23.3. If impression borders are not properly extended and shaped, the muscles act to unseat the dentures. The influence of the muscles of facial expression on denture borders is described in Chapter 7.

Figure 3.14. Oblique View of the Mylohyoid and Digastric Muscles.



3.24. Orbicularis Oris:

3.24.1. This ring-like muscle lies within the upper and lower lips and completely surrounds the opening to the mouth. When the orbicularis oris contracts, it causes the lips to close.

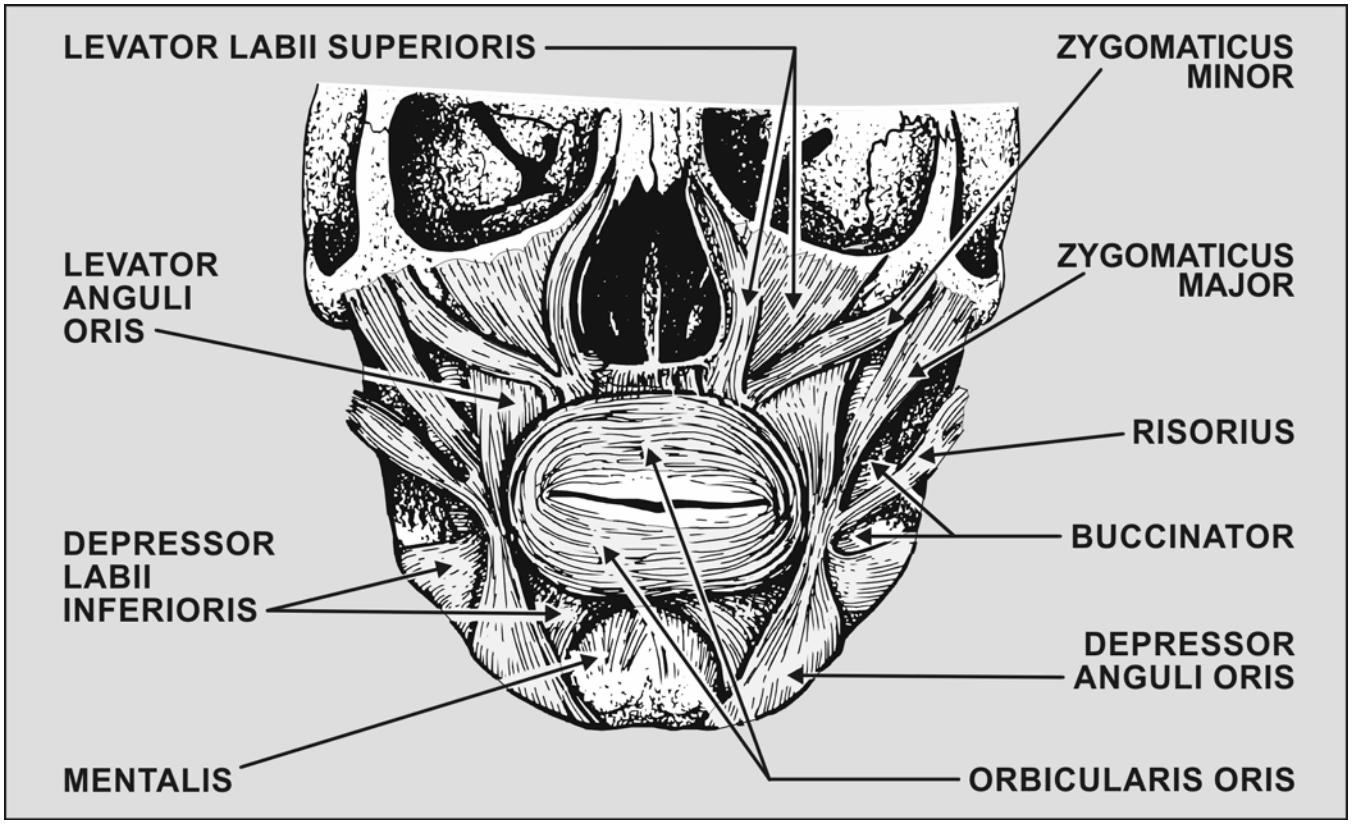
3.24.2. The orbicularis oris has no real bony origin. Instead, it is entirely rimmed by the insertions of other muscles of facial expression, most of which do originate on bone. Certain muscles of expression that insert into the orbicularis oris act to draw the corners of the mouth backward, while some depress the lower lip and others elevate the upper lip.

3.25. Levator Labii Superioris Muscle. This facial expression muscle is flat and triangular. It is positioned lateral to the nose and has an origin by two heads; the frontal process of the maxilla and the inferior margin of the orbit. These unite at one insertion point in the fibers of the obicularis oris beneath the nostrils. The levator labii superioris muscle acts to elevate the upper lip, widen the nasal opening, and raise the corner of the nose.

3.26. Zygomaticus Major Muscle. The zygomaticus major muscle is oblong, flat, and cylindrical. It is positioned lateral to and above the angle of the mouth. It originates at the zygomatic bone, lateral to the levator labii superioris muscle, and inserts in skin just superior to and at the angle of the mouth. The muscle’s action is to draw the angle of the mouth laterally and upward.

3.27. Levator Anguli Oris Muscle. The levator anguli oris muscle is flat and triangular. Its position is in the levator anguli oris fossa of the maxilla, covered by the levator labii superioris muscle. The levator anguli oris originates in the canine fossa and inserts at the angle of the mouth. It has three actions; it lifts the angle of the mouth upward, lifts the lower lip, and helps close the mouth.

Figure 3.15. Muscles of Facial Expression.



3.28. Risorius Muscle. The risorius muscle is flat and triangular. With a position lateral to the angle of the mouth, it originates in tissue over the masseter muscle and parotid gland. The risorius has an insertion at the angle of the mouth with the depressor anguli oris muscle. Its action is to draw the angle of the mouth laterally causing a smile and dimple.

3.29. Depressor Labii Inferioris Muscle. With a flat and quadrangular shape, this muscle covers the mental foramen. It has an origin along the lower border of the mandible and inserts into the skin of the lower lip. When contracted, it acts to depress and invert the lower lip.

3.30. Depressor Anguli Oris Muscle. Shaped flat and triangular, the depressor anguli oris muscle covers the depressor labii inferioris muscle. It also has an origin along the lower border of the mandible just beneath the mental foramen. With an insertion at the angle of the mouth, it acts to draw the angle upward.

3.31. Mentalis Muscle. The mentalis is a short, thick, cylindrical muscle positioned on the boney prominence of the chin, deep to the depressor labii inferioris muscle. Its origin on the mandible is also deep to the depressor labii inferioris. When contracting, it lifts and wrinkles the skin of the chin and pulls tissue below the lips towards the lower anterior teeth.

3.32. Buccinator Muscle:

3.32.1. The buccinator muscle is a thin, broad band of muscle tissue that forms the innermost muscle wall of a cheek.

3.32.2. A buccinator muscle has three sites of origin. They are the pterygomandibular raphe (ligament), which originates behind the maxillary tuberosity and inserts at the posterior end of the mandible's mylohyoid line; the buccal surface of the alveolar process in the maxilla immediately above the root tips of the molar teeth; and the external oblique ridge of the mandible.

3.32.3. The muscle fibers of the buccinator run parallel to the occlusal plane of the teeth and have a broad zone of insertion into the orbicularis oris at the corner of the mouth. Besides being muscles of facial expression, some anatomists classify the buccinators as accessory muscles of mastication.

3.32.4. The primary functions of these muscles are to pull the corners of the mouth laterally and hold food between the teeth while chewing.

3.33. Platysma Muscle. The platysma is a thin broad band of muscle that originates over the pectoralis major and deltoid muscles. Its insertion is the inferior border of the mandible and the skin of the lower face. The platysma acts to draw the corners of the mouth down and aids in depression of the mandible.

Section 3F—Intraoral Soft Tissue Anatomy

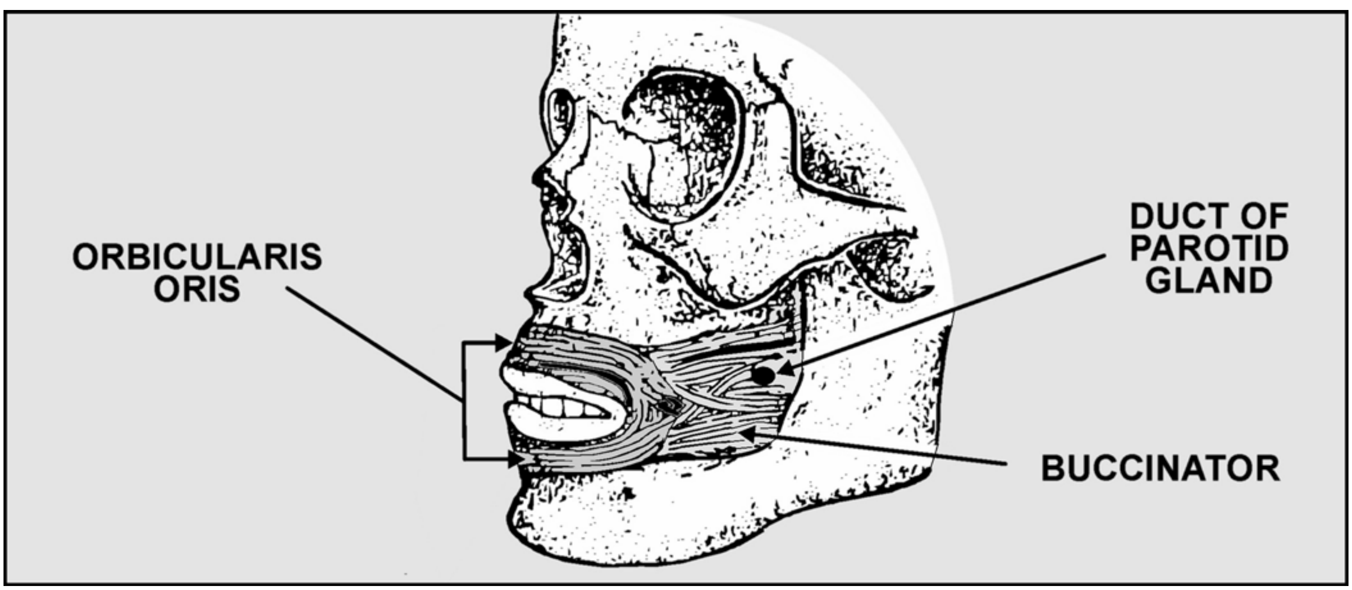
3.34. Introduction:

3.34.1. The muscles that form the sides, entrance, and floor of the oral cavity are the *buccinators*, *orbicularis oris*, and *mylohyoids* (in that order) (Figure 3.16).

3.34.2. The skin of the interior of the mouth is called oral mucous membrane or mucosa. In places like the alveolar processes and hard palate of the upper jaw, the mucous membrane is firmly and directly attached to bone. This kind of mucosa presents a stable surface. In other areas like the lips and the floor of the mouth, the mucous membrane covers active muscles that are constantly in motion. For example, the strong, muscular tongue is almost always moving.

3.34.3. A removable prosthesis is built to use stable mucosa for support and avoid areas of high muscle activity. There are soft tissue landmarks in the mouth that remain constant after natural teeth are extracted, and these landmarks are valuable aids in prosthesis construction.

Figure 3.16. Entrance and Sides of the Oral Cavity.



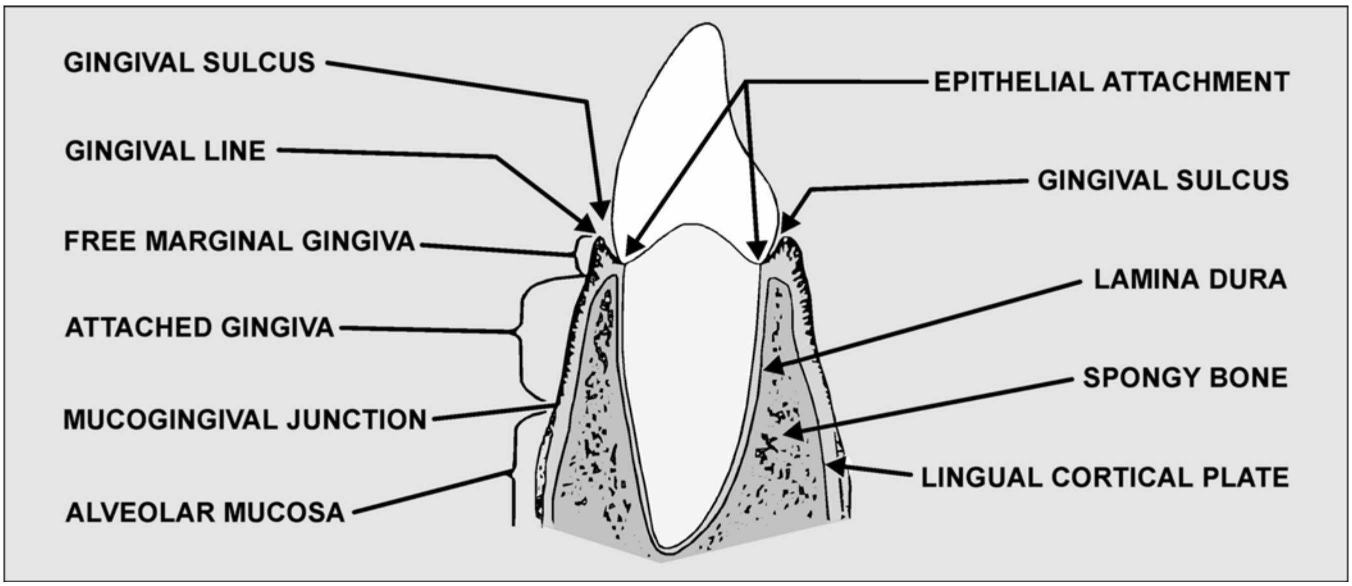
3.35. Mucous Membrane. Mucous membrane is the skin that lines the mouth (Figure 3.17 and 3.18).

3.35.1. **Mucous Membrane of the Alveolar Process.** The mucous membrane of the alveolar process is divided into gingiva and alveolar mucosa (Figure 3.17) as follows:

3.35.1.1. **Gingiva.** Gingiva covers the crestal three-fourths of the alveolar process. There are two kinds of gingiva, free and attached. Free gingiva is about 0.5 mm wide and is found at the neck of a tooth. Attached gingiva is continuous with the free gingiva and is tightly bound to bone. The attached gingival band varies between 2 and 9 mm wide; the widest part is found in the anterior regions.

3.35.1.2. **Alveolar Mucosa.** Alveolar mucosa covers the basal one-fourth of the alveolar process. Alveolar mucosa is very mobile because it is loosely bound to underlying bone.

Figure 3.17. Mucous Membrane of the Alveolar Process.



3.35.2. **Mucous Membrane of the Hard Palate.** The mucous membrane of the hard palate consists of attached gingiva.

3.36. Vestibule. The vestibules consist of two potential spaces. One vestibule is found between the facial aspect of the teeth and the internal surfaces of the cheeks and lips; the other vestibule is found between the lingual aspect of the mandibular teeth and the tongue (Figure 3.18).

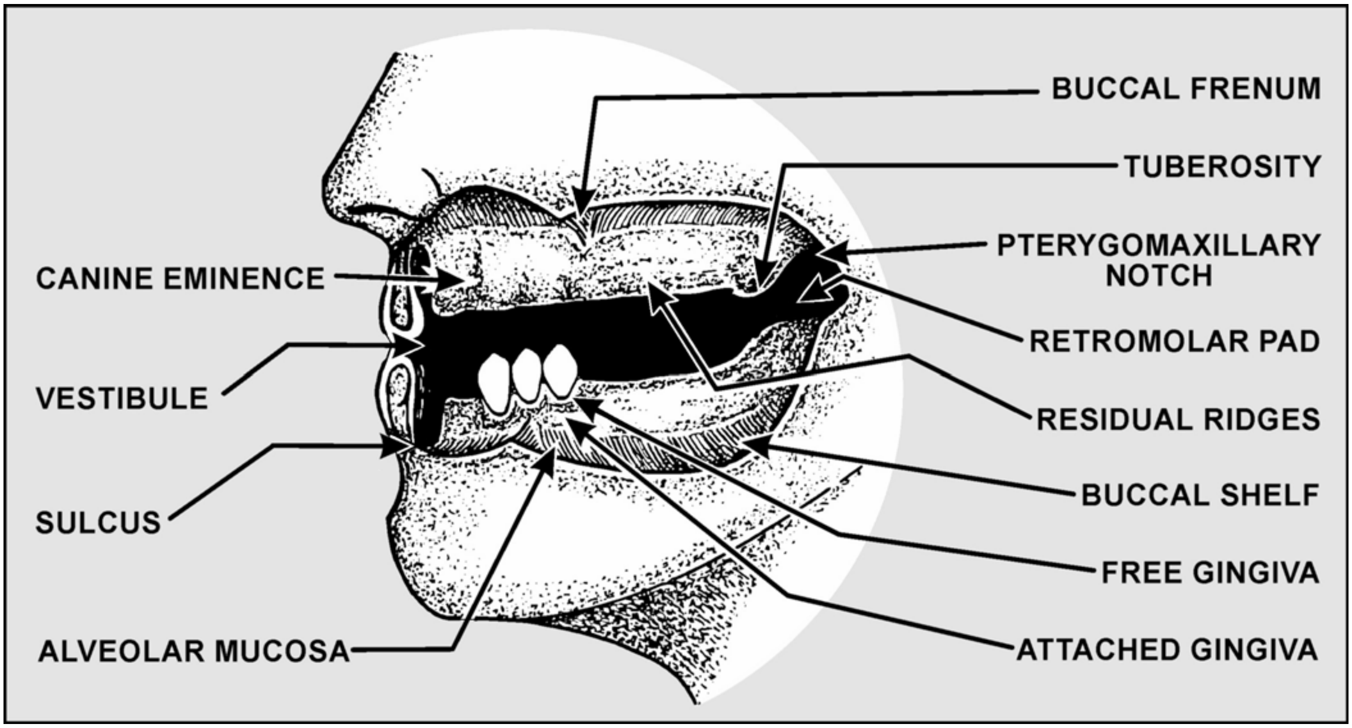
3.37. Maxilla: (***NOTE:*** See Figures 3.18, 3.19, and 3.20.)

3.37.1. **Alveolar (Residual) Ridge.** The alveolar (or residual) ridge is the remnant of the alveolar process which originally contained sockets for natural teeth. After natural teeth are extracted, the alveolar ridge can be expected to get smaller (resorb). The rate of resorption varies considerably from person to person.

3.37.2. **Maxillary Tuberosity.** The maxillary tuberosity is the most distal (posterior) portion of the maxillary alveolar ridge.

3.37.3. **Ptyerygomaxillary (Hamular) Notch.** The pterygomaxillary notch is a deep depression located posterior to the maxillary tuberosity. The depths of this depression are part of a series of guides used to determine the posterior border of a maxillary denture.

Figure 3.18. Lateral View of the Oral Cavity.



3.37.4. **Palate.** The palate extends from the roof of the mouth all the way back to the uvula as follows:

3.37.4.1. The hard palate is made up of the anterior two-thirds of the palatal vault supported by bone (the palatine processes of the maxillae and the horizontal plates of the palatine bones).

3.37.4.2. The soft palate is made up of the posterior one-third of the palatal vault not supported by bone. The soft palate is a muscular extension from the posterior edge of the hard palate, and the soft palate is very mobile, especially while speaking and swallowing.

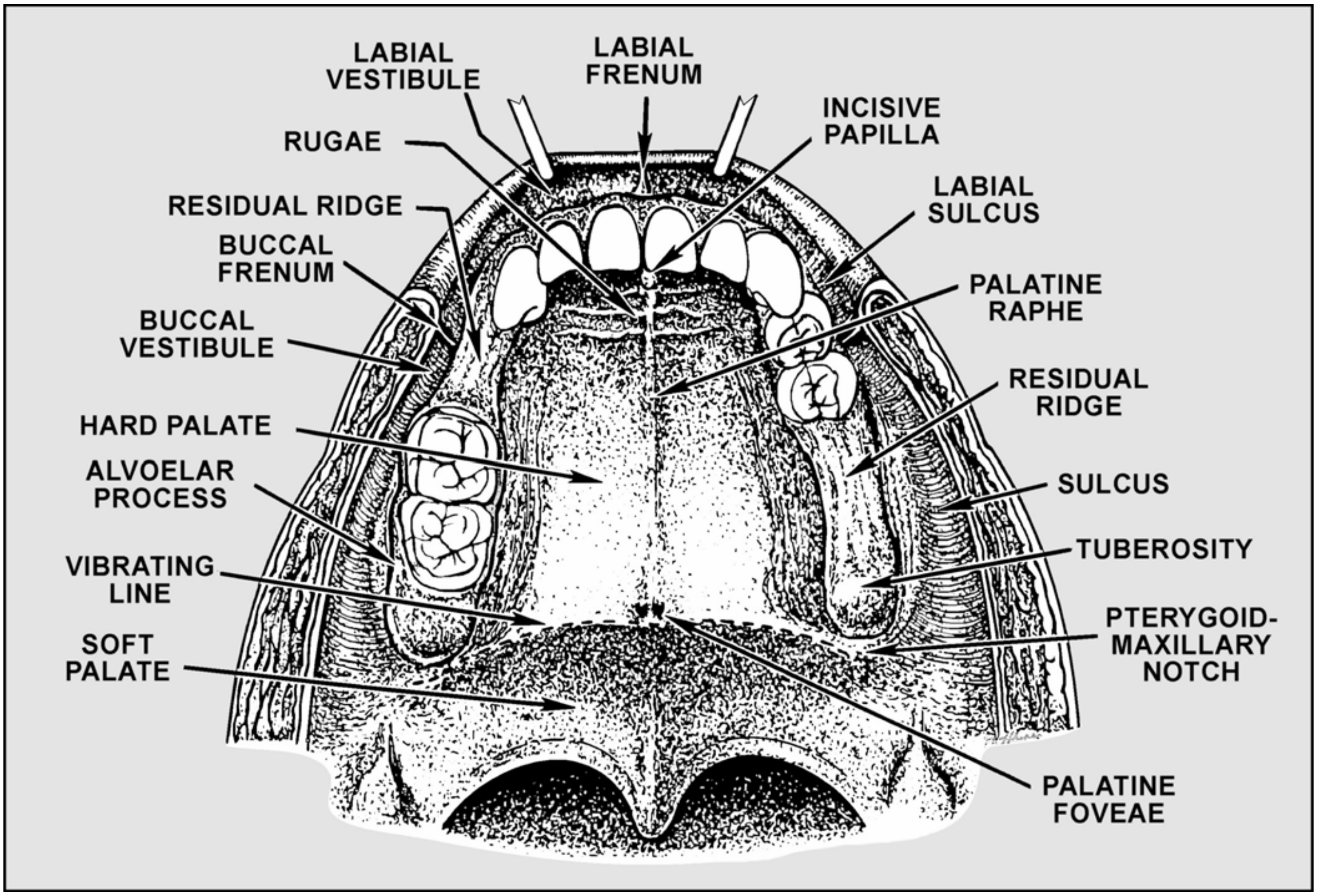
3.37.5. **Incisive Papilla.** The incisive papilla is the raised soft tissue covering the incisive foramen located in the midline of the hard palate, immediately behind the central incisors. Because the incisive papilla is visible in the exact midline of the hard palate (just behind the natural central incisors), it is a *reliable guide* for determining the midline relationships of upper anterior denture teeth.

3.37.6. **Rugae.** Rugae are irregular ridges of fibrous tissue found in the anterior one-third of the hard palate.

3.37.7. **Median Palatine Raphe.** The median palatine raphe is a slight tissue elevation occurring in the midline of the hard palate immediately over the median palatine suture.

3.37.8. **Vibrating Line.** The vibrating line is the line of flexion between the hard and soft palates. The line most frequently falls between the two pterygomaxillary notches on or near the palatine foveae in the midline. When a dentist looks at a patient's entire palatal vault, it is easy to see an abrupt transition between the unmoving hard palate and the highly mobile soft palate.

Figure 3.19. Occlusal View of the Maxilla.



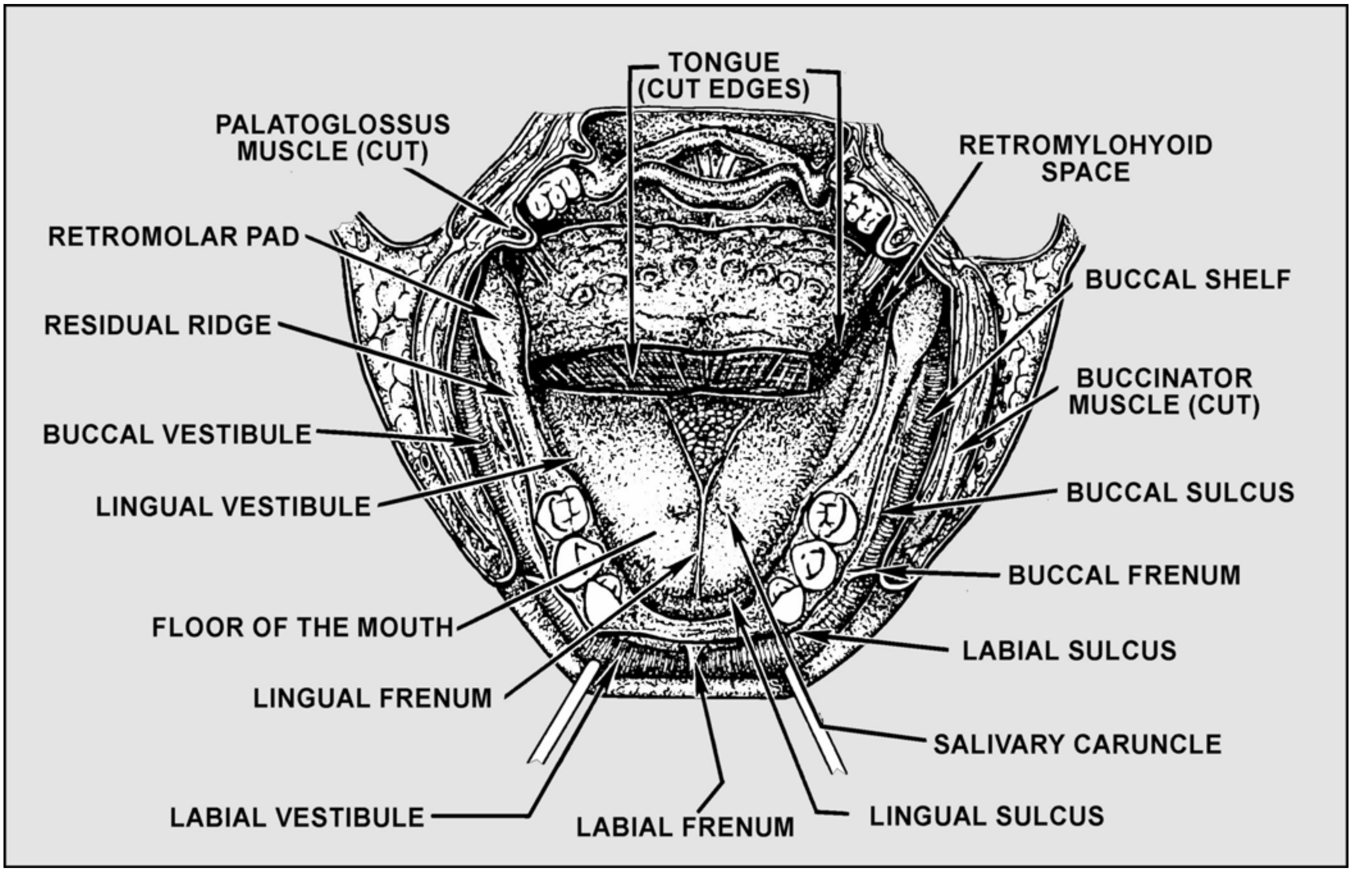
3.37.9. **Palatine Fovea.** The palatine fovea are two depressions located on either side of the midline on or very near the vibrating line. They are made by two groupings of minor palatine salivary glands. ***NOTE:*** The vibrating line helps the dentist determine the posterior border of an upper denture. In the absence of specific instructions from a dentist, the pterygomaxillary notches and the palatine foveae are the guide for determining the posterior border of an upper denture.

3.37.10. **Labial Frenum.** The labial frenum is a narrow fold of oral mucosa found in the approximate midline. It extends from the inner surface of the lip to the labial surface of the alveolar ridge. When natural teeth are absent, the labial frenum is *not* a reliable guide for determining the midline of the face.

3.37.11. **Buccal Frenum.** The buccal frenum extends from the mucosa of the cheek to the buccal aspect of the alveolar ridge. There are two buccal frena. They are located on each side of the arch, usually in the first premolar region.

3.37.12. **Sulci.** The maxillary sulcus is a groove formed by the mucosa of the cheek or lip and the mucosa at the base of the alveolar ridge. The portion of the sulcus that lies between the labial and buccal frena is the labial sulcus. The part of the sulcus between the buccal frenum and the pterygomaxillary notch is the buccal sulcus. The muscles shaping the sulcus cause its depth to change with every facial expression.

Figure 3.20. Occlusal View of the Mandible.



3.38. Mandible: (***NOTE:*** See Figures 3.18, 3.20, and 3.21.)

3.38.1. **Alveolar Ridge.** After natural teeth are extracted, the remnant of the alveolar process is called the alveolar or residual ridge. As time goes on, a residual ridge usually resorbs (gets smaller).

3.38.2. **Retomolar Pad.** The retromolar pad is a pear-shaped mass of soft tissue located at the posterior end of the mandibular alveolar ridge (Figure 3.22). The retromolar pads are important for the following reasons:

3.38.2.1. When maxillary and mandibular natural teeth are brought together, a plane of contact automatically forms between the occlusal surfaces of the upper and lower teeth (occlusal plane). When this plane of contact is projected posteriorly, it intersects with the mandible at two points, one point on each side of the arch. These points are about two-thirds of the way up the height of the retromolar pads.

3.38.2.2. The position of the pads remains constant even after the natural teeth are extracted. Thus, the pads are an *excellent guide* for determining and setting the plane of occlusion between upper and lower denture teeth.

3.38.2.3. The pads serve as bilateral, distal support for a mandibular denture. Covering the pads with the denture base helps reduce the rate of alveolar ridge resorption.

Figure 3.21. View of the Labial Vestibules.

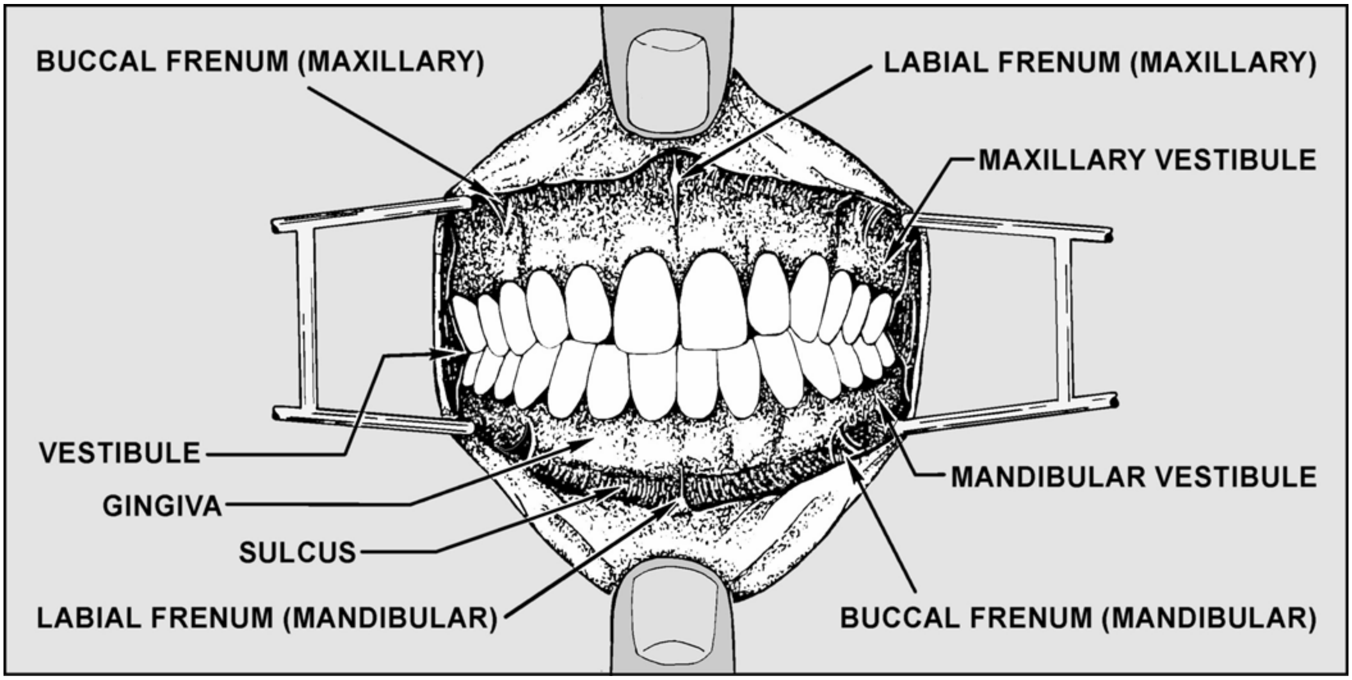
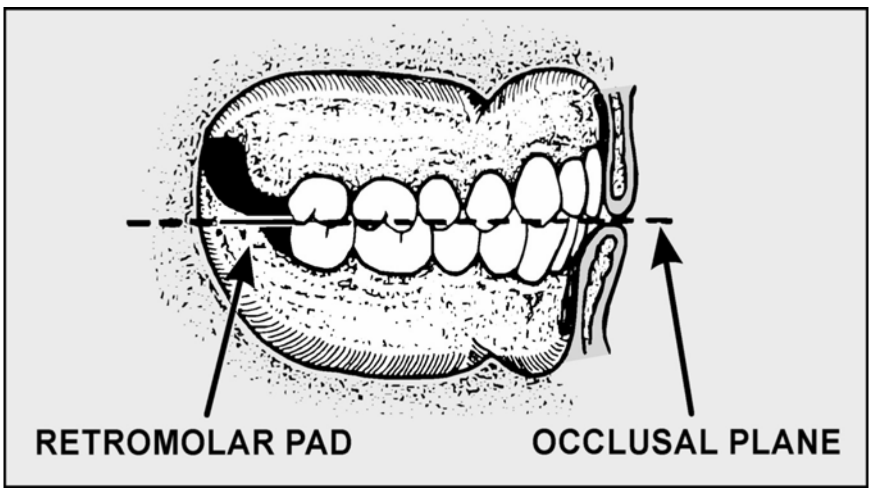


Figure 3.22. Relationship of the Retromolar Pads to the Occlusal Plane.



3.38.3. **Buccal Shelf.** The buccal shelf is a ledge located buccal to the base of the alveolar ridge in the premolar and molar regions. Laterally, the shelf extends from the alveolar ridge to the external oblique line. A buccal shelf is barely observable when the alveolar ridge is large. (The shelf increases in size as the ridge resorbs.) The buccal shelf is a support area for a mandibular denture, especially when the remaining alveolar ridge is relatively small.

3.38.4. **Mental Foramen:**

3.38.4.1. The mental foramen is a hole in bone ordinarily found on the buccal surface of the alveolar ridge. It is located between and slightly below the root tips of the first and second premolars. There is no tissue bump over the hole as in the case of the incisive foramen.

3.38.4.2. When resorption of the alveolar ridge is drastic, the mental foramen is found below the oral mucosa on the crest of the alveolar process. In this case, relief of the denture is necessary to avoid excessive pressure on the nerve fibers exiting from this foramen. Compression results in loss of feeling in the lower lip. *Relief* in this case is defined as space provided between the undersurface of the denture and the soft tissue to reduce or eliminate pressure on certain anatomical structures.

3.38.5. **Frena.** The labial and buccal frena of the mandible are in corresponding positions to their counterparts in the maxilla. A lingual frenum can be seen in the floor of the mouth when the tongue is raised. The lingual frenum is present in the approximate midline and extends from the floor of the mouth to the lingual surface of the alveolar ridge.

3.38.6. **Sulci.** Sulci rise and fall with facial expressions and tongue movements. The labial sulcus of the lower jaw lies at the base of the alveolar ridge between labial and buccal frena. The buccal sulcus extends posteriorly from the buccal frenum to the buccal aspect of the retromolar pad. The lingual sulcus is the groove formed by the floor of the mouth as it turns up onto the lingual aspect of the alveolar ridge.

3.38.7. **Floor of the Mouth.** The anterior two-thirds of the floor of the mouth is formed by the union of the right and left mylohyoid muscles in the midline. The depth of the floor of the mouth in relation to the mandibular alveolar ridge constantly changes due to factors such as mylohyoid muscle contractions, tongue movements, and swallowing activities. The posterior one-third of the lingual sulcus area is called the *retromylohyoid space.* Distally, the palatoglossus muscle shapes the area.

3.39. Tongue:

3.39.1. **Overview:**

3.39.1.1. The tongue is a muscular organ containing specialized cells for detecting the presence of chemicals in the food we eat (Figures 3.23 and 3.24). The brain interprets this chemical detection process as *taste*. The tongue's many different sets of muscles enable it to make the complex movements associated with speaking and with chewing food. The constant motion of the tongue represents a powerful force, and no artificial dental replacement can restrict that motion for long.

3.39.1.2. If a prosthesis is not constructed to work in harmony with the tongue, the prosthesis will fail. For example, the tongue can maintain a denture in position or throw it out, depending on how the lingual surfaces and borders of the denture are shaped.

3.39.2. **Muscle Groups.** The tongue is animated by two muscle groups, the intrinsic and extrinsic, as follows:

3.39.2.1. Intrinsic muscles represent the substance of the tongue (Figure 3.23). They are responsible for the tongue's ability to change shape.

3.39.2.2. Extrinsic muscles originate at sites like the hyoid bone, styloid process of the temporal bone, and genial tubercles (Figure 3.24). Extrinsic muscles proceed from their sites of origin and insert into the tongue's mass. The extrinsic musculature enables the mass of the tongue to move from place to place within the mouth.

3.39.2.3. Intrinsic and extrinsic muscles do not act in isolation from one another. The smooth, precise tongue movements we take for granted are the result of finely coordinated contractions generated by appropriate muscles in both groups.

Figure 3.23. Intrinsic Muscles of the Tongue.

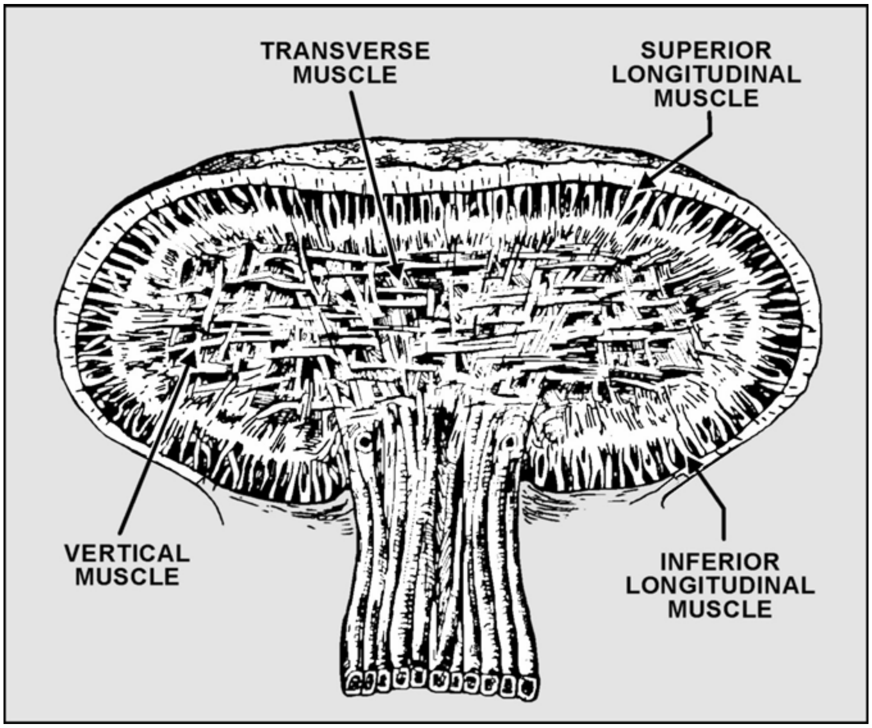
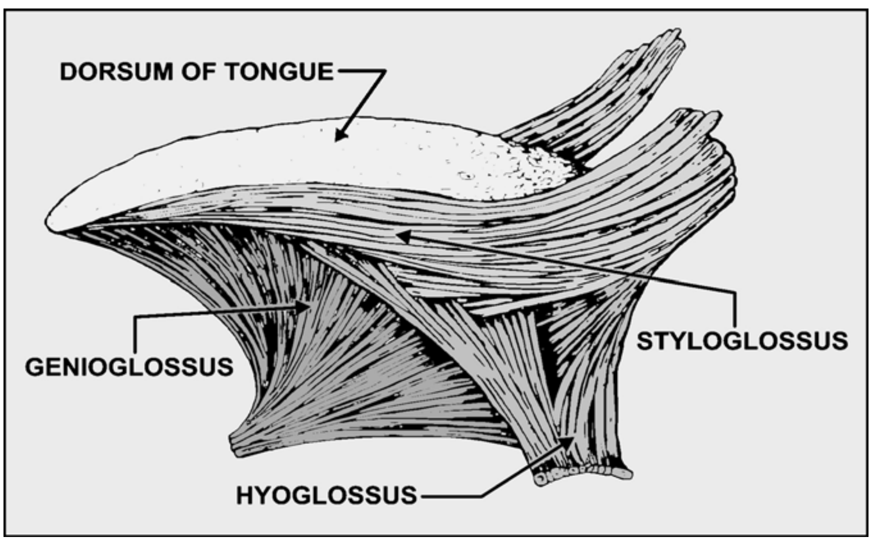


Figure 3.24. Extrinsic Muscles of the Tongue.



3.40. Major Salivary Glands:

3.40.1. The three pairs of major salivary glands are the parotid, submandibular, and sublingual glands (Figure 3.25) as follows:

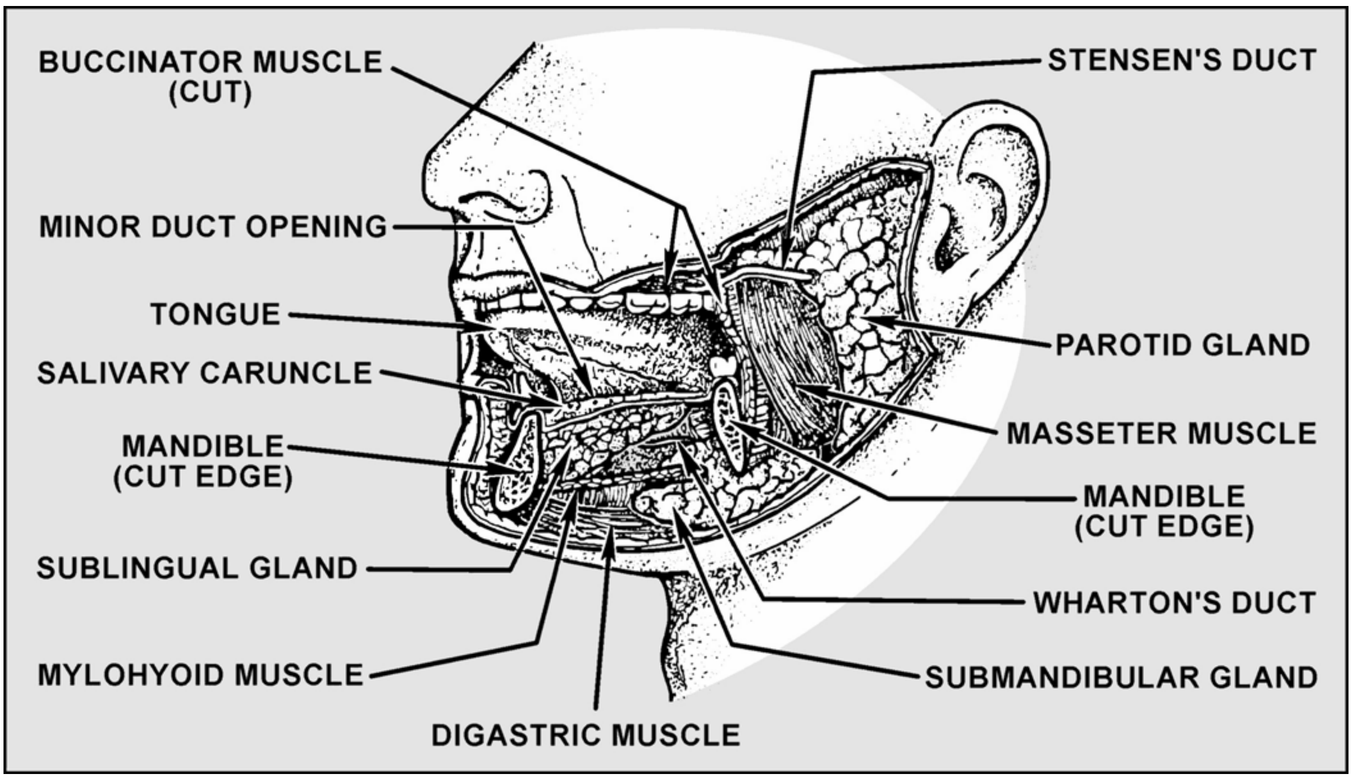
3.40.1.1. The *parotid glands* lie in front of and below the ears. Each discharges its secretion through the parotid duct (Stensen's duct), which enters the mouth in the maxillary buccal vestibule opposite the second molar. The opening is usually marked by a papilla called the parotid papilla.

3.40.1.2. The *submandibular glands* are also called the submaxillary glands. The submandibular glands are found on the right and left sides, between the mandible and the midline, mostly below and partially above the mylohyoid muscle's posterior edge. Each submandibular gland discharges its secretion through the submandibular duct (Warton's duct) which opens onto the floor of the mouth.

3.40.1.3. The *sublingual glands* are found beneath the surface of the floor of the mouth on top of the mylohyoid muscles; the lateral border of each gland rests in a corresponding sublingual fossa.

3.40.2. The sublingual duct (duct of Bartholin) either opens independently onto the floor of the mouth or joins the submandibular duct. The openings of the sublingual and submandibular ducts are located on an elevated line of mucous membrane on each side of the lingual frenum. These elevations are the sublingual caruncles.

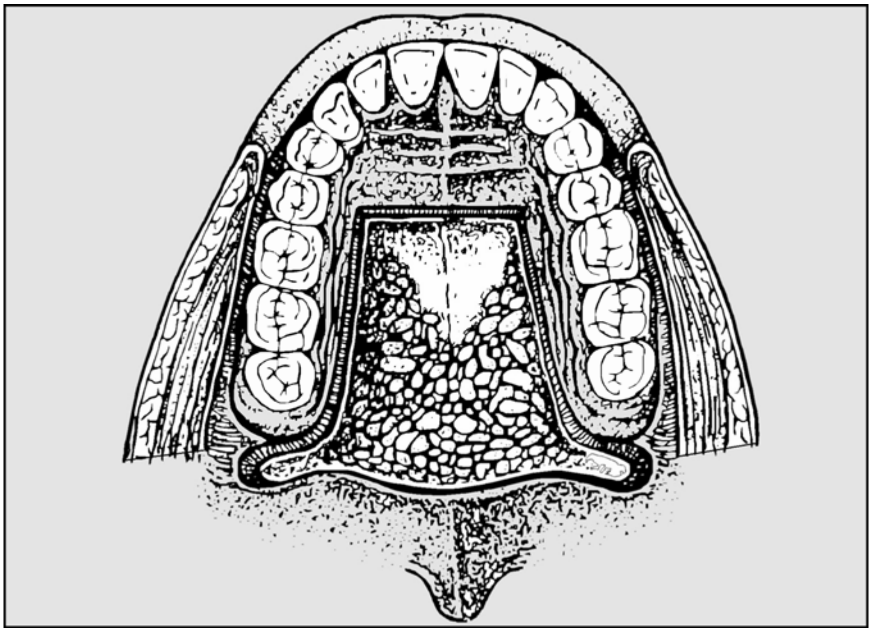
Figure 3.25. Major Salivary Glands.



3.41. Minor Salivary Glands:

3.41.1. Small, minor salivary glands can be found in many places around the interior of the mouth, but the ones of particular interest are located in the palate (Figure 3.26). The greatest concentrations of minor palatine glands are found in the hard and soft palates, below the surface of the mucosa, and behind a line drawn between the first molars. Skin surface exit holes for gland ducts are liberally scattered throughout this area.

Figure 3.26. Minor Palatine Salivary Glands.



Section 3G—Temporomandibular Joint

3.42. Formation of the Temporomandibular Joints:

3.42.1. The right and left temporomandibular joints are the two places where the mandible connects with the rest of the skull (Figure 3.27). In general terms, the temporomandibular joint is formed by the *glenoid fossa (mandibular fossa)* (paragraph 3.43) and *articular eminence* (paragraph 3.44) of the temporal bone and by the *condyle of the mandible* (paragraph 3.45) (Also see Section 3B.)

3.42.2. The fossa and eminence are separated from contact with the condyle by an articular disc. The condyle stays in the fossa during ordinary opening and closing (hinge) movements.

3.43. Glenoid Fossa. The glenoid fossa is a deep hollow on the undersurface of the zygomatic process of the temporal bone. The condyle stays in the fossa during ordinary opening and closing (hinge) movements.

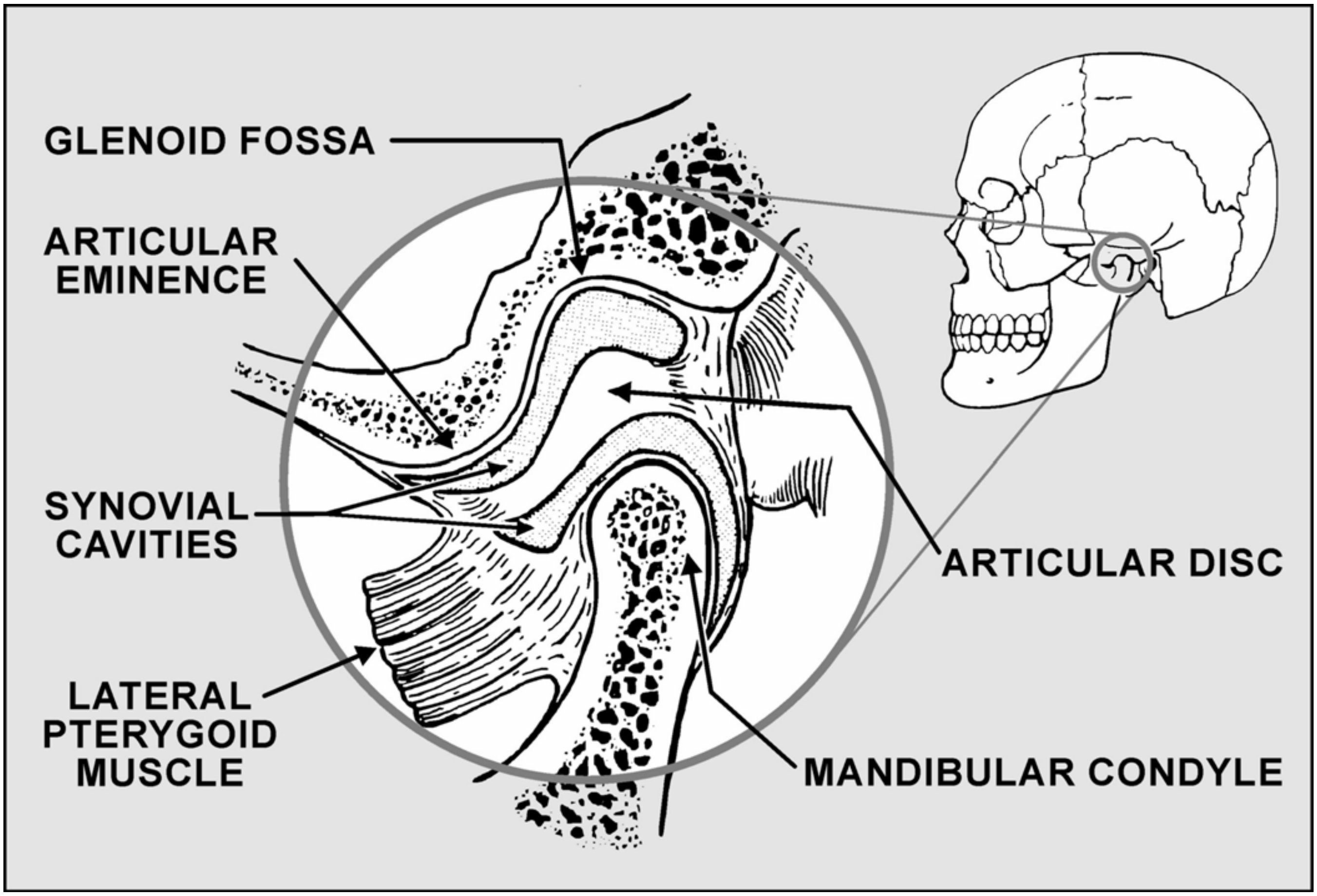
3.44. Articular Eminence. The articular eminence is a ramp-shaped prominence that extends forward and downward from the anterior boundary of the glenoid fossa. During forward (protrusive) movements of the entire mandible, both condyles leave their fossae and move onto eminences. In lateral movements, one condyle usually stays in a fossa and the other condyle moves out of the fossa onto its eminence.

3.45. Condyle. The condyle is the oval- or kidney-shaped structure found on the end of the condyloid process of the mandible.

3.46. Articular Disc. The articular disc is a pad of tough, flexible fibrocartilage situated between the condyle and the glenoid fossa. The disc is a shock-absorbing mechanism. When the condyle moves out onto the articular eminence, the disc travels with it.

3.47. Synovial Cavities. The synovial cavities are also referred to as the upper and lower joint compartments. The upper synovial cavity is found between the top of the disc and the glenoid fossa. The lower synovial cavity is found between the bottom of the disc and the condyle of the mandible.

Figure 3.27. Temporomandibular Joint.



3.48. Synovial Membrane. The synovial membrane is the lining of a synovial cavity. The cells of the lining make a lubricating liquid called *synovial fluid*.

3.49. Capsule:

3.49.1. The capsule is the major ligament of the temporomandibular joint. This ligamentous sleeve or capsule originates from the entire rim of the glenoid fossa and articular eminence, attaches to the edges of the articular disc, and passes to insert around the rim of the condyle.

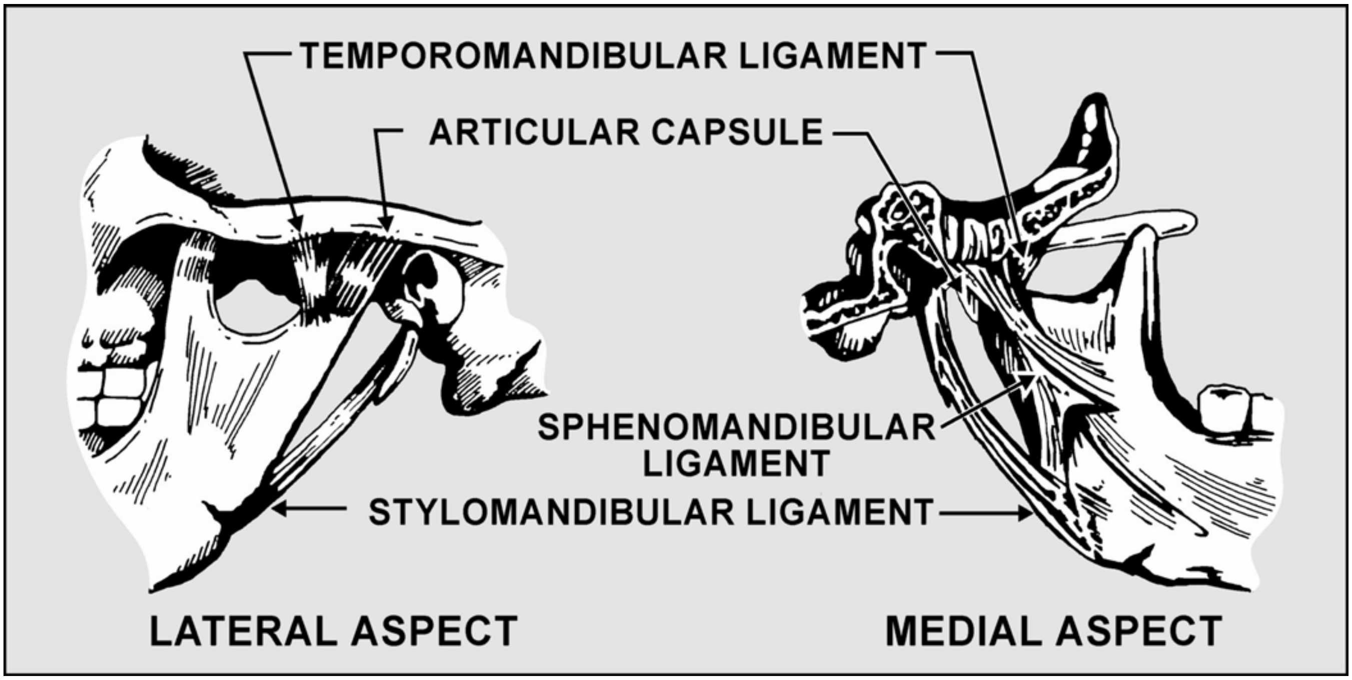
3.49.2. The capsule holds the disc in place between the condyle and the fossa, it retains the synovial fluid in the upper and lower joint compartments, and it acts to prevent dislocation of the mandible. Some authors of anatomy texts mention a *temporomandibular ligament*, which is an anterior thickening of the capsule, not a separate ligament.

3.50. Auxiliary Ligaments. Auxiliary ligaments (Figure 3.28) generally act to restrict the condyle to a normal range-of-movement and prevent dislocation as follows:

3.50.1. The stylomandibular ligament originates on the styloid process of the temporal bone and inserts on the posterior border of the ramus near the angle.

3.50.2. The sphenomandibular ligament originates on the spine of the sphenoid bone and inserts on the anterior-superior of the mandibular foramen (lingula). The mandibular foramen is found on the internal surface of the ramus of the mandible.

Figure 3.28. Auxiliary Ligaments of the Temporomandibular Joint.



Chapter 4

DENTAL (TOOTH) ANATOMY

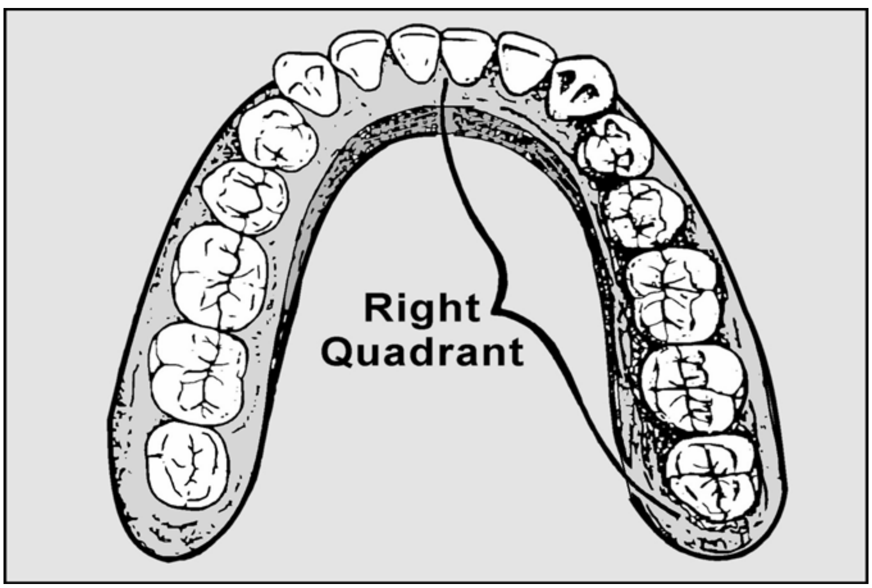
Section 4A—How Teeth are Identified

4.1. Groups of Teeth. Teeth, as they exist in the mouth, can be placed into one of three broad groupings; maxillary or mandibular, right or left, or anteriors or posteriors. These groupings, detailed below, apply to both the natural dentition and artificial teeth.

4.1.1. **Maxillary or Mandibular.** Each person has two jaws, a maxillary (upper) and a mandibular (lower). The teeth in these jaws are called either *maxillary* or *mandibular* teeth. The combination of natural teeth and supporting alveolar bone found in an upper or a lower jaw is called a *dental arch*. When natural teeth are extracted, the healed alveolar process is called the *alveolar ridge*. Artificial teeth are set over alveolar ridges so they coincide with the original arch form.

4.1.2. **Right or Left.** If the two dental arches are split down the midline from front to back, the arches can be divided into upper and lower right sections and upper and lower left sections. Because one of these sections represents one-fourth of the upper and lower arches taken together, each section is called a quadrant (Figure 4.1). If a tooth is located to the left of the midline in the upper arch, the tooth is part of the maxillary left quadrant (and so forth).

Figure 4.1. Mandibular Right Quadrant.

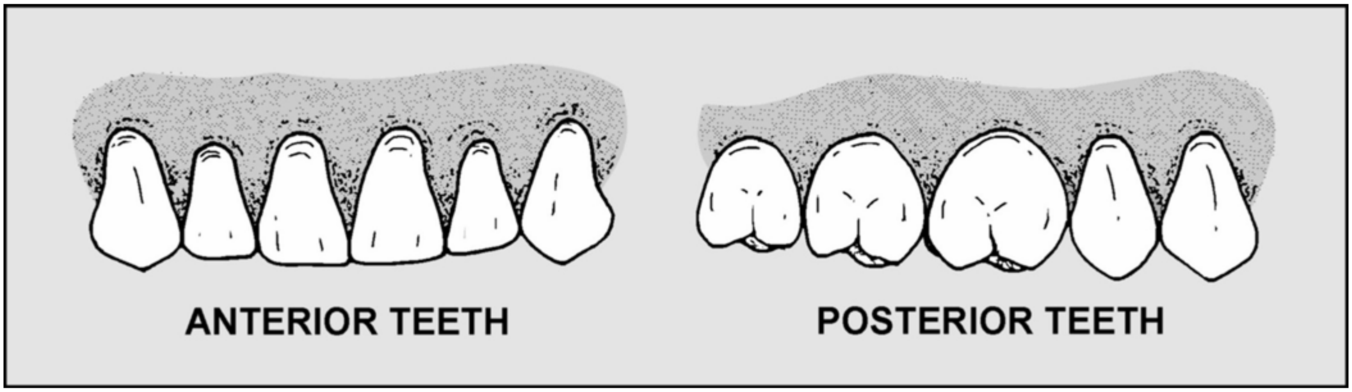


4.1.3. **Anteriors or Posteriors:**

4.1.3.1. Teeth can also be classified as anteriors (incisors and canines) or posteriors (premolars and molars) (Figure 4.2). A complete adult natural dentition has 32 teeth, and each arch contains 16.

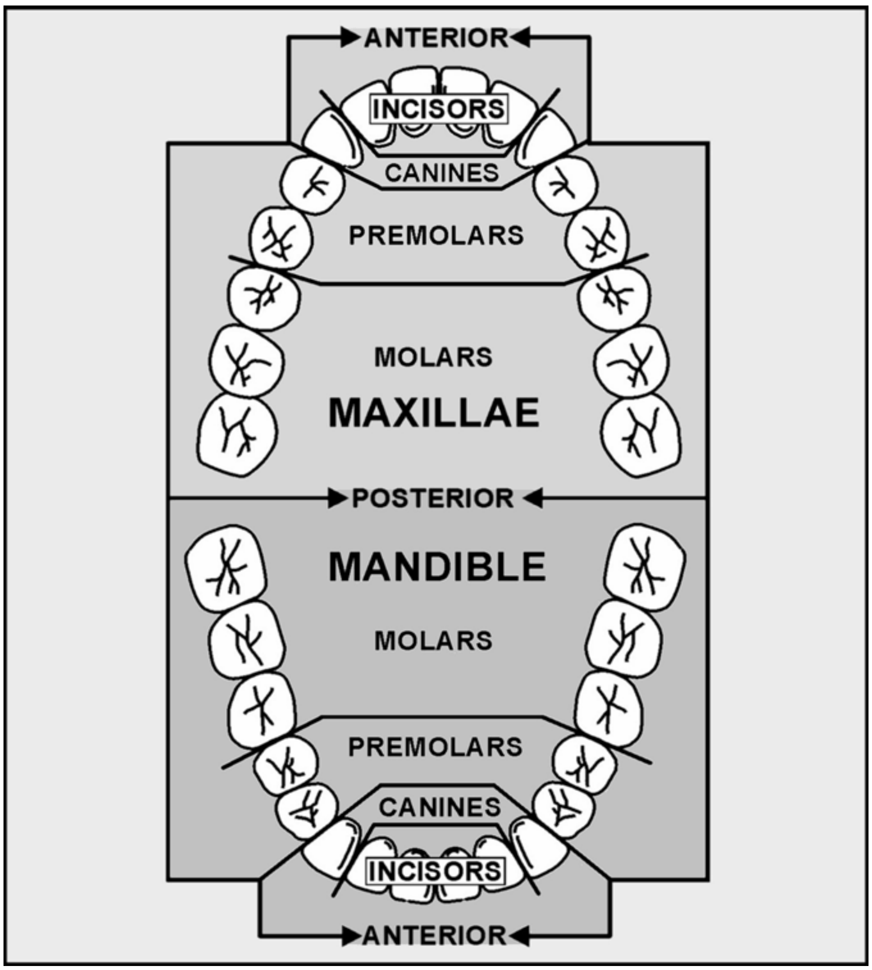
4.1.3.2. The teeth in an arch are composed of six anteriors (canine to canine) and ten posteriors (all teeth distal to the canines). There are three anteriors and five posteriors in a quadrant. ***NOTE:*** Complete dentures for the upper and lower arches usually consist of 28 teeth. The third molars (4) are not used.

Figure 4.2. Anterior and Posterior Teeth.



4.2. Names of Teeth. See Figure 4.3 and the subparagraphs herein for the names of groups of teeth.

Figure 4.3. Names of Teeth (Groups).



4.2.1. **Anteriors:**

4.2.1.1. **Central and Lateral Incisors.** The word "incisor" describes the function of incising or cutting food. In each quadrant, the two teeth nearest the midline of the dental arches are called *incisors*. The first incisor on either side of the midline is called a *central incisor*. The second incisor from the midline of either arch is called a *lateral incisor*.

4.2.1.2. **Canines.** In each quadrant, the third tooth nearest the midline of the dental arches is called a *canine*. These teeth are used to tear food, and each dental arch has two canines. A canine is sometimes called a cuspid because its cutting edge is a single, pointed elevation or cusp.

4.2.2. **Posteriors:**

4.2.2.1. **Premolars.** *Premolars* are so named because they occupy an anatomical position mesial to the molars. (They are sometimes called *bicuspids* because most have two cusps on their chewing surfaces.) There are eight premolars, two in each quadrant, which function as seizing and grinding teeth. The two premolars in any given quadrant are further called *first* and *second premolars*, the first located immediately behind the canine.

4.2.2.2. **Molars.** *Molars*, the largest teeth in the dental arches, lie directly behind the premolars and function as grinders during mastication (chewing). Under normal conditions, there are six molars in each arch (three in each quadrant). They are called *first*, *second*, and *third molars*. The first molar is the first tooth distal to the second premolar.

4.3. Number Substitutes for Teeth Names. Formal descriptions like "maxillary right molar" and "mandibular left lateral incisor" can be time-consuming when many people must be examined in a short time. They can also be too lengthy when space on forms is limited. Therefore, numerical shorthand is often used as a substitute for complete, formal tooth names. See Figure 4.4 (and paragraphs 4.3.1 and 4.3.2) for number substitutes 1 through 32 for the full complement of natural teeth.

4.3.1. Numbers 1 through 16 are in the maxillary arch. The upper right third molar is number 1, the upper right second molar is number 2, and as you proceed in consecutive order around the maxillary arch to the upper left third molar, the last number is 16.

4.3.2. Numbers 17 through 32 are in the mandibular arch. The lower left third molar is number 17; the lower left second molar is number 18; and, as you proceed around the mandibular arch to the lower right third molar, the last number is 32.

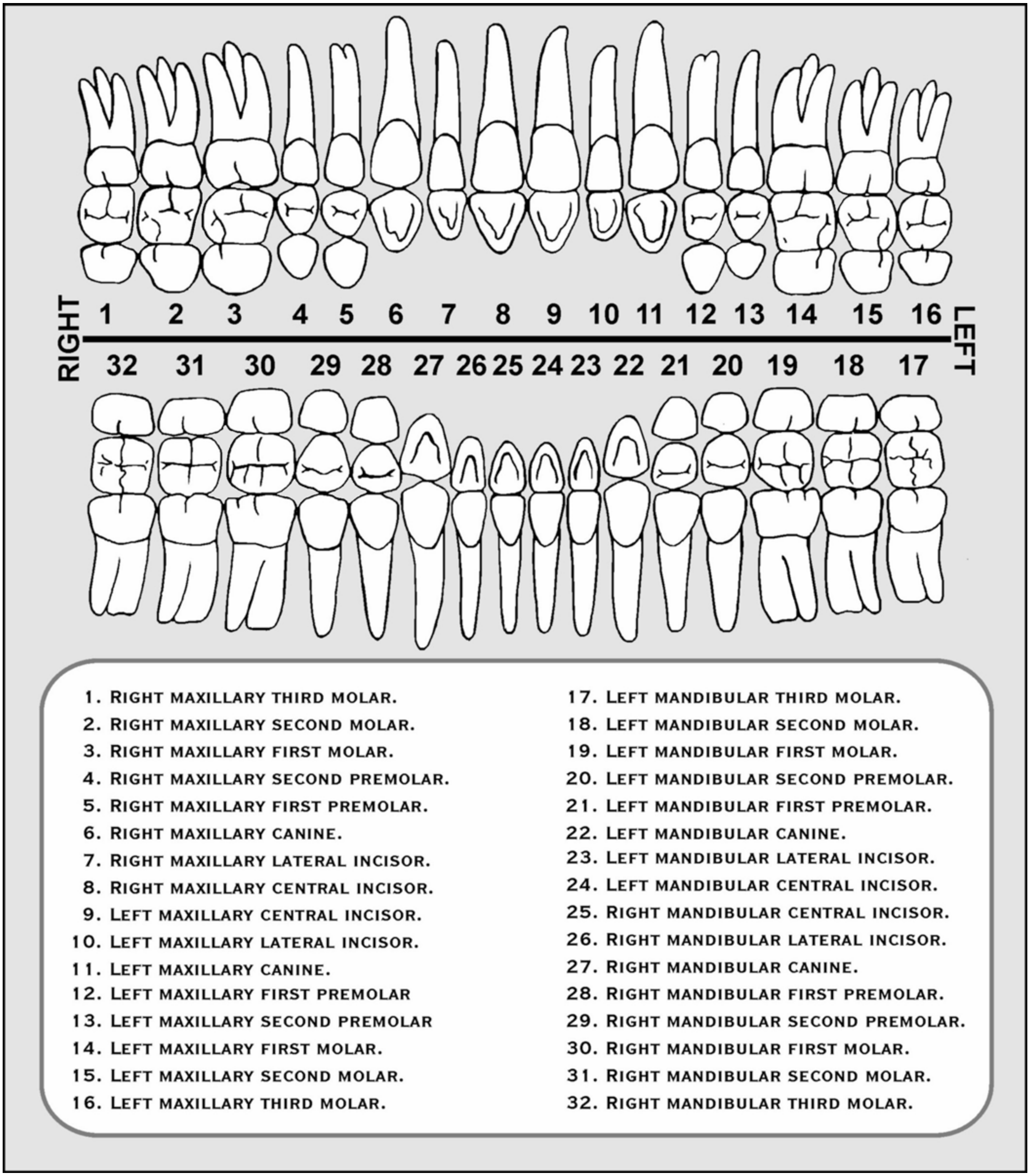
4.4. Structures of the Teeth:

4.4.1. A tooth is divided into two parts, the *crown* and the *root* (Figure 4.5). The *anatomical crown* is the part of the tooth covered with enamel. The root of a tooth is embedded in alveolar bone and covered with cementum. ***NOTE:*** In young people, areas of the anatomical crown are frequently buried in gingival tissue. As a person gets older it becomes common for a tooth's enamel to be completely exposed above the gingiva and to have root surface showing.

4.4.2. The term *clinical crown* is applied to the part of the tooth that is visible above the gingiva to include root surface. The bulk of a tooth is composed of a bone-like substance called *dentin* that is covered by enamel to form the crown and *cementum* to form the root. The line of division between the crown and root is called the *cervical line* or *cementoenamel junction*. The dividing line is found in a somewhat constricted region on the tooth's surface called the *cervix* or *neck*.

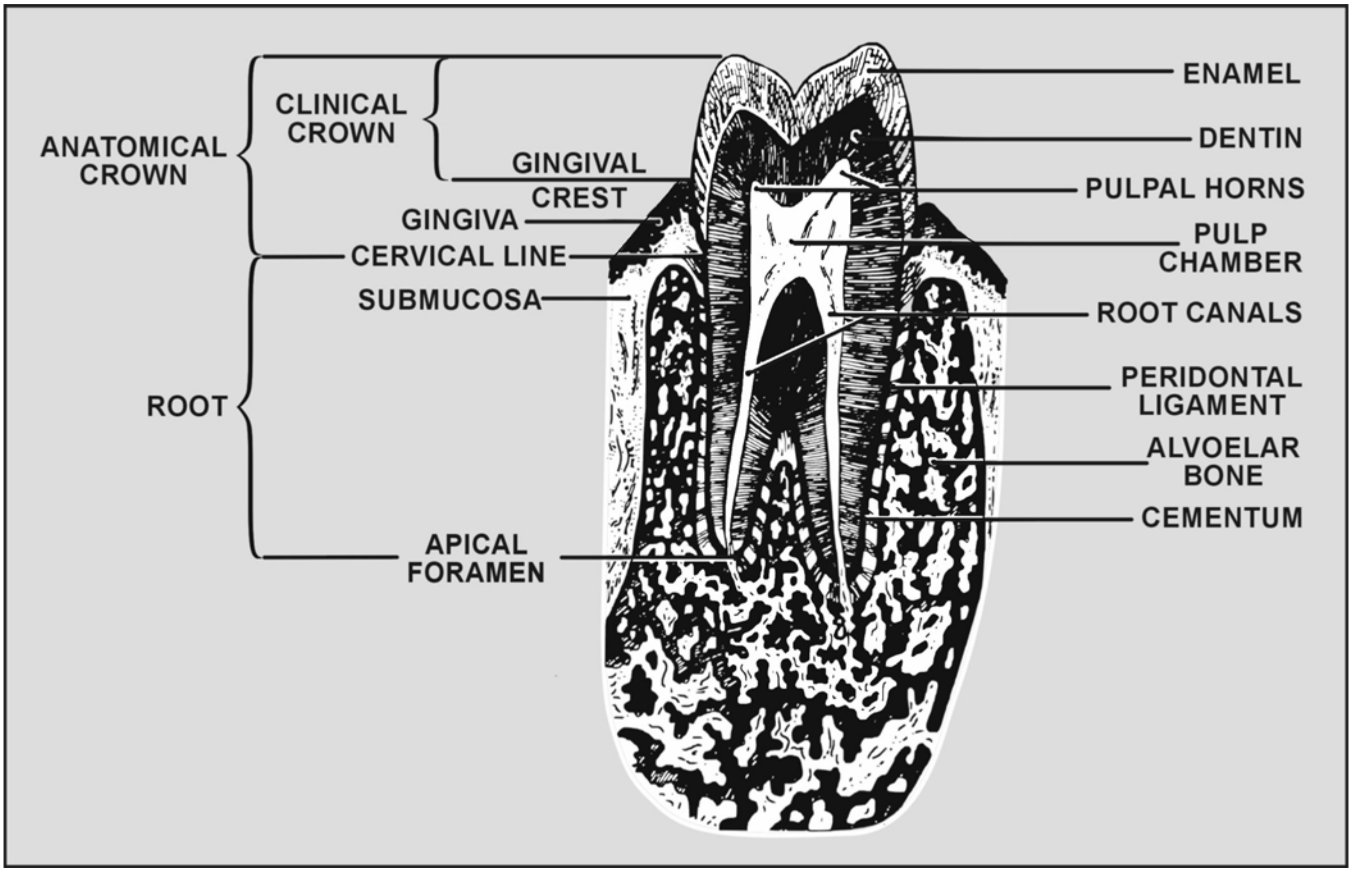
4.4.3. The tip of the root is known as the *apex*. The tooth contains an aggregate of blood vessels, nerves, and cellular connective tissue called the *dental pulp,* which is housed within a pulp chamber and root canal of a tooth.

Figure 4.4. Number Substitutes for Teeth Names.



4.4.4. Anterior teeth ordinarily have one root canal; multiple canals occur in posterior teeth. The nerves and blood vessels enter and leave the tooth through an opening called the *apical foramen* at or near the apex of the root.

Figure 4.5. Structures of Teeth and Supporting Tissues.



4.5. Supporting Structures of the Teeth. The supporting tissues of the teeth are collectively called the *periodontium*. The periodontium consists of the alveolar process of the maxillae and mandible, periodontal ligament, cementum of the tooth, and gingiva, as follows:

4.5.1. **Alveolar Process:**

4.5.1.1. The alveolar process is the portion of the maxillae or mandible in which the roots of the teeth are embedded and by which tooth roots are supported. An alveolar process consists of three kinds of bone; the outer cortical plate, lamina dura, and spongy bone.

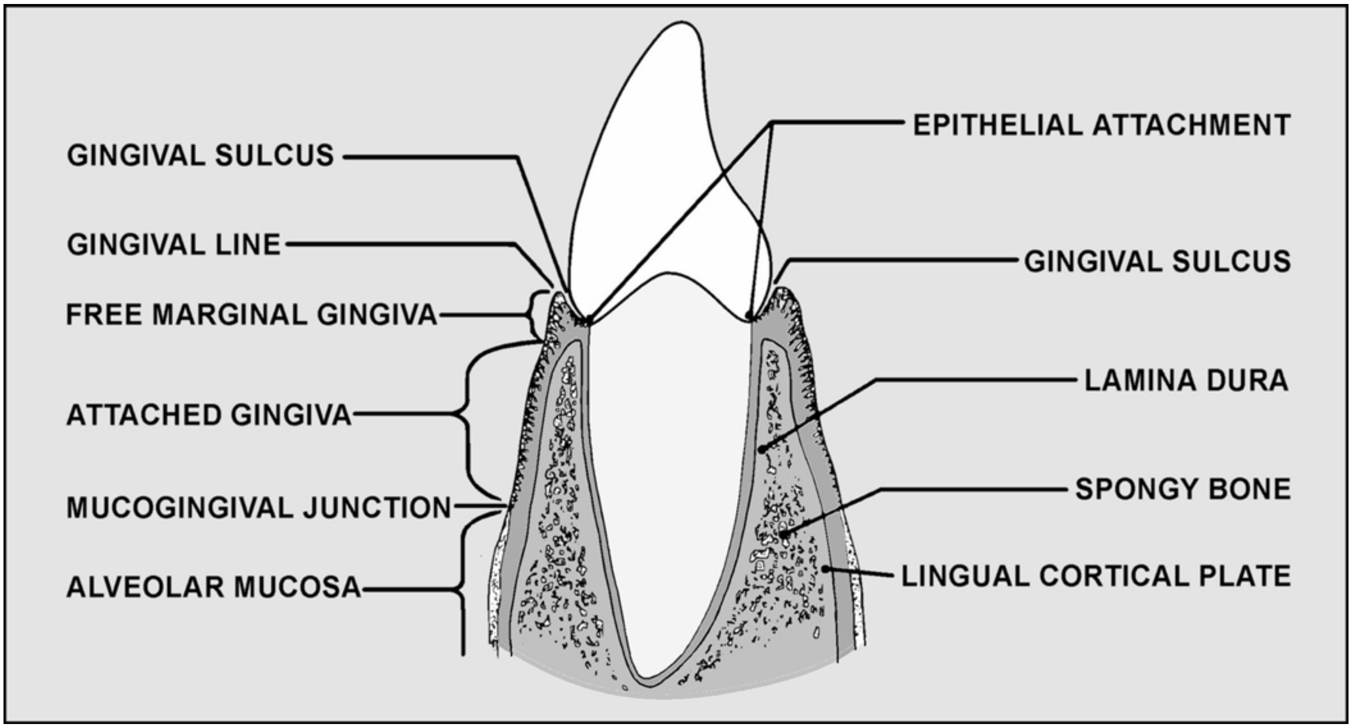
4.5.1.2. The *outer cortical plate* is a compact layer of bone on the bone's surface. The *lamina dura* is a thin, dense layer of bone that lines tooth sockets and is a specialized continuation of the cortical plate. The *spongy bone* is the less dense, cancellous bone representing central mass of the alveolar process.

4.5.2. **Periodontal Ligament.** The periodontal ligament is a thin, fibrous ligament connecting a tooth to the lamina dura of the bony socket. Normally, teeth do not contact the bone directly; a tooth is suspended in its socket by the fibers of the ligament. This arrangement allows each tooth limited individual movement. The fibers act as shock absorbers to cushion the force of chewing impacts.

4.5.3. **Cementum.** The cementum is the only tissue considered as both a basic part of the tooth and a component of the periodontium. Formed during the development of the tooth's root, cementum is a thin, calcified layer of tissue that completely covers the root's dentin. It functions as an area of attachment for periodontal ligament fibers.

4.5.4. **Gingiva.** The gingiva is the specialized mucous membrane covering the alveolar processes and encircling the necks of the teeth (Figure 4.6). It aids in the support of the teeth and protects the alveolar process and periodontal ligament from bacterial invasion. Healthy gingiva is pale pink, firm, and resilient. It is divided into two types, *free* and *attached* gingiva.

Figure 4.6. Free and Attached Gingiva.



4.5.4.1. Free gingiva is "free" to the extent that it can be displaced. That is, it is not tightly bound to anything underneath it. Free gingiva extends from the gingival crest to the bottom of the gingival sulcus. At the bottom of the sulcus, an *epithelial attachment* joins the free gingiva to the tooth surface. The *interdental papilla* is the portion of the free gingiva that fills the proximal space below the contact areas of adjacent teeth. It helps prevent food from packing between the teeth.

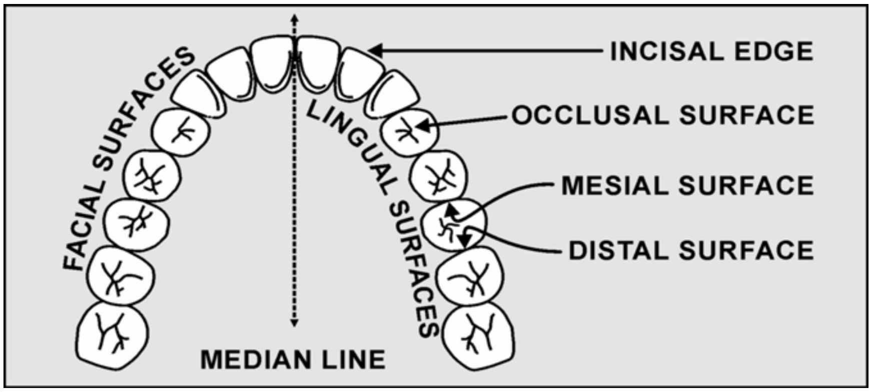
4.5.4.2. Attached gingiva covers the labial cortical plate of the alveolar process. It is firmly fixed to underlying bone.

4.6. Crown Morphology (Contours). There are almost no perfectly flat or perfectly straight surfaces; most surfaces are curved. The contour of a crown is a combination of *convex* and *concave* curves. A convex surface is one that is curved outward; a concave surface is curved inward.

4.7. Tooth Surfaces:

4.7.1. **Proximal.** A tooth has two proximal surfaces, one oriented toward the midline of the dental arch and another oriented away from the midline of the arch (Figure 4.7). The mesial is the proximal surface closest to the midline of the arch. The distal is the proximal surface oriented away from the midline of the arch.

Figure 4.7. Tooth Surfaces.



4.7.2. **Facial.** The facial is the surface of a tooth that "faces" toward the lips or cheeks (Figure 4.7). When there is a requirement to be more specific, terms like *labial* and *buccal* are used. The labial is the surface of an anterior tooth that faces toward the lips. The buccal is the surface of a posterior tooth that faces toward the cheek.

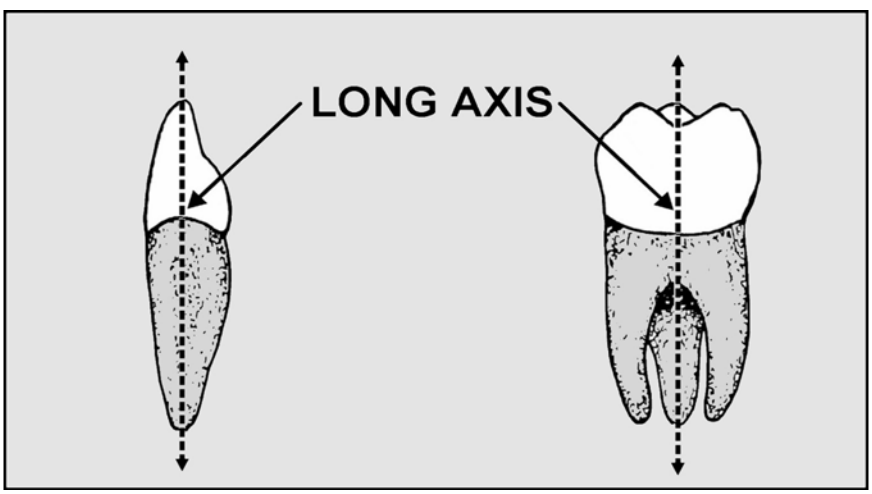
4.7.3. **Lingual.** The lingual is the surface of a tooth facing toward the tongue.

4.7.4. **Incisal.** The incisal is the cutting edge of an anterior tooth.

4.7.5. **Occlusal.** The occlusal is the chewing surface of a posterior tooth.

4.7.6. **Long Axis and Axial Surface.** The *long axis* of a tooth is an imaginary line that goes through the crown and root around which the substance of a tooth is most symmetrically distributed (Figure 4.8). Any surface of a tooth that is parallel to the long axis is called an *axial surface* (for example, mesial, distal, facial, or lingual surfaces).

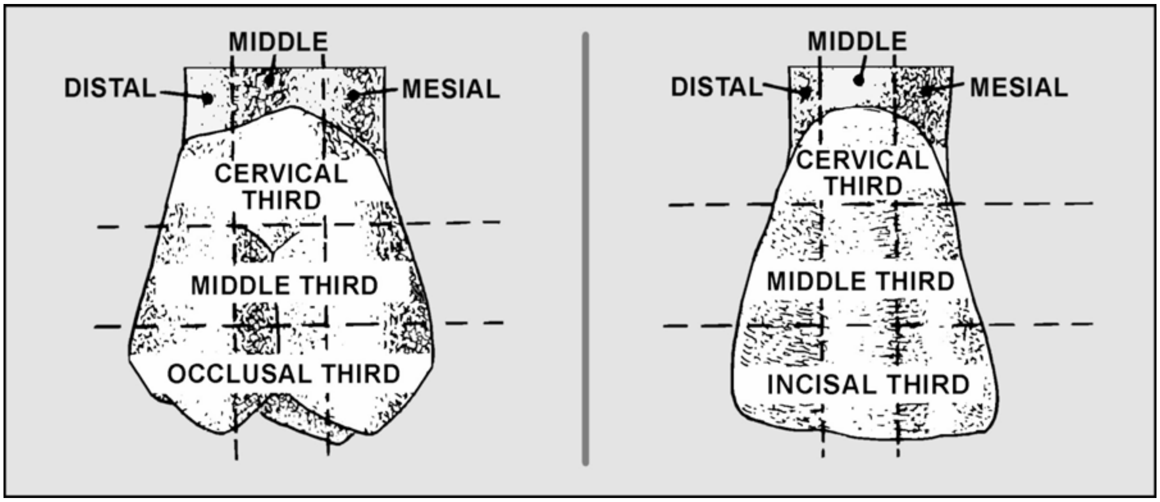
Figure 4.8. Long Axis.



4.7.7. **Dividing a Crown Into Thirds.** The facial, lingual, mesial, and distal surfaces of a crown can be divided into thirds, both horizontally and longitudinally, as follows:

4.7.7.1. **Horizontal Division.** Each axial surface of a crown is divided horizontally into a cervical, a middle, and an occlusal (or incisal) third (Figure 4.9).

Figure 4.9. Anterior and Posterior Crown Divisions.



4.7.7.2. **Longitudinal Division.** Each mesial or distal axial surface may be divided into a facial, a middle, and a lingual third. Each facial or lingual surface may be divided into a mesial, a middle, and a distal third.

4.7.8. **Line Angle.** A line angle is an angle formed by the junction of two crown surfaces. It derives its name from those two surfaces. There are eight line angles per tooth.

4.7.8.1. The eight anterior tooth line angles are the mesiolabial, mesiolingual, distolabial, distolingual, labioincisal, linguoincisal, mesioincisal, and distoincisal.

4.7.8.2. The eight posterior tooth line angles are the mesiobuccal, mesiolingual, distobuccal, distolingual, bucco-occlusal, linguo-occlusal, disto-occlusal, and mesio-occlusal.

4.7.9. **Point Angle.** The junction of three crown surfaces forms a point angle. Combining the names of the three surfaces derives the name of the point angle.

4.7.9.1. The four anterior tooth point angles are the mesiolabioincisal, mesiolinguoincisal, distolabioincisal, and distolinguoincisal.

4.7.9.2. The four posterior tooth point angles are the mesiobucco-occlusal, mesiolinguo-occlusal, distobucco-occlusal, and distolinguo-occlusal.

4.8. Distinctive Crown Convexities:

4.8.1. **Lobes.** *Lobes* are one of the primary anatomical divisions of a crown; all teeth develop from either four or five lobes (Figure 4.10). (For example, a central incisor develops from four lobes while first molars develop from five lobes.) Lobes are usually separated by readily identifiable *developmental grooves*.

4.8.2. **Mamelons.** *Mamelons* are small, rounded projections of enamel from the incisal edges of newly erupted anterior teeth (Figure 4.11). The projections wear away soon after eruption.

4.8.3. **Cingulum.** A *cingulum* is found on the lingual aspect of an anterior tooth (Figure 4.12). It is a convex mount of enamel localized to the cervical one-third of the crown.

4.8.4. **Cusps.** *Cusps* are cone-shaped elevations on the occlusal surface of a premolar or molar and on the incisal edge of the canine (Figure 4.13).

Figure 4.10. Lobes.

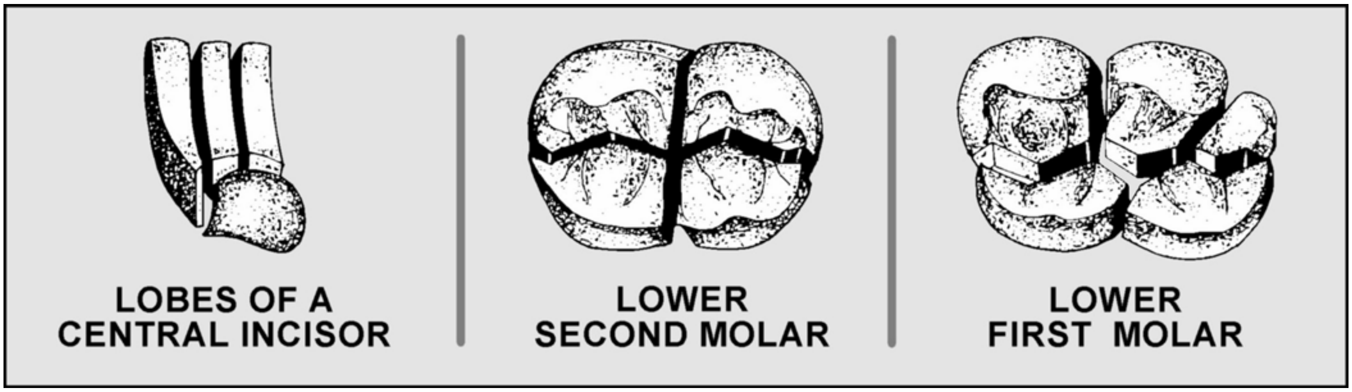


Figure 4.11. Mamelons.

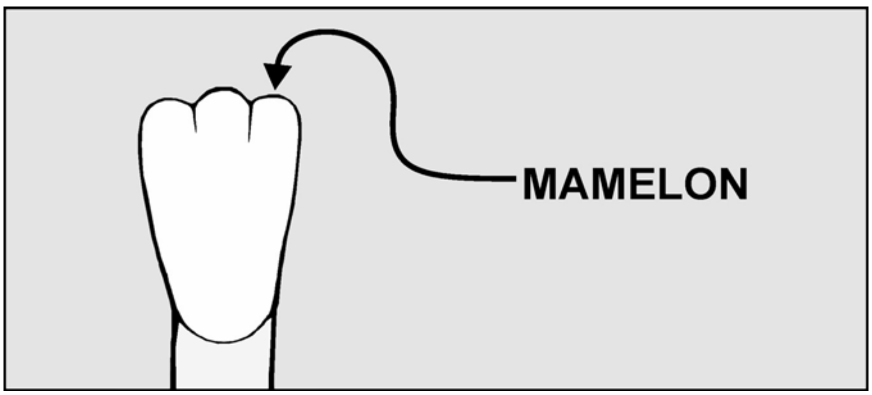
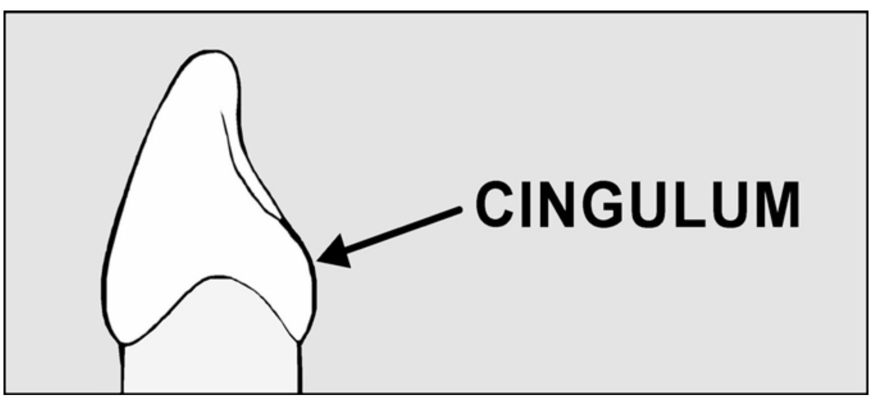


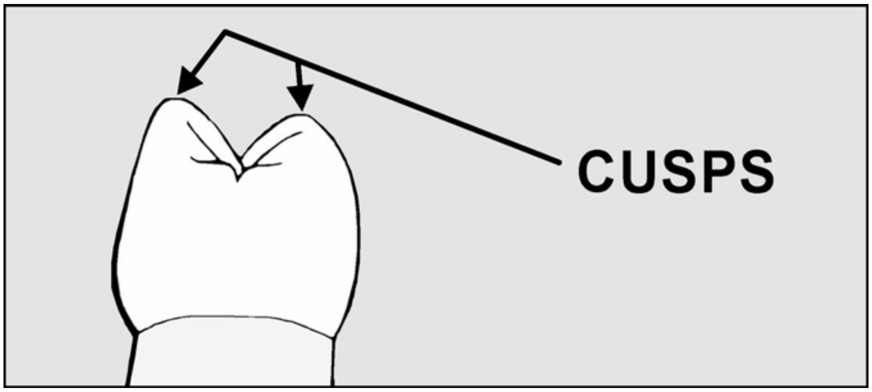
Figure 4.12. Cingulum.



4.8.4.1. Canines have one cusp that represents the tooth's cutting edge. Maxillary premolars and the mandibular first premolars have two cusps, one buccal and one lingual. The mandibular second premolar normally has three cusps, one buccal and two lingual. The lingual cusps are subdivided into a mesiolingual and a distolingual.

4.8.4.2. Maxillary molars have four cusps, two buccal and two lingual. The two buccal cusps are subdivided into a mesiobuccal and a distobuccal. The two lingual cusps are subdivided into a mesiolingual and a distolingual. (Once in awhile, the mesiolingual cusp of a maxillary first molar carries an underdeveloped, rudimentary cusp called the cusp of Carabelli.)

Figure 4.13. Cusps.

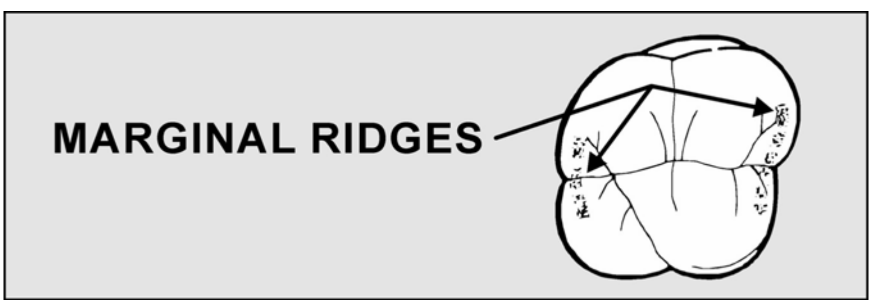


4.8.4.3. The mandibular first molar has five cusps, three buccal and two lingual. From anterior to posterior, the three buccal cusps are subdivided into a mesiobuccal, a distobuccal, and a distal. The two lingual cusps are divided into a mesiolingual and a distolingual. The mandibular second molar has four cusps called the mesiobuccal, distobuccal, mesiolingual, and distolingual.

4.8.5. **Ridge.** A ridge is a linear elevation found on the surface of a tooth as follows:

4.8.5.1. **Marginal Ridge.** A marginal ridge is a linear, rounded border of enamel that forms the mesial and distal margins of anterior teeth (as viewed from the lingual) and the mesial and distal borders of occlusal surfaces on posterior teeth (Figure 4.14). ***NOTE:*** When wax patterns are developed according to the *additive wax* technique, the definition of a marginal ridge is extended to include mesial and distal cusp ridges of buccal and lingual cusps on posterior teeth (paragraph 4.8.5.3).

Figure 4.14. Marginal Ridges.



4.8.5.2. **Lingual Ridge.** The ridge of enamel that extends from the cingulum to the cusp tip on the lingual surface of most canines is called the lingual ridge (Figure 4.15).

4.8.5.3. **Cusp Ridges.** Each cusp has four cusp ridges radiating from its tip (Figure 4.16). They are named according to the direction they take away from the cusp tip (mesial, distal, facial, or lingual).

4.8.5.4. **Triangular Ridge:**

4.8.5.4.1. The occlusal surface of a cusp is composed of a mesial and a distal incline (Figure

4.17). These two inclines meet to form a *triangular ridge* of enamel that descends from the tip of the cusp to the central portion of the occlusal surface. A triangular ridge is either a facial or a lingual cusp ridge, depending on where the cusp is located.

Figure 4.15. Lingual Ridge.

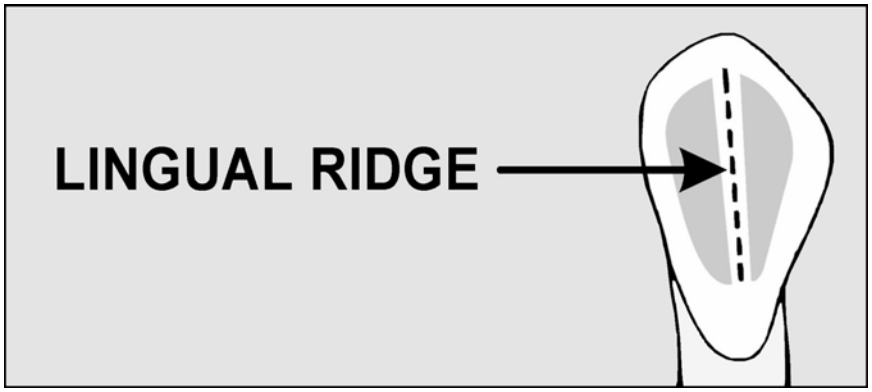


Figure 4.16. Cusp Ridges.

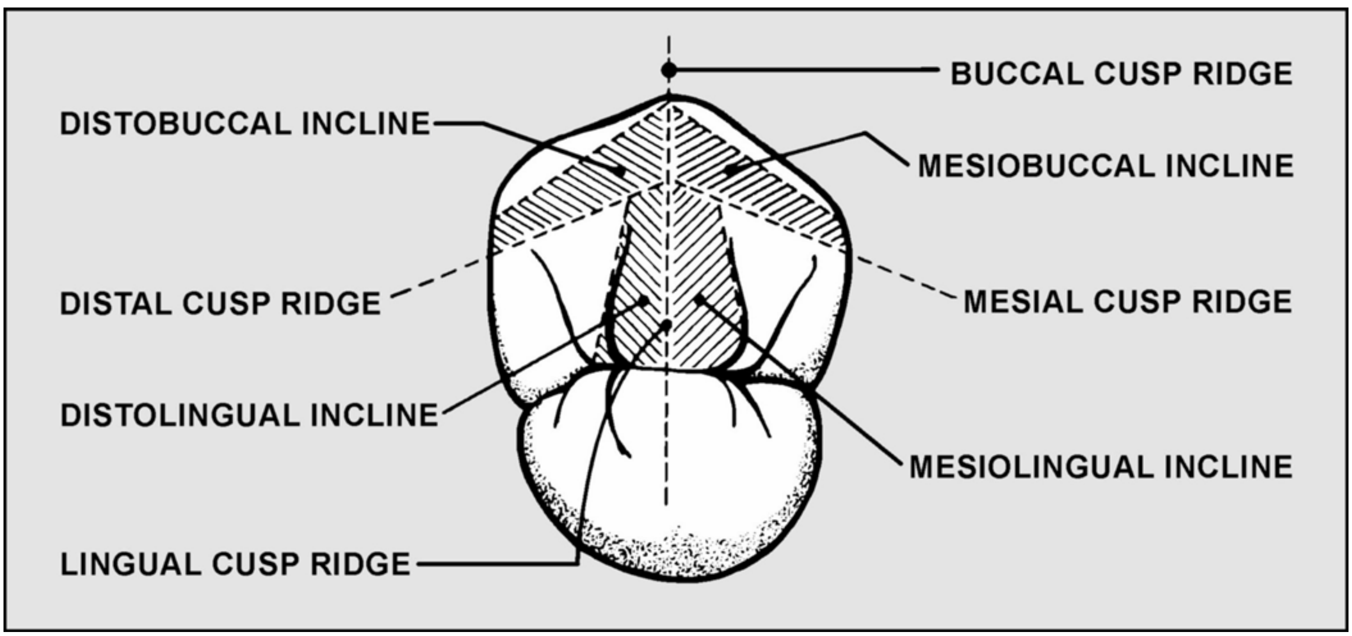
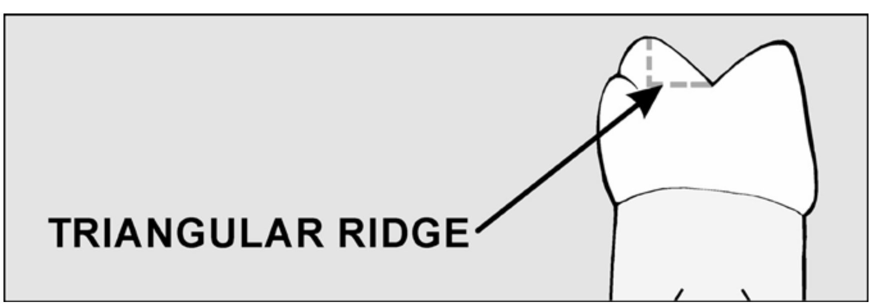
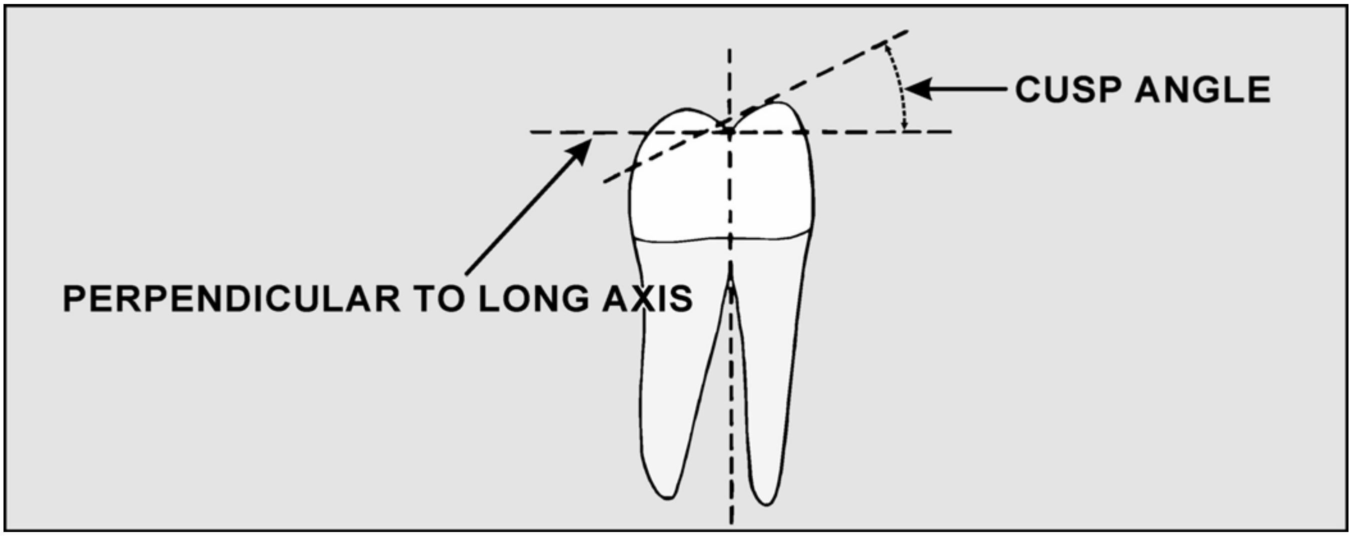


Figure 4.17. Triangular Ridge.



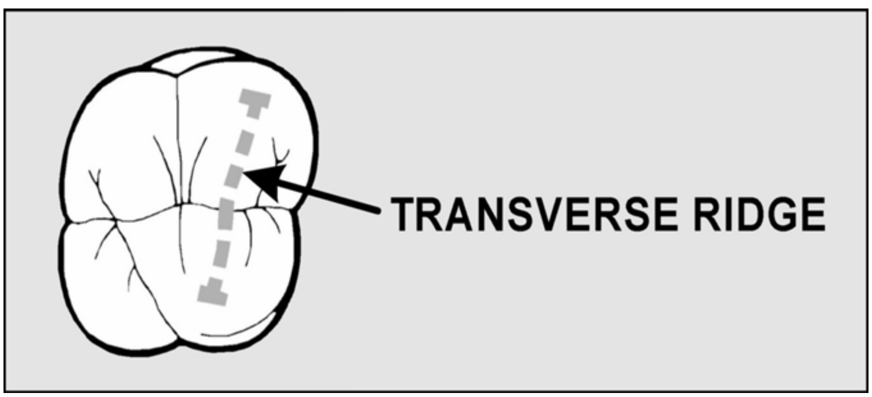
4.8.5.4.2. Cusps are described in some mouths as being “pointy” and in others as being “flat” or “blunt.” Most pointy posterior teeth have high cusp angle values (Figure 4.18). A *cusp angle* is the angle that a triangular ridge makes with a plane perpendicular to the long axis of the tooth.

Figure 4.18. Cusp Angle.



4.8.5.5. **Transverse Ridge.** A transverse ridge is the union of a buccal and lingual triangular ridge that crosses the surface of a posterior tooth transversely (roughly 90 degrees to both the buccal and lingual tooth surfaces) (Figure 4.19).

Figure 4.19. Transverse Ridge.



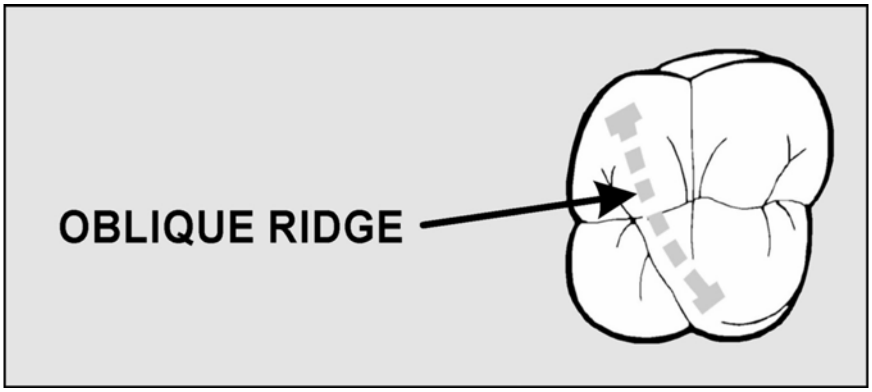
4.8.5.6. **Oblique Ridge.** The only tooth on which an oblique ridge is found is the maxillary molar (Figure 4.20). An oblique ridge consists of a union between the triangular ridge of the distobuccal cusp and the distal cusp ridge of the mesiolingual cusp.

4.8.6. **Cusp Inclines.** A *cusp incline* or *inclined plane* is the sloping area found between two cusp ridges. To name an incline, you must combine the names of the cusp ridges that define a large part of its borders, for example, the *distolingual incline* of the buccal cusp of a maxillary first premolar (Figure 4.16).

4.9. Distinctive Crown Concavities:

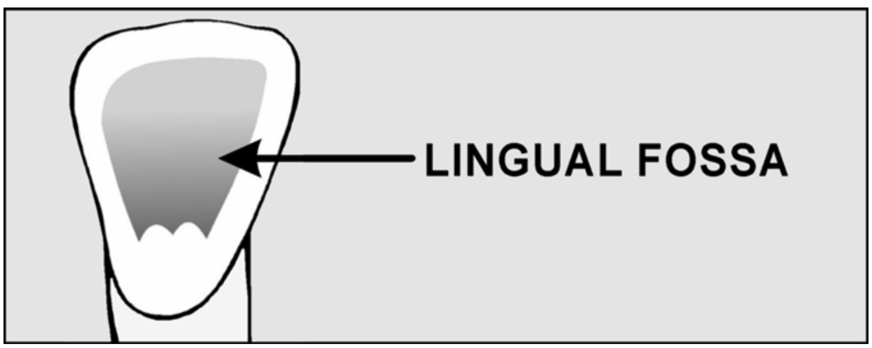
4.9.1. **Fossae:**

Figure 4.20. Oblique Ridge.



4.9.1.1. **Lingual Fossa.** The lingual fossa is an irregular, rounded concavity bound by the mesial marginal ridge, distal marginal ridge, cingulum, and incisal edge of the lingual surface of an incisor tooth (Figure 4.21). Lingual fossae are also found on both sides of the lingual ridge of a canine tooth.

Figure 4.21. Lingual Fossa.

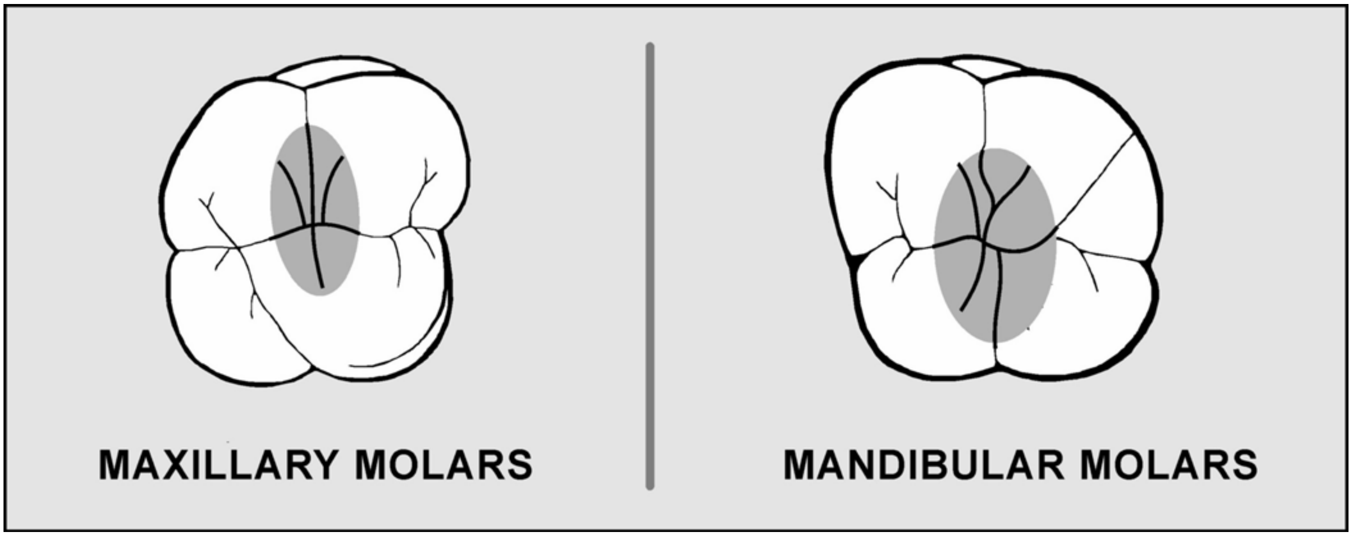


4.9.1.2. **Triangular Fossa.** Triangular fossae are located adjacent to marginal ridges on the occlusal surfaces of posterior teeth (Figure 4.22). There are two kinds of triangular fossae, a *mesial* and a *distal*.

Figure 4.22. Triangular Fossa.

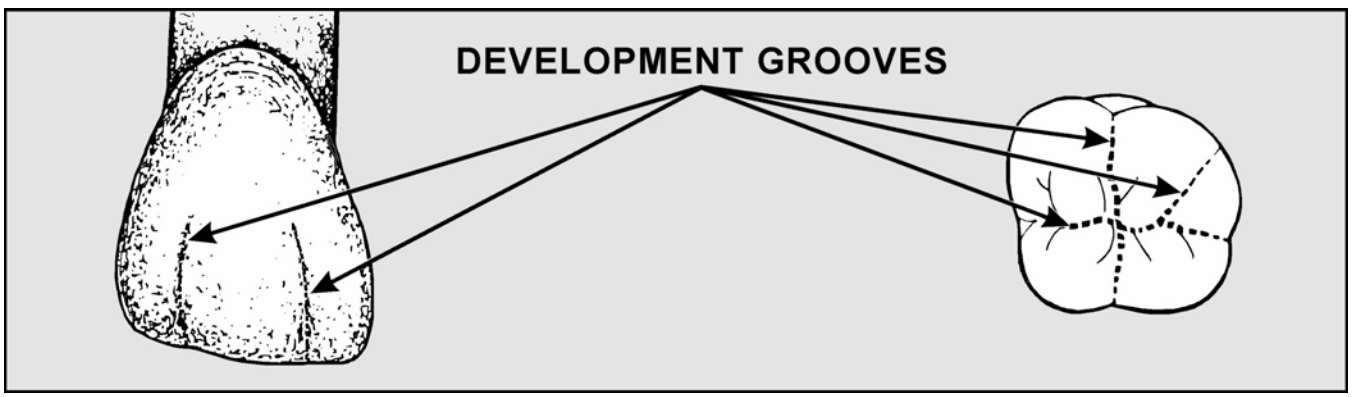
4.9.1.3. **Central Fossa.** A central fossa is a centrally located depression or concavity found on the occlusal surface of molars and mandibular second premolars (Figure 4.23). The other premolars have mesial and distal triangular fossae, but do not have a central fossa.

Figure 4.23. Central Fossa.



4.9.2. **Developmental Groove.** A developmental groove is the junction line between the inclined walls of adjacent cusp or ridges (Figure 4.24). Developmental grooves represent lines of union between lobes of the crown during its formation. These grooves appear on labial, occlusal, buccal, and lingual surfaces, and they are least apparent on the labial aspect of anteriors.

Figure 4.24. Developmental Grooves.



4.9.3. **Supplemental Groove.** A supplemental grove is a minor, auxiliary groove that branches off from a much more prominent developmental groove (Figure 4.25). Supplemental grooves do not represent the junction of primary tooth parts.

4.9.4. **Fissure.** A fissure is a linear fault that sometimes occurs in a developmental groove (Figure 4.26). A fissure represents a lack of union between the inclined walls of a sulcus.

4.9.5. **Pit.** A pit is a small, pinpoint fault on the surface of a tooth usually found at the end of a developmental groove or where two fissures intersect.

Figure 4.25. Supplemental Grooves.

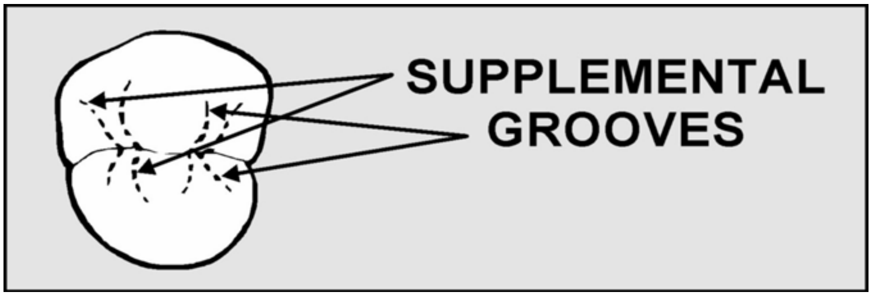
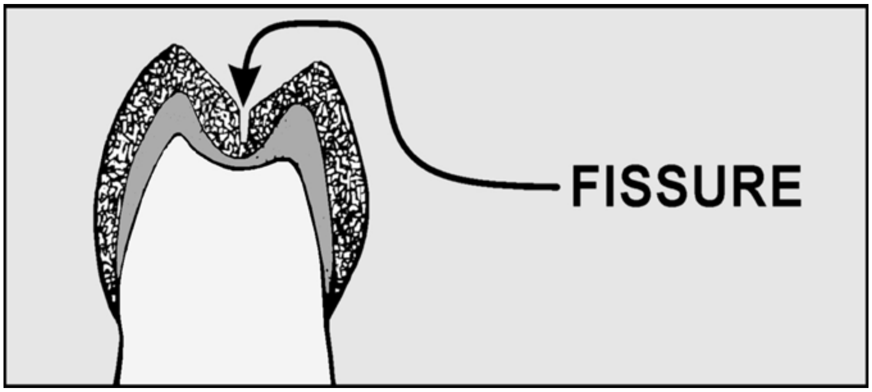


Figure 4.26. Fissure.



4.10. Description of Anterior and Posterior Tooth Surfaces. Figures 4.27 through 4.32 show specific convexities and depressions on anteri or and posterior teeth. You shoul d be able to na me the coronal features of teeth after you study these figures closely.

Figure 4.27. Maxillary Central Incisor (Facial View).

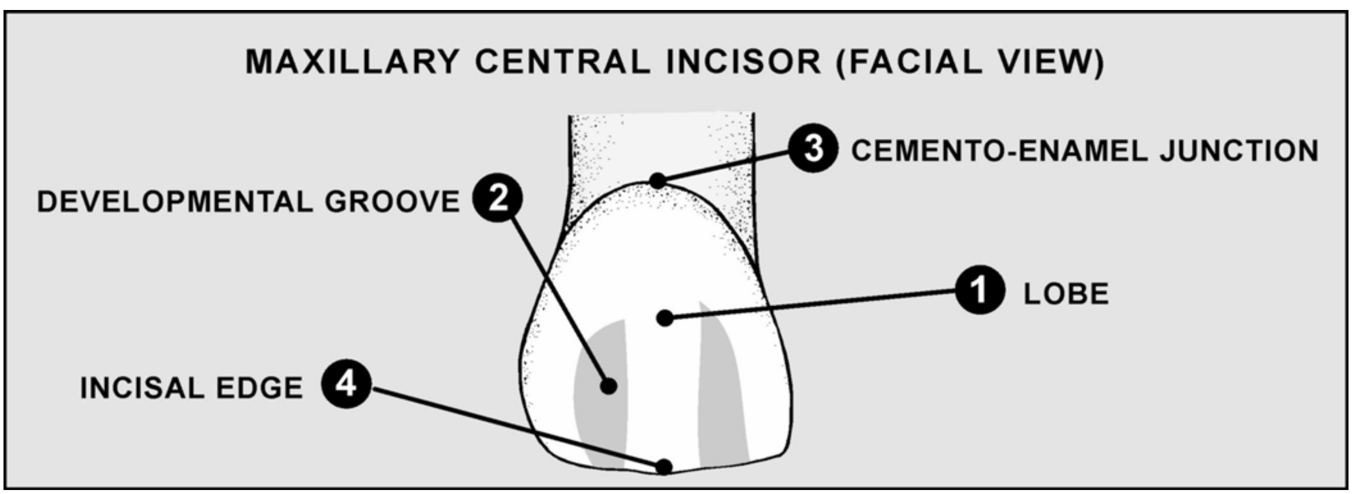
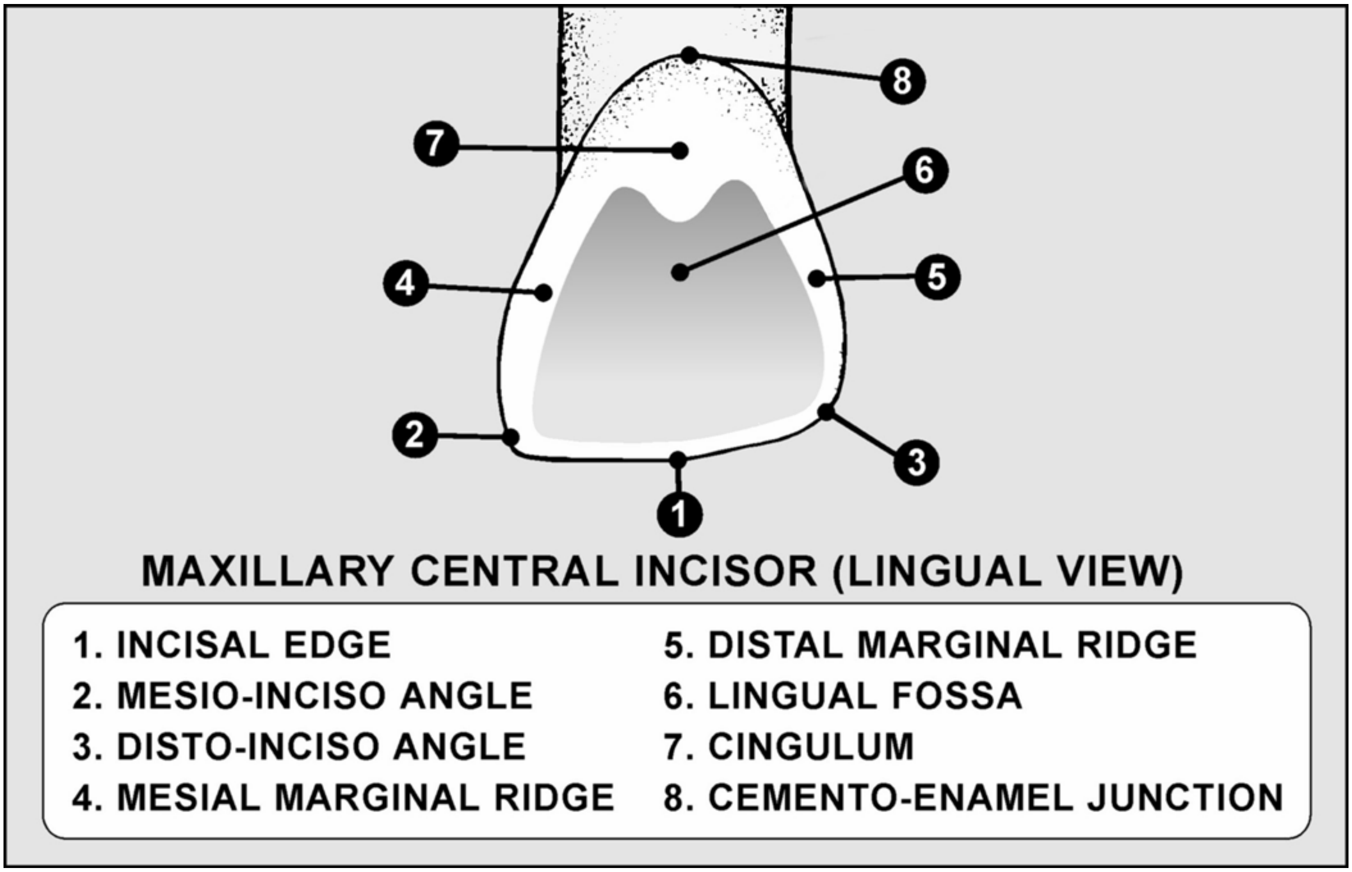


Figure 4.28. Maxillary Central Incisor (Lingual View).



4.11. Proximal Surface Contact Characteristics:

4.11.1. **Contact Points or Areas.** Teeth make contact with one another at points or areas on the greatest contour of their proximal surfaces (Figure 4.33). The places where adjacent teeth make point contact are called *contact points*. Contact points become wider and flatter in time from wear that occurs during functional movements (chewing) or parafunctional movements (grinding). A flattened contact point is called a *contact area.*

4.11.2. **Embrasure:**

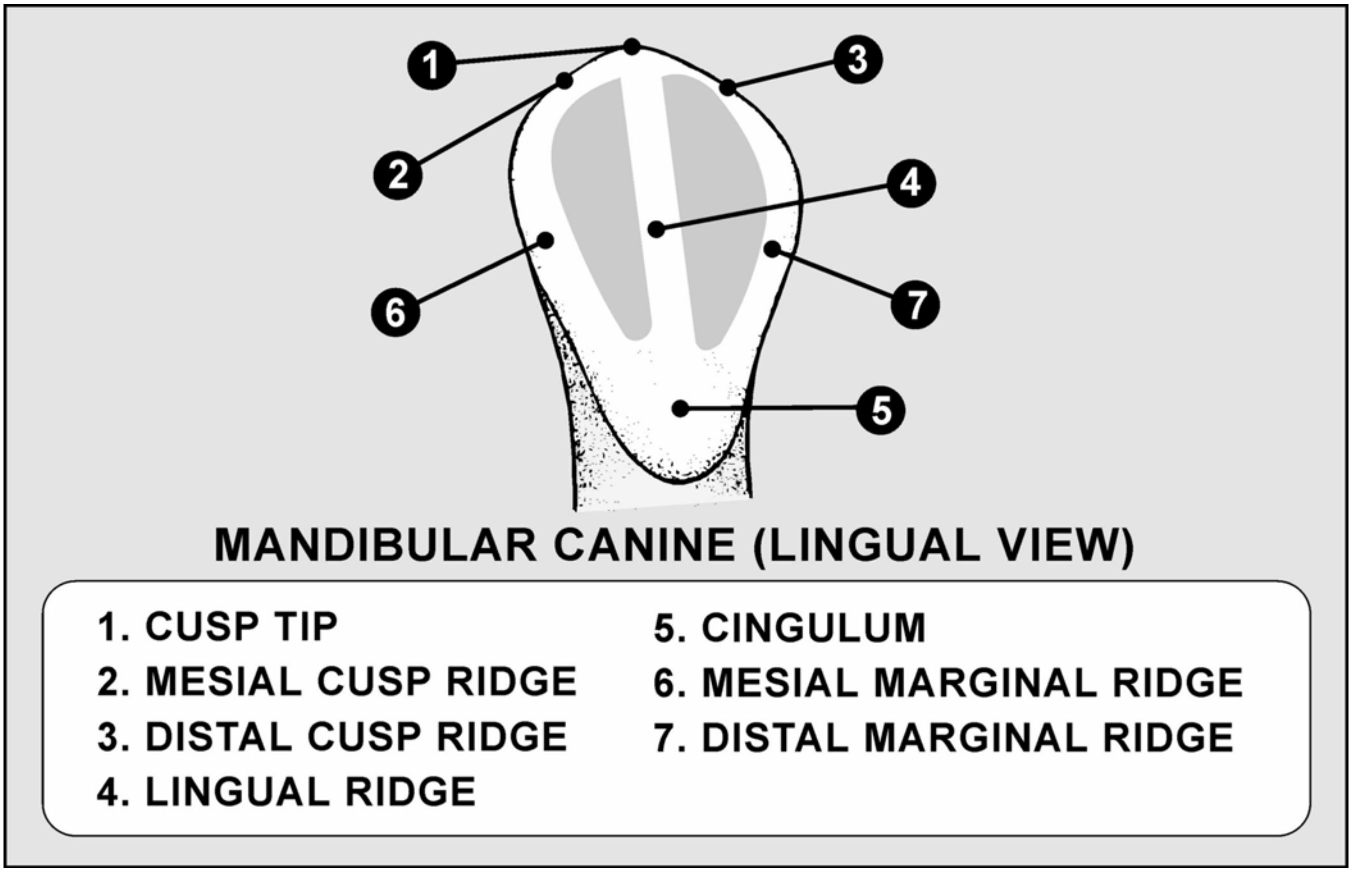
4.11.2.1. An embrasure is a space diverging from the contacting proximal surfaces of two adjacent teeth (Figure 4.34). There are four of these spaces or *embrasures* recognized. They are the facial, lingual, gingival, and occlusal or incisal (depending on whether they are posterior or anterior teeth).

4.11.2.2. The gingival embrasure is located *cervical* to the contacting areas of adjacent teeth. A gingival embrasure has other names like *cervical embrasure*, *apical embrasure*, *interproximal space*, and *septal space*.

4.11.2.3. *Interdental papillae* (gingival tissue) fill interproximal spaces to a greater or lesser extent.

4.12. Occlusal Surface Outlines of Posterior Teeth. Figure 4.35 and the subparagraphs herein show the types of occlusal surface outlines:

Figure 4.29. Mandibular Canine (Lingual View).



4.12.1. **Circular (Round).** The occlusal surfaces of the lower premolars are circular in outline.

4.12.2. **Rectangular.** The occlusal surfaces of the lower second molar and the upper premolars are often described as being rectangular or oblong in outline.

4.12.3. **Trapezoid.** A trapezoid is a plain four-sided figure with two parallel sides. The occlusal surface of the lower first molar is said to be trapezoidal in outline.

4.12.4. **Rhomboid.** A rhomboid is shaped as an equilateral parallelogram with two opposing oblique angles. The occlusal surfaces of the upper molars are rhomboidal in outline.

Section 4B—Descriptions of Individual Teeth

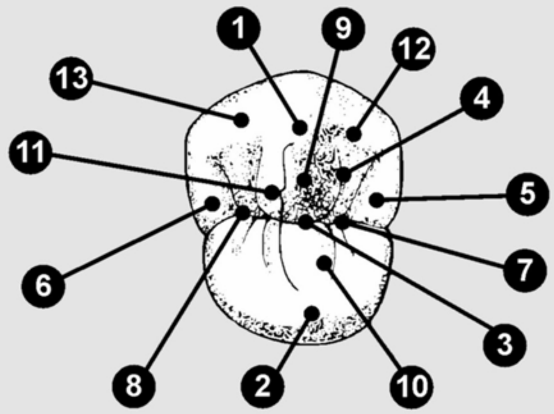
4.13. Introduction:

4.13.1. Paragraphs 4.14 through 4.27 describe each tooth of the permanent dentition (except the third molars, which are not reproduced in artificial teeth). In each instance, *the tooth from the right side of the mouth* is illustrated. ***NOTE:*** The drawings in this section were adapted from those appearing in the Ney Crown and Bridge Manual, J. M. Ney Co., Hartford CN.

4.13.2. The teeth are described as they usually look; however, teeth vary considerably from one person to another and certain teeth in the dentition tend to vary more than others.

4.13.3. Included in the illustrations of the premolars and the molars are drawings showing angles that can be carved in reproducing the occlusal surfaces of these teeth. The broken lines shown in the illustrations of the facial and lingual surfaces of the teeth indicate proper food deflection contours.

Figure 4.30. Maxillary Second Premolar (Occlusal View).



MAXILLARY SECOND PREMOLAR (OCCLUSAL VIEW)

1. BUCCAL CUSP
2. LINGUAL CUSP
3. CENTRAL DEVELOPMENTAL GROOVE
4. SUPPLEMENTAL GROOVE
5. MESIAL MARGINAL RIDGE
6. DISTAL MARGINAL RIDGE
7. MESIAL TRIANGULAR FOSSA
8. DISTAL TRIANGULAR FOSSA
9. BUCCAL TRIANGULAR RIDGE (CREST)
10. LINGUAL TRIANGULAR RIDGE (MESIAL INCLINE)
11. TRANSVERSE RIDGE
12. MESIAL CUSP RIDGE
13. DISTAL CUSP RIDGE

4.14. Maxillary Central Incisor. The maxillary central incisor (Figure 4.36) is the tooth nearest the median line in the maxillary arch.

4.14.1. **Facial Surface.** The facial surface is broad and resembles a thumbnail in outline. The right maxillary central incisor can be distinguished from the left maxillary central incisor because the distoincisal angle is more rounded than the mesioincisal angle and the incisal edge slopes slightly gingivally in a mesiodistal direction. The facial surface is convex, both mesiodistally and incisocervically. Three distinct lobes may be seen in the incisal portion, and they are separated by two developmental grooves.

4.14.2. **Lingual Surface.** The lingual surface appears slightly smaller than the facial surface, and the cervical portion is narrower. The large lingual fossa is bounded by prominent mesial and distal marginal ridges. There is a cingulum in the cervical portion, and there may be a pit in conjunction with the cingulum.

4.14.3. **Incisal Edge.** Viewed on end, the incisal edge appears nearly straight. Most of the wear is on the lingual portion of the edge, so the edge becomes beveled lingually. The cingulum lies more to the distal side of the tooth than to the mesial side.

4.14.4. **Mesial Surface.** The mesial surface looks like a wedge. The apex of the wedge is at the incisal edge of the tooth. The facial outline is slightly convex. The lingual outline is slightly concave from the incisal edge to the cingulum and convex from the cingulum to the cervical margin.

4.14.5. **Distal Surface.** The distal surface closely resembles the mesial surface. The lingual outline is more concave in the incisal portion than it is on the mesial surface.

Figure 4.31. Maxillary First Molar (Occlusal View).

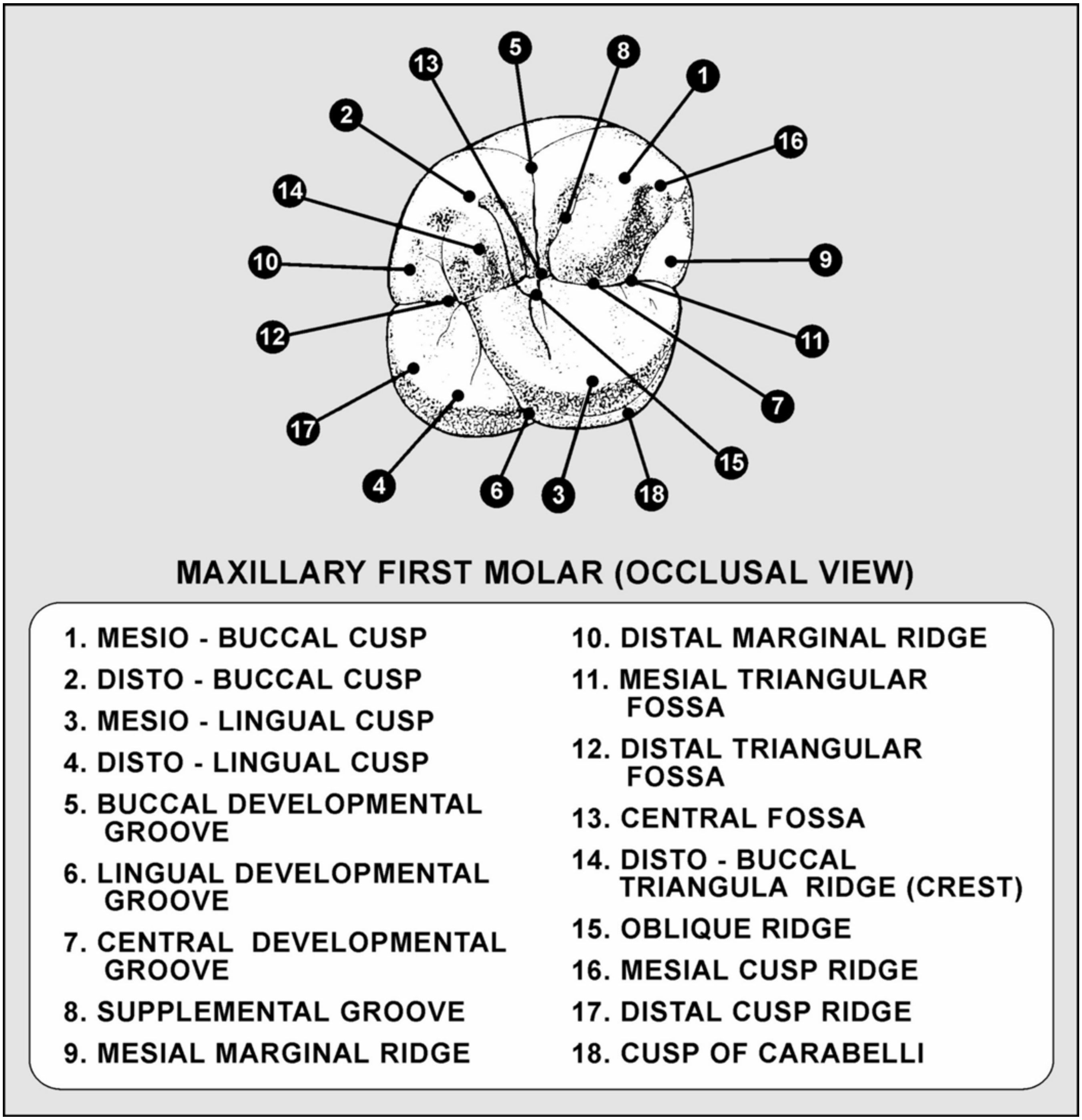


Figure 4.32. Mandibular First Molar (Occlusal View).

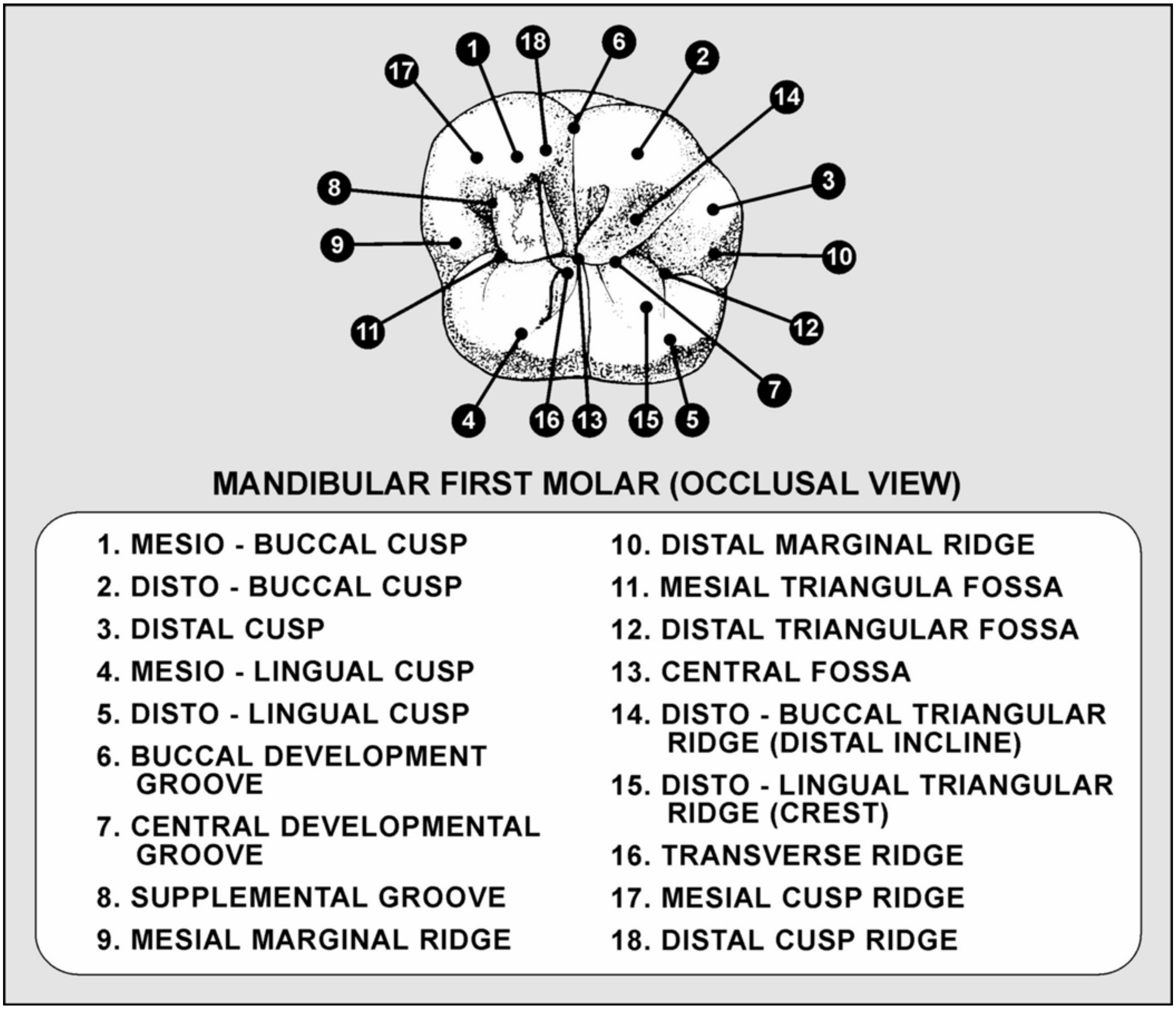


Figure 4.33. Contact Areas.

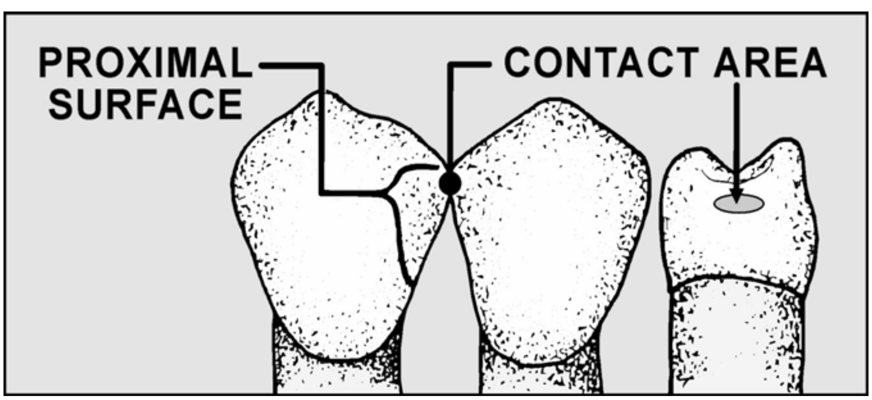


Figure 4.34. Embrasures.

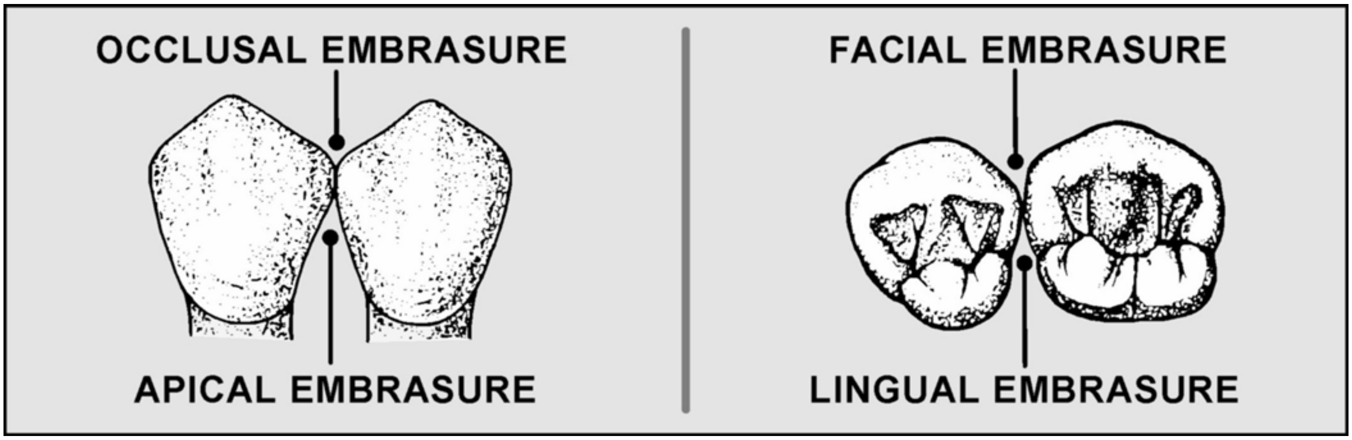


Figure 4.35. Occlusal Surface Outlines of Posterior Teeth.

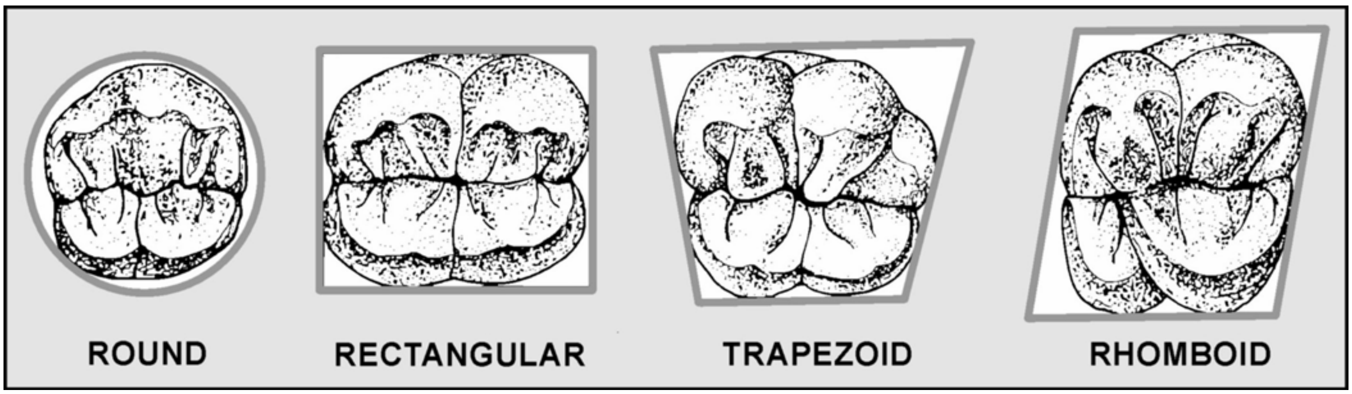
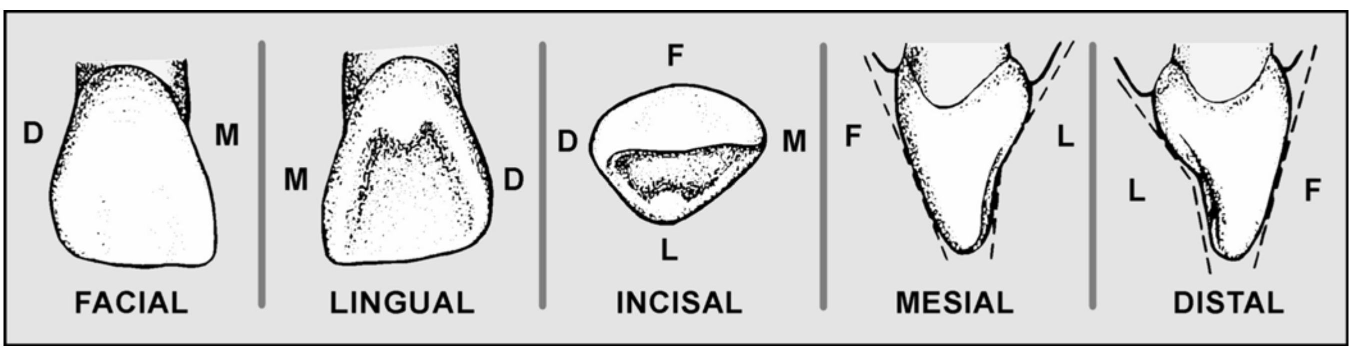


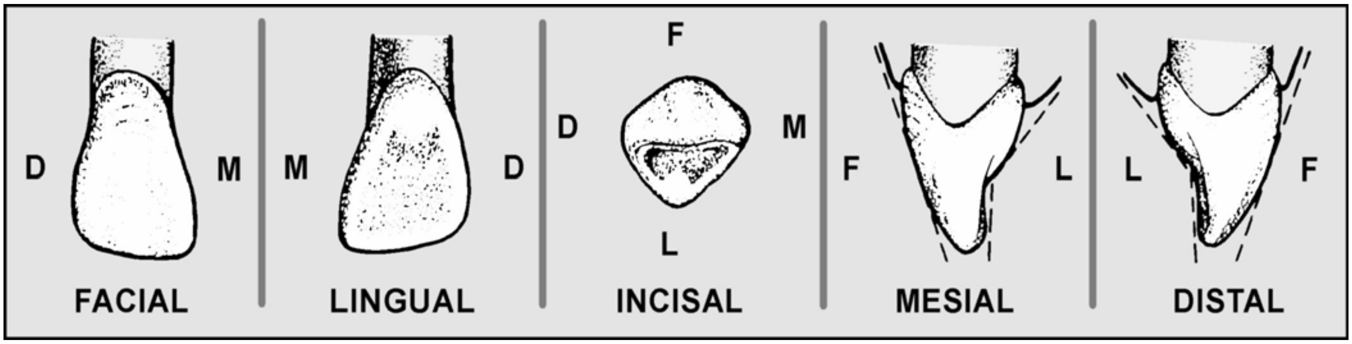
Figure 4.36. Maxillary Central Incisor.



4.15. Maxillary Lateral Incisor. The maxillary lateral incisor (Figure 4.37) is the second tooth from the median line in the maxillary arch. It resembles the central incisor, but is smaller in all dimensions.

4.15.1. **Facial Surface.** The facial surface is narrower and shorter than the central incisor. The distoincisal angle is more rounded than the mesioincisal angle. The distal portion of the incisal ridge slopes upward toward the distoincisal angle. The facial surface is convex.

Figure 4.37. Maxillary Lateral Incisor.



4.15.2. **Lingual Surface.** The lingual surface resembles the facial surface in peripheral outline except that the cervical portion is narrower. The features of this surface vary considerably from one individual to another. Proportionally, the lingual surface characteristics of a lateral incisor are more marked than similar features on a central incisor.

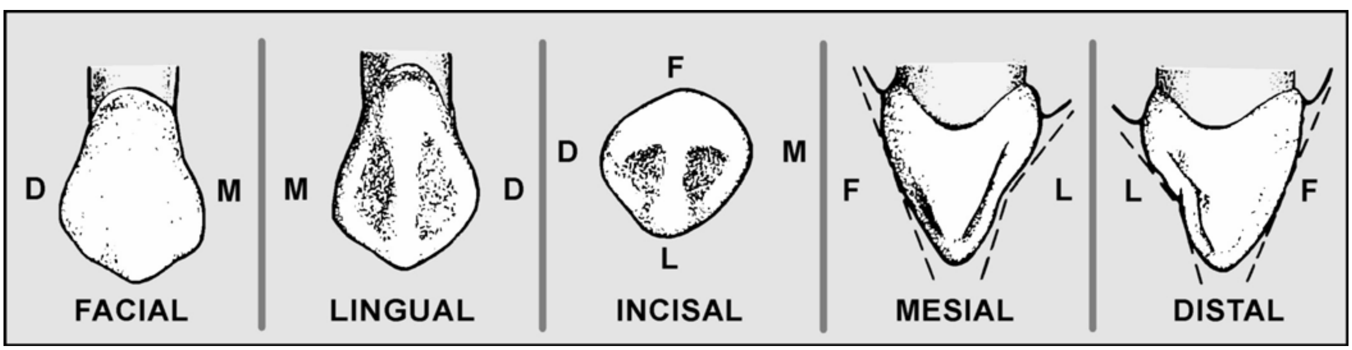
4.15.3. **Incisal Edge.** Viewed on end, the incisal edge appears nearly straight. The cingulum lies slightly to the distal side of the tooth.

4.15.4. **Mesial Surface.** The mesial surface, like the central incisor's, is wedge shaped. The apex of the wedge is at the incisal edge. The incisal edge lies somewhat further lingually than it does in the central incisor.

4.15.5. **Distal Surface.** The distal surface resembles the mesial surface, but the facial outline is more convex and the incisal portion of the lingual outline is more concave.

4.16. Maxillary Canine. The maxillary canine (Figure 4.38) is the third tooth from the median line in the maxillary arch. It is located at the corner of the arch, and its long root is embedded in the canine (cuspid) eminence. The maxillary canine is usually the longest tooth in either jaw. It is called canine because it resembles a dog's tooth. (It is sometimes referred to as a cuspid because it has one cusp on its incisal edge.)

Figure 4.38. Maxillary Canine.



4.16.1. **Facial Surface.** The incisal portion of the facial surface is much broader than the cervical portion. The mesial and distal cusp ridges of the incisal edge slope downward toward the center to meet at the tip of the cusp. The distal slope is longer than the mesial slope. The facial surface is convex. It is divided into mesial and distal surfaces by the facial ridge. The ridge extends from the tip of the cusp to the point of greatest convexity. The mesiofacial surface of the canine falls on the curve of the arch formed by the anterior teeth. The distofacial surface conforms to the buccal alignment of posterior teeth.

4.16.2. **Lingual Surface.** The lingual surface resembles the facial surface in outline, but the cervical portion is narrower. The mesial and distal marginal ridges are prominent, and a strong lingual ridge runs from the tip of the cusp to the cingulum. The maxillary canine has the largest cingulum of all the anterior teeth.

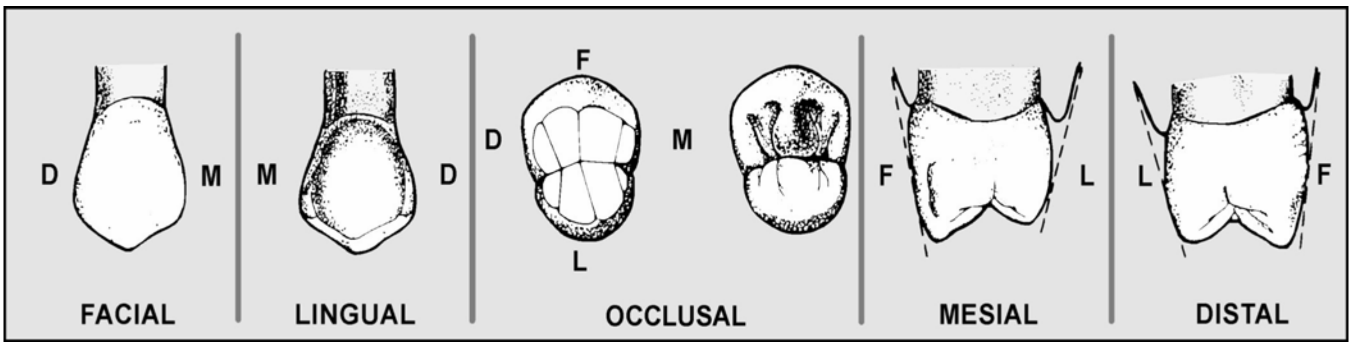
4.16.3. **Incisal Edge.** Viewed on end, the incisal edge is slightly curved. The lingual portion of the tooth appears rugged; the ridges and grooves are very well defined.

4.16.4. **Mesial Surface.** The mesial surface is roughly triangular. From this aspect, the canines appears much thicker than the incisors.

4.16.5. **Distal Surface.** The distal surface is shaped very much like the mesial surface, but is shorter because the distal portion of the incisal edge slopes further cervically than the mesial portion.

4.17. Maxillary First Premolar. The maxillary first premolar (Figure 4.39) is the fourth tooth from the median line in the maxillary arch. It is the first posterior tooth. The premolars are sometimes called bicuspids because most of them have two cusps.

Figure 4.39. Maxillary First Premolar.



4.17.1. **Facial Surface.** The facial surface resembles the canine in outline, but it is shorter occlusocervically and not quite as convex. The slopes of the mesial and distal cusp ridges are about equal in length. The facial ridge is prominent.

4.17.2. **Lingual Surface.** The lingual surface is much smaller than the facial surface in all dimensions, but is generally similar in outline. The lingual cusp is shorter than the facial cusp and is located mesial to the midline of the tooth.

4.17.3. **Occlusal Surface:**

4.17.3.1. The occlusal surface is broader facially than lingually. There are two cusps, the facial cusp and the lingual cusp.

4.17.3.2. The mesial and distal marginal ridges correspond to the marginal ridges of the anterior teeth. The mesial and distal proximal surfaces converge toward the lingual. Of the two, the distal surface has the greatest convergence.

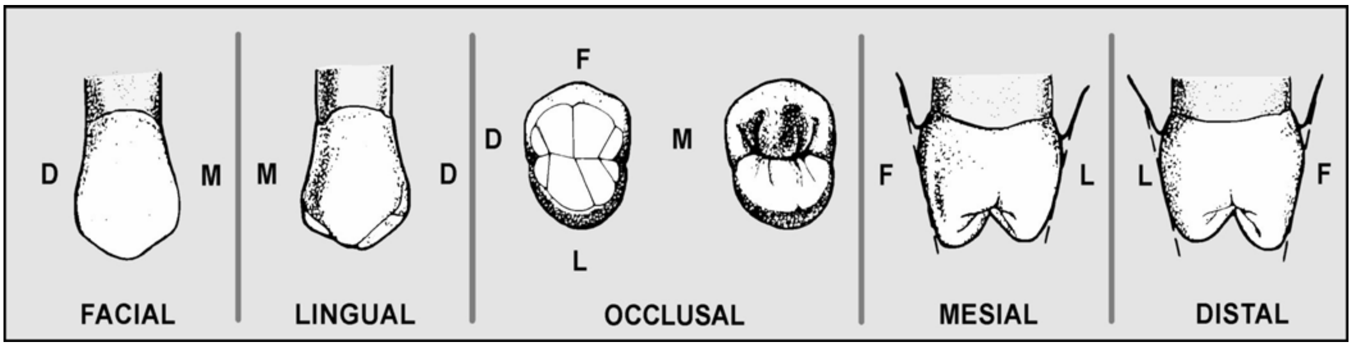
4.17.3.3. The mesial fossa is distal to the mesial marginal ridge and the distal fossa is mesial to the distal marginal ridge. The facial and lingual triangular ridges extend from the tips of the cusps to the central groove. This groove ends at the mesial and distal pits. The mesial and distal marginal grooves arise from the mesial and distal pits and end on the mesial and distal surfaces, respectively.

4.17.4. **Mesial Surface.** The mesial surface is roughly rectangular in outline. The facial and lingual outlines are convex. The mesial surface is generally convex except for a concave area on the facial portion of the surface above the cervical margin. The mesial marginal groove extends onto the mesial surface.

4.17.5. **Distal Surface.** The distal surface resembles the mesial surface, but does not have the concave area above the cervical margin.

4.18. Maxillary Second Premolar. The maxillary second premolar is the fifth tooth from the median line in the maxillary arch. It closely resembles the first premolar, but it is more rounded in outline (Figure 4.40).

Figure 4.40. Maxillary Second Premolar.



4.18.1. **Facial Surface.** The facial surface is slightly smaller than the facial surface of the first premolar. The slopes of the mesial and distal cusp ridges are about equal in length. The facial surface is convex, and the facial ridge is prominent.

4.18.2. **Lingual Surface.** The lingual surface is only slightly shorter than the facial surface because the facial and lingual cusps are nearly equal in length. This surface is also slightly narrower than the facial surface. The lingual surface is smoothly convex in all directions, and its greatest convexity is in the cervical third.

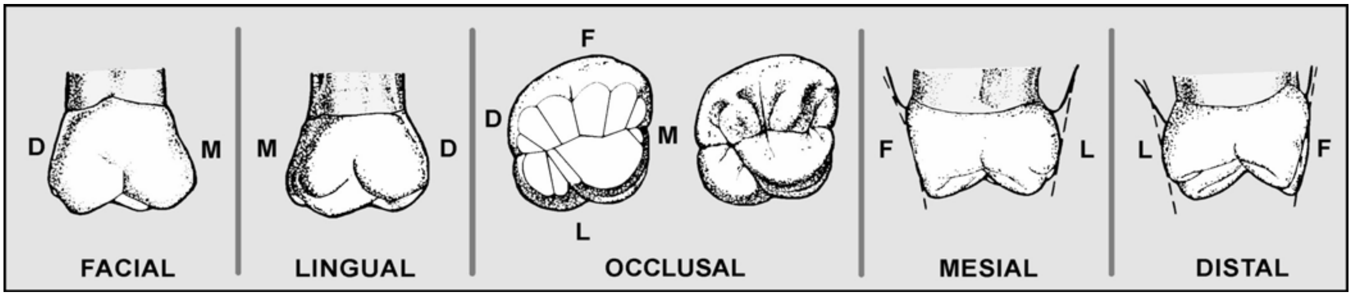
4.18.3. **Occlusal Surface.** In general, the occlusal surface has the same form and features as the occlusal surface of the first premolar. However, the facial and lingual portions are more nearly equal in size and the mesial and distal pits are closer together.

4.18.4. **Mesial Surface.** The mesial surface is wider in the cervical portion than in the occlusal portion. The facial outline is slightly convex except in the central portion. The lingual outline is convex. Both cusps appear more rounded that the cusps of the first premolar.

4.18.5. **Distal Surface.** The distal surface is slightly shorter than the mesial surface, but it is about the same width. The facial and lingual outlines are convex. The surface is smoothly convex except at the distal marginal groove.

4.19. Maxillary First Molar. The maxillary first molar (Figure 4.41) is the sixth tooth from the median line in the maxillary arch. It is the largest tooth in either arch. The maxillary and mandibular first molars are often called 6-year molars.

Figure 4.41. Maxillary First Molar.



4.19.1. **Facial Surface.** The facial surface is roughly heart-shaped in outline. The mesiofacial and distofacial cusps form the occlusal border, and the facial groove divides the cusps. The surface is generally convex except at this groove. The surface has three ridges. A ridge extends perpendicularly from the tip of each cusp and a third ridge extends horizontally in the cervical portion.

4.19.2. **Lingual Surface.** The mesiolingual and distolingual cusps outline the occlusal border of the lingual surface. The mesiolingual cusp is the largest of the posterior teeth. Quite often this tooth has a residual fifth cusp, the cusp of Carabelli, which is on the lingual surface of the mesiolingual cusp. When present, this cusp is shorter than the other cusps and does not form part of the occlusal surface. The lingual surface is generally convex except at the distolingual groove.

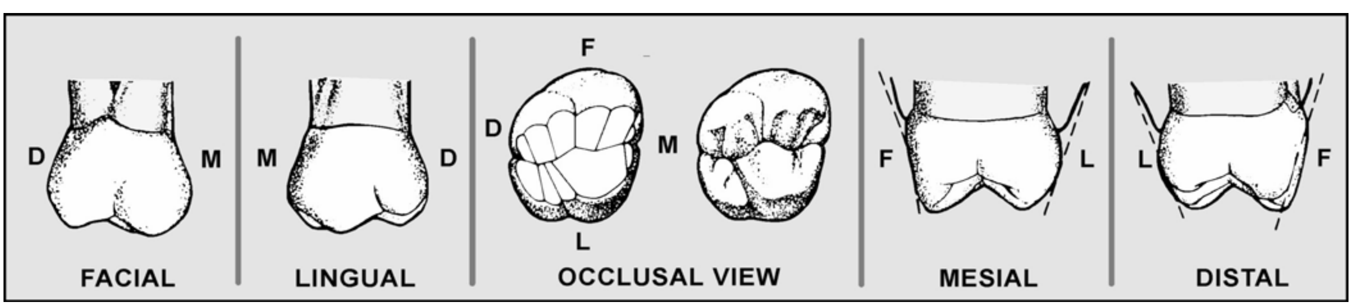
4.19.3. **Occlusal Surface.** The occlusal surface is roughly rhomboidal. The cusps are large and prominent, with broad surfaces broken up into rugged ridges and well-defined grooves. The mesiolingual cusp is the largest of the cusps. The distolingual groove separates it from the distolingual cusp. An oblique ridge connects the mesiolingual and distofacial cusps. It runs parallel to the distolingual groove. The facial groove runs from the central pit onto the facial surface. The mesial and distal pits lie near the mesial and distal marginal ridges, respectively.

4.19.4. **Mesial Surface.** The mesial marginal groove, which starts at the mesial pit, notches the occlusal border of the mesial surface. A double convexity marks the lingual margin if the cusp of Carabelli is present.

4.19.5. **Distal Surface.** The distal marginal groove, which starts at the distal pit, notches the occlusal border of the distal surface.

4.20. Maxillary Second Molar. The maxillary second molar (Figure 4.42) is the seventh tooth from the median line in the maxillary arch. It is quite similar to the first molar, but it is smaller. This tooth is often called the 12-year molar.

Figure 4.42. Maxillary Second Molar.



4.20.1. **Facial Surface.** The facial surface of the maxillary second molar is less symmetrical than the first molar. The mesiofacial cusp is larger than the distofacial cusp. The facial groove lies nearer to the distal surface than it does to the mesial surface. The same three ridges appear on the facial surface as appear on the facial surface of the first molar (paragraph 4.19.1).

4.20.2. **Lingual Surface.** The occlusal border of the lingual surface is marked by two cusps, the mesiolingual and the distolingual. The mesiolingual cusp is the largest. (***NOTE:*** The distolingual cusp is not fully reproduced in artificial teeth. For this reason, many of these artificial teeth appear triangular when viewed occlusally.) The second molar has no cusp of Carabelli. The cervical border is nearly straight, and the lingual surface is generally convex.

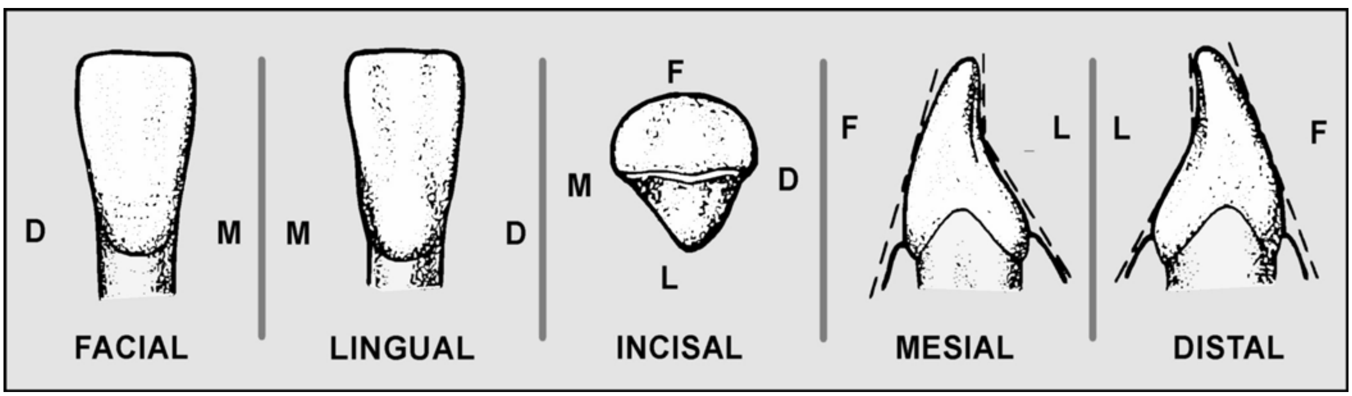
4.20.3. **Occlusal Surface.** The occlusal surface is very similar to the occlusal surface of the first molar (paragraph 4.19.3).

4.20.4. **Mesial Surface.** The mesial surface is fairly symmetrical in outline. The mesiofacial cusp is slightly longer than the mesiolingual cusp. The facial outline is nearly straight, but the lingual outline is distinctly convex.

4.20.5. **Distal Surface.** The distal surface is somewhat smaller than the mesial surface. The distofacial cusp is longer than the distolingual cusp. The facial outline appears less convex than it does from the mesial aspect.

4.21. Mandibular Central Incisor. The mandibular central incisor (Figure 4.43) is the first tooth from the median line in the mandibular arch. As described in the paragraphs below, it is the smallest tooth in either arch and the simplest in form:

Figure 4.43. Mandibular Central Incisor.



4.21.1. **Facial Surface.** The facial surface is widest at the incisal edge. The mesioincisal and distoincisal angles are almost 90-degree angles. The mesial and distal borders are almost parallel in the incisal portion. In their middle and cervical portions, the outlines converge but do not meet. The facial surface is convex. There are three lobes separated by two developmental grooves. The grooves are more faint than they are in the maxillary central incisor, often disappearing entirely.

4.21.2. **Lingual Surface.** The lingual surface is quite similar in outline to the facial surface, but the cervical portion is more narrow. The incisal portion of the lingual surface is concave. The cingulum, which begins fairly close to the cervical margin, blends more smoothly with the rest of the lingual surface than it does on the maxillary incisors.

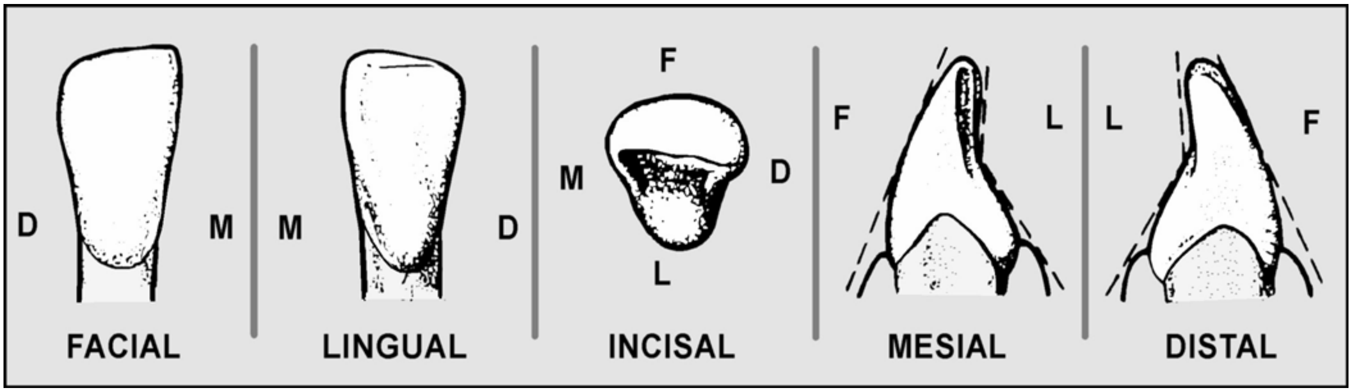
4.21.3. **Incisal Edge.** Viewed on end, the incisal edge appears nearly straight; and, in adults, the edge is worn smooth and sharp.

4.21.4. **Mesial Surface.** The mesial surface is wedge shaped. The facial outline is convex. The lingual outline is concave in the incisal and middle portions and convex in the cervical portion. The mesial surface is almost flat incisogingivally.

4.21.5. **Distal Surface.** The distal surface closely resembles the mesial surface.

4.22. Mandibular Lateral Incisor. The mandibular lateral incisor (Figure 4.44) is the second tooth from the median line in the mandibular arch. Although it resembles the mandibular central incisor, it is wider and longer:

Figure 4.44. Mandibular Lateral Incisor.



4.22.1. **Facial Surface.** The facial surface is less symmetrical than the facial surface of the mandibular central incisor. The incisal edge slopes upward toward the mesioincisal angle, which is slightly less than 90 degrees. The distoincisal angle is rounded. The mesial border is more nearly straight than the distal border. (The distal border is slightly convex in the incisal portion and slightly concave in the middle and cervical portions.) The facial surface is convex.

4.22.2. **Lingual Surface.** The lingual surface is similar in outline to the facial surface. The mesial and distal borders converge more sharply than they do on the facial surface. The incisal portion of the lingual surface is concave. The cingulum is quite large, but blends smoothly with the rest of the surface.

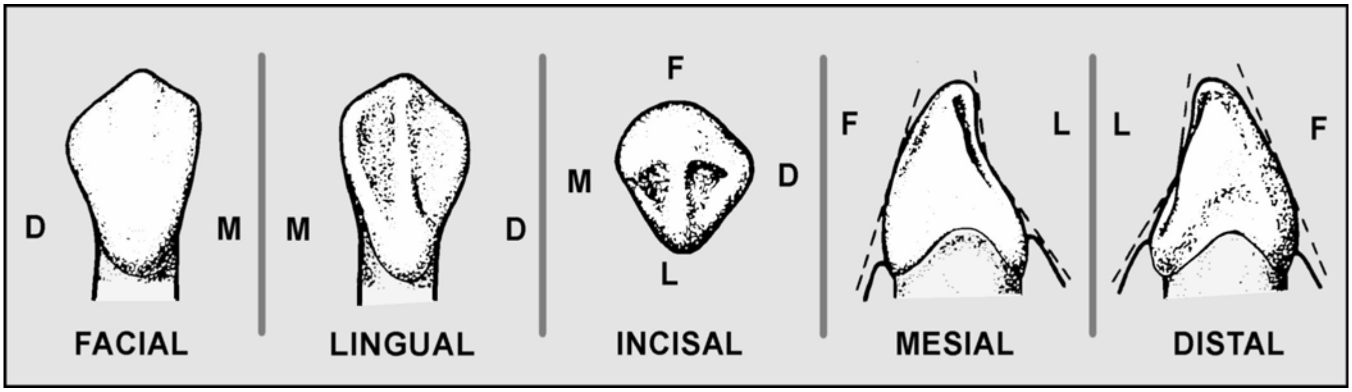
4.22.3. **Incisal Edge.** Viewed on end, the incisal edge forms a nearly straight line that slants lingually toward its distal end. This is because the distal portion of the facial surface is more convex than the mesial portion.

4.22.4. **Mesial Edge.** The mesial surface is wedge shaped. The facial outline is convex. The lingual outline is concave in the incisal portion and convex in the middle and cervical portions.

4.22.5. **Distal Edge.** The distal surface is slightly shorter than the mesial surface because the incisal edge slants downward toward the distoincisal angle. The incisal portion of the distal surface is thicker than the incisal portion of the mesial surface.

4.23. Mandibular Canine. The mandibular canine (Figure 4.45) is the third tooth from the median line in the mandibular arch. It is similar to the maxillary canine, but more narrow.

Figure 4.45. Mandibular Canine.



4.23.1. **Facial Surface.** The facial surface is asymmetrical in outline. The distal portion of the surface is shorter and broader than the mesial portion. Consequently, the distal cusp ridge of the incisal edge is much longer than the mesial edge. The mesial border is slightly convex. The upper portion of the distal border is very convex, and the lower portion is slightly concave. The three lobes are quite distinct. The central lobe forms the strong facial ridge.

4.23.2. **Lingual Surface.** The lingual surface is similar in outline to the facial surface except the cervical portion is more narrow. Most of the surface is concave incisocervically. The lingual ridge divides the surface into two planes. The ridge blends smoothly with the cingulum, which is small and confined to the cervical portion of the tooth.

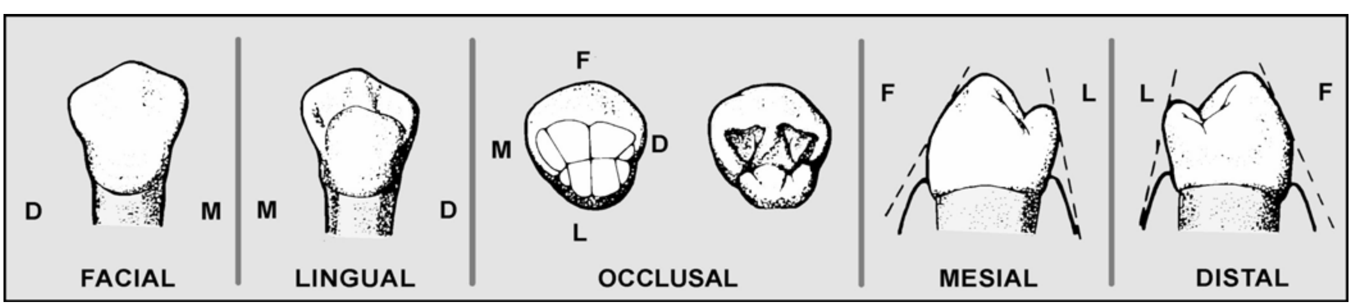
4.23.3. **Incisal Edge.** Viewed on end, the incisal edge forms two curves that meet at the tip of the cusp. The mesial portion of the facial outline is convex, but the distal portion is slightly flattened. The mesial curve follows the alignment of the facial surfaces of the anterior teeth. The distal part of the facial outline conforms to the buccal surface alignment of posterior teeth. The cingulum appears uniformly curved on both sides.

4.23.4. **Mesial Surface.** The mesial surface more nearly resembles the incisors than the mesial surface of the maxillary canine in outline. The facial outline is convex. The lingual outline is chiefly concave except near the cervical margin. The mesial surface is generally convex.

4.23.5. **Distal Surface.** The distal surface is shorter than the mesial surface, but about the same width. The incisal portion is very convex both faciolingually and incisogingivally. The cervical portion is concave incisogingivally.

4.24. Mandibular First Premolar. The mandibular first premolar (Figure 4.46) is the fourth tooth from the median line in the mandibular arch. It is the smallest and least typical of the premolars.

Figure 4.46. Mandibular First Premolar.



4.24.1. **Facial Surface.** The facial surface is shaped somewhat like a bell because the cervical portion is markedly constricted in comparison with the occlusal portion. The distal cusp ridge of the occlusal border is slightly longer than the mesial cusp ridge, and the distoincisal angle is more rounded than the mesioincisal angle. The distal portion of the surface is slightly shorter and broader than the mesial surface. The surface is convex.

4.24.2. **Lingual Surface.** The lingual surface is much smaller than the facial surface because the lingual cusp is smaller than the facial cusp. The tip of the lingual cusp is closer to the mesial margin than to the distal margin. The surface is convex.

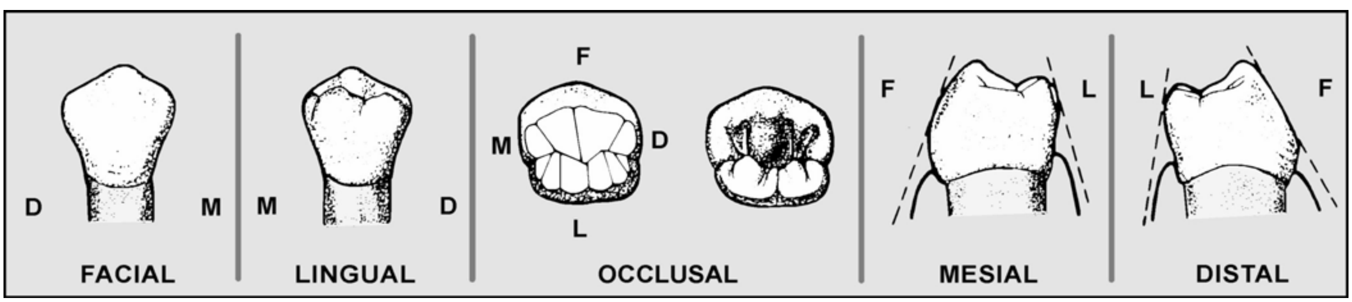
4.24.3. **Occlusal Surface.** The occlusal surface is marked by a strong facial cusp and a lingual cusp that may appear almost rudimentary. The marginal ridges are well defined. The strong lingual ridge of the facial cusp and the facial ridge of the lingual cusp may join, forming a transverse ridge. In this instance, the central groove would be very faint.

4.24.4. **Mesial Surface.** The mesial surface is irregular in outline. From this aspect, the tooth appears to be tipped lingually. The facial cusp forms most of the occlusal outline. The facial outline is very convex, and the greatest convexity is in the cervical third. The lingual outline is fairly straight. Occlusocervically, the mesial surface is very convex in the occlusal portion and concave in the cervical portion.

4.24.5. **Distal Surface.** The distal surface is similar to the mesial surface.

4.25. Mandibular Second Premolar. The mandibular second premolar (Figure 4.47) is the fifth tooth from the median line in the mandibular arch.

Figure 4.47. Mandibular Second Premolar.



4.25.1. **Facial Surface.** The facial surface is very similar to the surface of the mandibular first premolar. The facial ridge is prominent, and the surface is convex.

4.25.2. **Lingual Surface.** The lingual surface is similar to the surface of the mandibular first premolar except there may be two cusps--the mesiolingual and the distolingual.

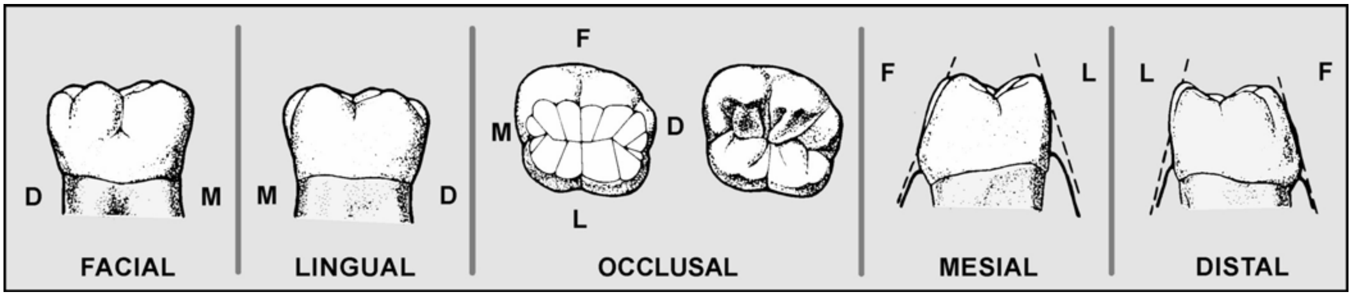
4.25.3. **Occlusal Surface.** The occlusal surface may appear in a number of forms. In the form pictured, the mesial and distal triangular fossae are quite distinct as they join the short central groove. There are three pits; central, mesial, and distal.

4.25.4. **Mesial Surface.** The mesial surface is similar to the surface of the mandibular first premolar, but it is more regular in outline. The surface is convex faciolingually. Occlusocervically, the occlusal portion is convex, and the cervical portion is concave.

4.25.5. **Distal Surface.** The distal surface is very similar to the mesial surface.

4.26. Mandibular First Molar. The mandibular first molar (Figure 4.48) is the sixth tooth from the median line in the mandibular arch. It is also the largest tooth in the mandibular arch. The maxillary and mandibular first molars are often called 6-year molars.

Figure 4.48. Mandibular First Molar.



4.26.1. **Facial Surface.** The facial surface presents three cusps; mesiofacial, distofacial, and distal. The mesiofacial cusp is the largest; the distal is the smallest. The distofacial cusp, though smaller than the mesiofacial cusp, may be slightly higher. The mesiofacial (facial) groove, which may end in a pit, separates the mesiofacial and distofacial cusps. The distofacial groove separates the distofacial and distal cusps. The facial surface is convex except at the grooves.

4.26.2. **Lingual Surface.** The lingual surface has a mesiolingual cusp and a distolingual cusp, which are similar in outline. They are separated by the sharply defined lingual groove. The surface is slightly convex.

4.26.3. **Occlusal Surface.** The occlusal surface of this tooth, unlike the surface of the maxillary first molar, is formed by all five cusps and is trapezoidal in shape. There are three pits; mesial, central, and distal. A central groove, which connects these pits, divides the occlusal surface into the lingual and facial halves. From the occlusal aspect, the mesiofacial cusp appears the largest and the distal cusp appears the smallest.

4.26.4. **Mesial Surface.** The mesial surface is wider in the cervical portion than it is in the occlusal portion because the occlusal and middle thirds of the facial outline slope outward occlusocervically. The lingual outline is quite straight and nearly perpendicular.

4.26.5. **Distal Surface.** The distal surface is more symmetrical than the mesial surface because the facial outline is more nearly perpendicular than it is on the mesial surface.

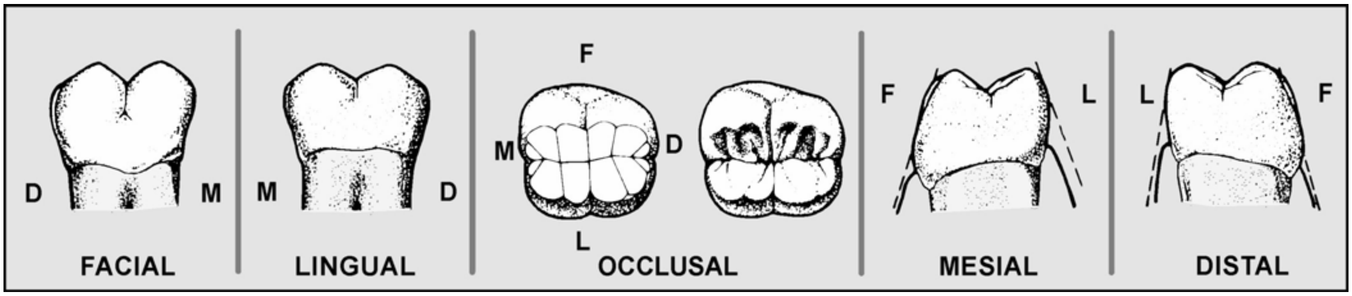
4.27. Mandibular Second Molar. The mandibular second molar (Figure 4.49) is the seventh tooth from the median line in the mandibular arch. It is one of the 12-year molars.

4.27.1. **Facial Surface.** The facial surface is almost symmetrical in outline, and the mesiofacial and distofacial cusps appear nearly equal in size. The two cusps are separated by the deep facial groove. There is no third cusp.

4.27.2. **Lingual Surface.** The lingual surface is symmetrical, but the mesiolingual cusp is slightly longer and bulkier than the distolingual cusp. The lingual groove is shorter and less distinct than the groove on the facial surface.

4.27.3. **Occlusal Surface.** The occlusal surface is rectangular in shape. From this view, the mesiofacial cusp appears slightly larger than the other three cusps. The occlusal surface has three pits; mesial, central, and distal.

Figure 4.49. Mandibular Second Molar.



4.27.4. **Mesial Surface.** The mesial surface resembles the mesial surface of the mandibular first molar, but it is shorter. The facial outline is convex occlusocervically. The occlusal portion of the lingual outline is convex, and the cervical portion is more nearly straight.

4.27.5. **Distal Surface.** The distal surface resembles the mesial surface.

Chapter 5

OCCLUSION PATTERNS ASSOCIATED WITH BASIC MANDIBULAR POSITIONS AND MOVEMENTS

Section 5A—Basic Terminology

5.1. Overview:

5.1.1. *Occlusion* is defined as the "the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth." *Articulation* is defined as "the contact relationship between the occlusal surfaces of the teeth during function."

5.1.2. Many patterns of tooth contact are possible. Part of the reason for the variety is the mandibular condyle's substantial range of movement within the temporomandibular joint. Some of the more vital terms and fundamental occlusion patterns associated with the basic mandibular positions and movements are described in this chapter.

5.2. Maximum Intercuspation (MI). *Maximum intercuspation* is the complete intercuspation of the opposing teeth independent of condylar position.

5.2.1. It is important to understand the value of MI in the natural dentition. The MI position is a highly reproducible guide for restoring the shape of badly broken down natural teeth. It is also a guide for aligning and shaping artificial teeth for partially edentulous arches.

5.2.2. A dentist checks the height of all kinds of restorations by asking the patient to bring opposing teeth into MI. A technician routinely makes restorations on casts that have been related to each other in MI. When a natural dentition has grossly deteriorated or when all teeth have been extracted, one of the best means a dentist had for accurate, reproducible positioning of the lower jaw in relation to the upper is gone.

5.2.3. Restorative challenges, like making complete dentures or rehabilitating an entire natural dentition, require the dentist to make an educated guess. He or she must determine just where the lower jaw was located when the natural teeth contacted in correct MI. The problem is two-fold; properly orientating the lower jaw vertically and properly positioning the lower jaw horizontally.

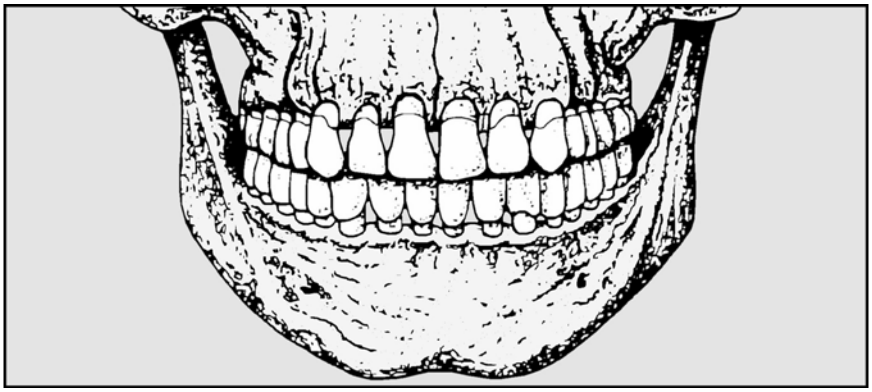
5.3. Centric Relation. *Centric relation* is a maxillomandibular relationship in which the condyles articulate with their respective discs in the anterior-superior position of the glenoid fossa against the articular eminences.

5.3.1. For most people, when their teeth are in MI, the condyles are situated 1.25 mm plus or minus 1 mm forward of centric relation. When surfaces of teeth are grossly deteriorated or when all teeth are lost, there is no way of telling exactly where the normal MI position placed the condyles in the glenoid fossae. In these cases, the dentist uses the highly reproducible centric relation position to horizontally orient the lower jaw for prosthesis construction procedures.

5.3.2. How do we rationalize the probability that the condyles were not in centric relation when the patient had a full complement of sound natural teeth in good MI? Fortunately for dentistry, most patients function well when the centric relation position is used to horizontally orient the lower jaw to the upper. For example, denture teeth are purposely assembled to come together in MI when the condyles are in centric relation. The dental laboratory technician's ability to fabricate any restoration or prosthesis in centric relation requires an accurate jaw relation record in centric relation.

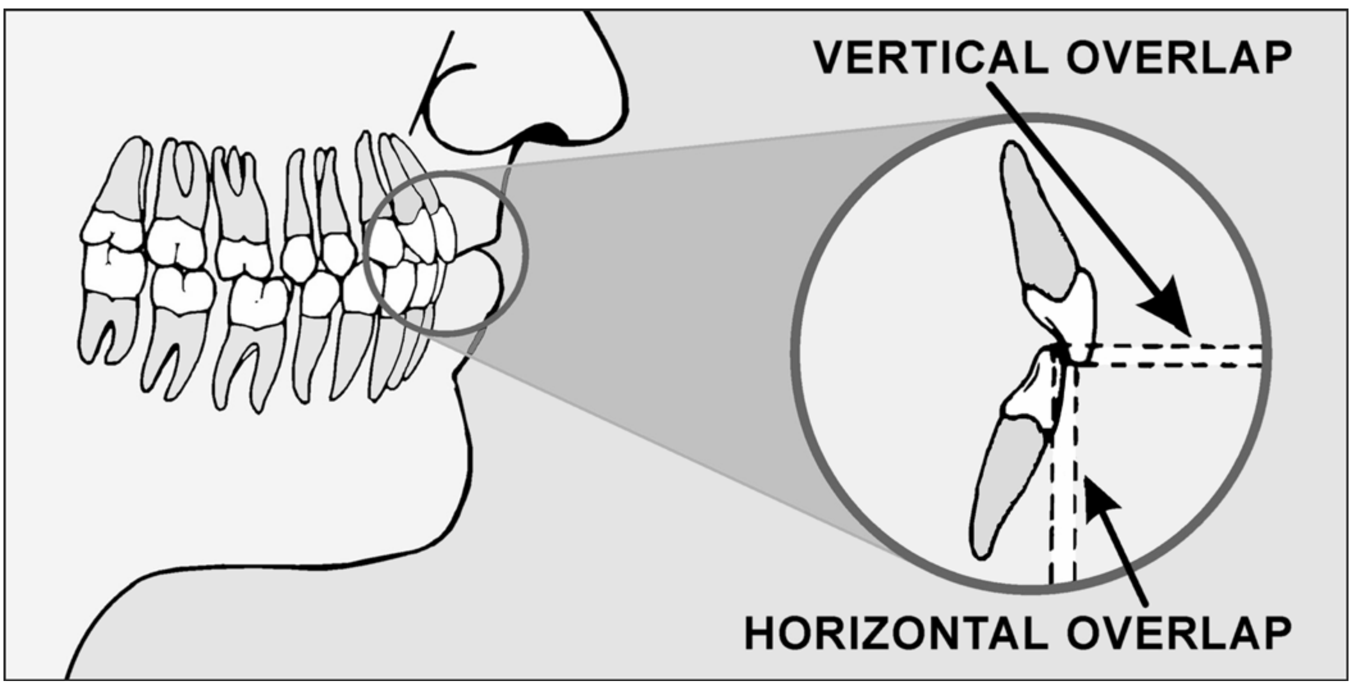
5.4. Centric Occlusion. Centric occlusion is the occlusion of teeth when the mandible is in centric relation (Figure 5.1). This position may or may not coincide with MI.

Figure 5.1. Centric Occlusion.



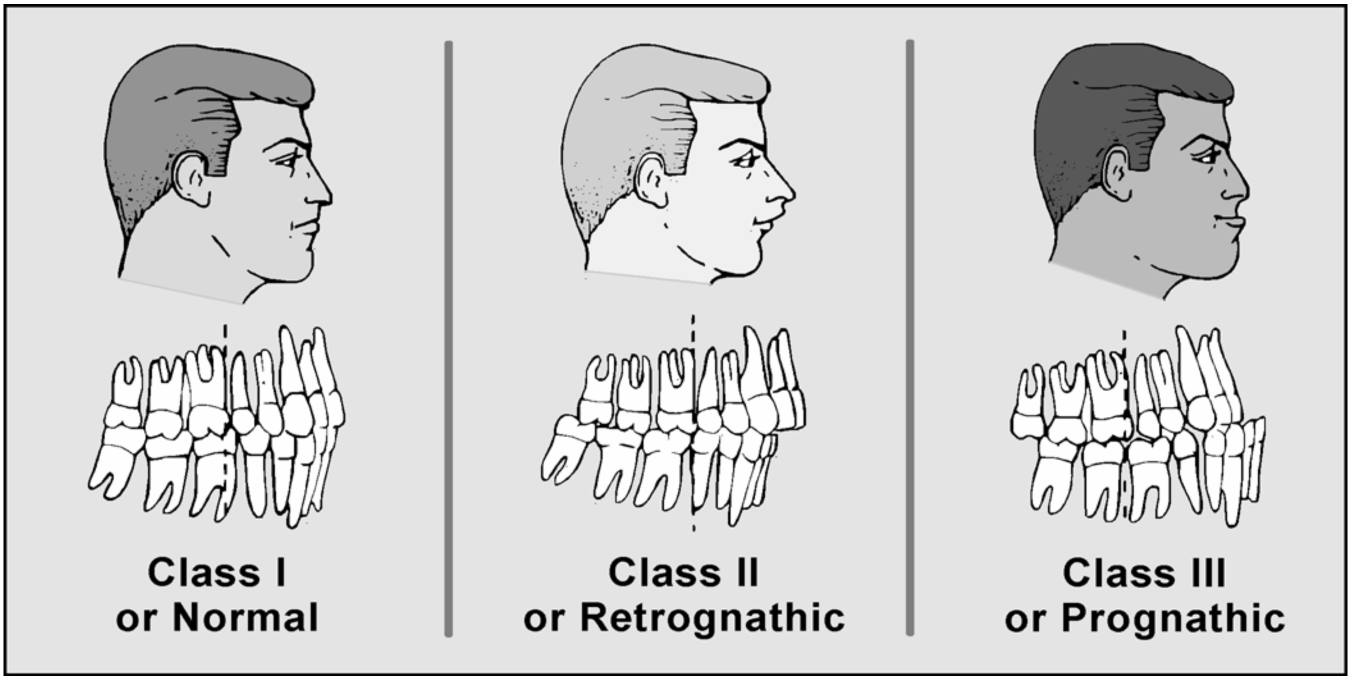
5.5. Vertical and Horizontal Overlap. Vertical overlap is the extension of the maxillary teeth over mandibular counterparts in a vertical direction when the dentition is in MI (Figure 5.2). Horizontal overlap is the projection of teeth beyond their antagonists in a horizontal direction.

Figure 5.2. Vertical and Horizontal Overlap.



5.6. Angle's Classification. E. H. Angle (1899) developed a classification of the normal and abnormal relationships of maxillary to mandibular teeth (Figure 5.3). Angle defined three classes; I, II, and III. These classes are based on a person's profile, the position of the mesiobuccal cusp of the upper first molar relative to the buccal developmental groove of the lower first molar, and the upper anterior to lower anterior tooth relations in terms of vertical and horizontal overlap.

Figure 5.3. Angle's Classification.



5.6.1. **Class I.** In this class, the patient's profile is characterized as normal. The mesiobuccal cusp of the upper first molar falls in the buccal groove of the lower first molar when the teeth are in MI. In the anterior area, the normal range of horizontal overlap is 0 to 2 mm and the average range of vertical overlap is 1 to 5 mm.

5.6.2. **Class II.** In this class, the patient's profile is deficient in chin length and characterized as a retruded (retrognathic) profile. The mesiobuccal cusp of the upper first molar falls anterior to the buccal groove of the lower first molar in MI. In the anterior area, horizontal overlaps in excess of 10 mm are not uncommon. Vertical overlaps, where the lower incisors make indentations in the gingiva of the palate, happen occasionally. In any event, the most significant feature about the anterior tooth relationships in Angle's Class II is the marked horizontal overlap. There are two subdivisions of Angle's Class II as follows:

5.6.2.1. **Class II, Division 1 (II/1).** In Class II/1 malocclusions, the maxillary incisors have a normal labiolingual inclination or are too labially inclined.

5.6.2.2. **Class II, Division 2 (II/2).** In Class II/2 malocclusions, two or more maxillary incisors are tipped palatally.

5.6.3. **Class III.** In this class, the patient's profile is excessive in chin length and characterized as a protruded (prognathic) profile. The mesiobuccal cusp of the upper first molar falls posterior to the buccal groove of the lower first molar in MI. In the anterior area, the upper and lower anteriors are usually edge to edge (0 mm of vertical and horizontal overlap). Negative vertical and horizontal overlaps are possible. (The lingual surfaces of the lower anteriors are forward to and extend up over the incisal edges of the upper anteriors.)

Section 5B—Cusp Position in Maximum Intercuspation (MI)

5.7. Types of Cusps. From a functional point of view, there are two types of cusps—stamp cusps and shearing cusps.

5.7.1. **Stamp Cusps (Lingual of the Upper and Buccal of the Lower).** Another name for a stamp cusp is *occlusal vertical dimension holding cusp*. This is because stamp cusps act to maintain a constant distance between the upper and lower jaws when the teeth are in MI.

5.7.2. **Shearing Cusps (Buccal of the Upper and Lingual of the Lower).** By exclusion, shearing cusps are cusps other than stamp cusps. That is, shearing cusps do not maintain the vertical distance between the upper and lower jaws when the teeth are in MI.

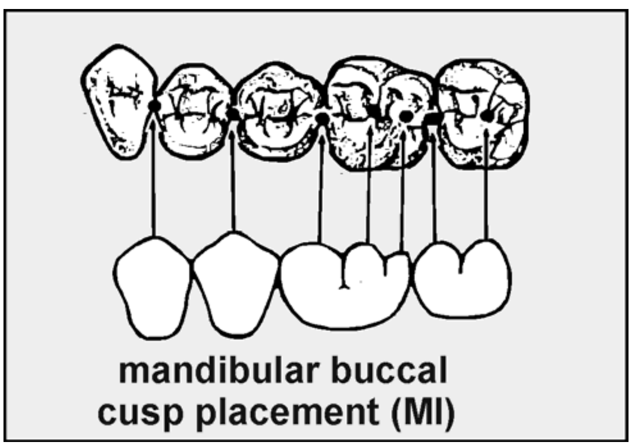
5.8. Cusp Relationships With Opposing Teeth. When teeth come into MI (Class I, II, or III), the stamp cusps in one arch hit in fossae or across occlusal embrasures of the teeth in the opposite arch. Two basic varieties of stamp cusp arrangements are used in making prosthodontic restorations; the cusp-to-occlusal embrasure pattern (paragraph 5.9) and the cusp-to-fossae pattern (paragraph 5.10).

5.9. Cusp-to-Occlusal Embrasure Pattern. Variations of this pattern are frequently seen in natural dentitions. This type of cusp placement was originally established for complete denture setups. It is basically a one tooth to two teeth relationship of all of the teeth except the mandibular central incisor and the last maxillary molar. In MI, most of the mandibular buccal cusps are in embrasure contact with the maxillary teeth, and almost all of the maxillary lingual cusps are in a fossa relationship with the mandibular teeth.

5.9.1. **Stamp Cusp Impacts:**

5.9.1.1. Look at Figure 5.4 as you read the information in Table 5.1 on contact locations of mandibular buccal cusps on maxillary teeth in a cusp-embrasure occlusion. You can see that all of the mandibular buccal cusps are in an embrasure contact relationship with the maxillary teeth, except the distobuccal (DB) cusps of the mandibular first and second molars and the distal (D) cusp of the mandibular first molar.

Figure 5.4. Cusp-to-Embrasure Tooth Orientations (Mandibular Buccal).



5.9.1.2. Look at Figure 5.5 as you read the information in Table 5.2 on contact locations on mandibular teeth by the maxillary lingual cusps in a cusp-embrasure occlusion. All of the maxillary lingual cusps are in a fossa relationship except the distolingual (DL) cusps of the maxillary first and second molars.

Table 5.1. Contact Locations of Mandibular Buccal Cusps on Maxillary Teeth.

ITEM	A Mandibular Buccal Cusps	B Contact Areas on Maxillary Teeth
1	First premolar	Embrasure between canine and first premolar
2	Second premolar	Embrasure between first and second premolars
3	First molar (MB cusp)	Embrasure between second premolar and first molar
4	First molar (DB cusp)	Central fossa of maxillary first molar
5	First molar (D cusp)	Distal fossa of maxillary first molar
6	Second molar (MB cusp)	Embrasure between first and second molars
7	Second molar (DB cusp)	Central fossa of maxillary second molar

Figure 5.5. Cusp-to-Embrasure Tooth Orientations (Maxillary Lingual).

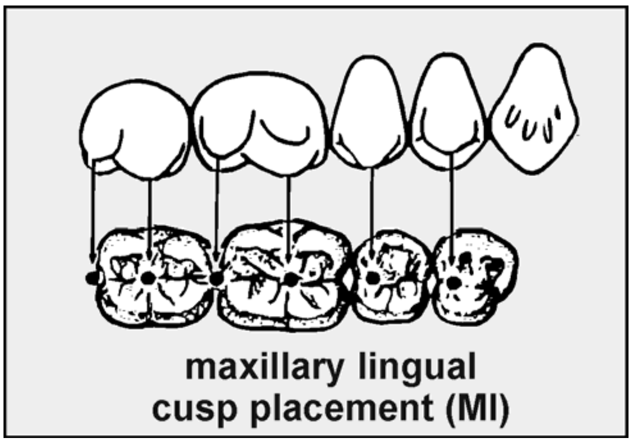


Table 5.2. Contact Locations of Maxillary Lingual Cusps on Mandibular Teeth.

ITEM	A Maxillary Lingual Cusps	B Contact Area on Mandibular Teeth
1	First premolar	Distal fossa of lower first premolar
2	Second premolar	Distal fossa of lower second premolar
3	ML cusp of first molar	Central fossa of lower first molar
4	DL cusp of first molar	Embrasure between first and second molars
5	ML cusp of second molar	Central fossa of lower second molar
6	DL cusp of second molar	Embrasure distal to lower second molar

5.9.2. **Shearing Cusp Positions:**

5.9.2.1. All of the maxillary buccal cusp tips are in a buccal embrasure relationship with lower teeth. (Exceptions are the mesiobuccal cusp of the maxillary first molar in the buccal developmental groove of the mandibular first molar, distobuccal cusp of the maxillary first molar resting over the distobuccal developmental groove of the mandibular first molar, and the mesiobuccal cusp of the maxillary second molar in the buccal developmental groove of the mandibular second molar.)

5.9.2.2. All of the mandibular lingual cusp tips are in a lingual embrasure relationship with the upper teeth. (Exceptions are the distolingual cusp of the mandibular first molar situated in the lingual developmental groove of the maxillary first molar and the distolingual cusp of the mandibular second molar in the lingual developmental groove of the maxillary second molar.

5.10. Cusp-to-Fossa Pattern:

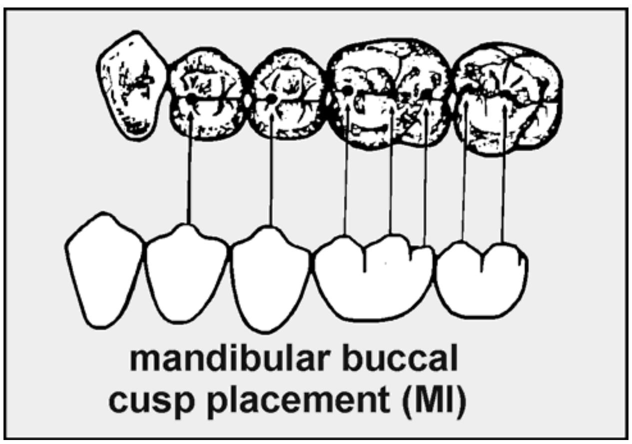
5.10.1. **Placement.** This type of cusp placement locates all mandibular buccal cusps into the fossae of their maxillary counterparts. Also, all maxillary lingual cusps are positioned in the fossae of their mandibular antagonists. Under ideal conditions, it is a tooth-to-tooth relationship; that is, each mandibular posterior tooth contacts one maxillary opponent. Although the cusp-to-fossa pattern is extensively used to restore teeth in fixed prosthetic dentistry, it is rarely seen in the natural dentition.

5.10.2. **Three Advantages.** A cusp-to-fossa relationship has three significant advantages over a cusp to embrasure relationship. First, it better directs forces over the long axes of the teeth. Second, is it helps stabilize individual teeth in their respective positions in the dental arches. Finally, a cusp-to-fossa relationship reduces food impaction in the proximal area because there are no cusp tips striking in the embrasures to force the teeth apart.

5.10.3. **Stamp Cusp Impacts:**

5.10.3.1. Look at Figure 5.6 as you read the information in Table 5.3 on contact locations in the maxillary fossae by the mandibular buccal cusps in a cusp-fossa occlusion.

Figure 5.6. Cusp-to-Fossa Tooth Orientations (Mandibular Buccal).



5.10.3.2. Look at Figure 5.7 as you read the information in Table 5.4 on contact locations in the mandibular fossae by the maxillary lingual cusps in a cusp-fossa occlusion.

5.10.4. **Shearing Cusp Positions:**

5.10.4.1. The maxillary molar buccal cusps are located over mandibular buccal developmental grooves. Maxillary premolar buccal cusps are situated over specially formed notches in the distal cusp ridges of mandibular premolar buccal cusps. ***NOTE:*** Notches are also placed in the mesial cusp ridges of maxillary premolar buccal cusps.

Table 5.3. Contact Locations of Mandibular Buccal Cusps on Maxillary Fossae.

ITEM	A Mandibular Buccal Cusp	B Contact Areas on Maxillary Teeth
1	First premolar	Mesial fossa of maxillary first premolar
2	Second premolar	Mesial fossa of maxillary second premolar
3	First molar (MB cusp)	Mesial fossa of maxillary first molar
4	First molar (DB cusp)	Central fossa of maxillary first molar
5	First molar (D cusp)	Distal fossa of maxillary first molar
6	Second molar (MB cusp)	Mesial fossa of maxillary second molar
7	Second molar (DB cusp)	Central fossa of maxillary second molar

Figure 5.7. Cusp-to-Fossa Tooth Orientations (Maxillary Lingual).

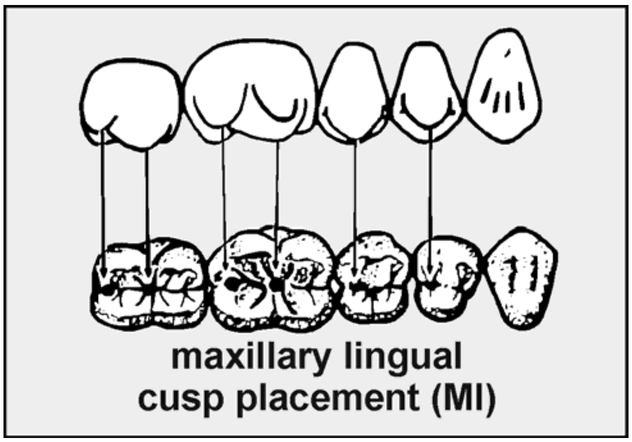


Table 5.4. Contact Locations of Maxillary Lingual Cusps on Mandibular Fossae.

ITEM	A Maxillary Lingual Cusps	B Contact Areas on Mandibular Teeth
1	First premolar	Distal fossa of mandibular first premolar
2	Second premolar	Distal fossa of mandibular second premolar
3	First molar (ML cusp)	Central fossa of mandibular first molar
4	First molar (DL cusp)	Distal fossa of mandibular first molar
5	Second molar (ML cusp)	Central fossa of mandibular second molar
6	Second molar (DL cusp)	Distal fossa of mandibular second molar

5.10.4.2. The buccally located maxillary and mandibular notches reduce the possibility of lateral movement interference during working excursions. Natural teeth do not show such notching.

5.10.4.3. As previously stated, the cusp-to-fossa type of MI is frequently incorporated into fixed prosthodontic restorations. All such restorations start as *wax patterns* (wax simulations of natural teeth surfaces). Within limits, this means stamp cusps can intentionally be waxed into fossae and cusp arms can be notched for better lateral excursion clearance. Mandibular shearing cusps are positioned to avoid collision with maxillary stamp cusps in working excursions.

5.10.4.4. In MI, the distolingual cusp of the mandibular first molar is situated in the lingual developmental groove of the maxillary first molar. The distolingual cusp of the mandibular second molar is in the lingual developmental groove of the maxillary second molar. The positions of the other mandibular shearing cusps are somewhat more variable. Therefore, the mandibular lingual cusp position has to conform to the working excursion rule (no opposing cusp collisions). Notching maxillary and mandibular cusp arms on the lingual aspect of posterior teeth is just as acceptable as it was on the buccal.

5.11. Applying the Cusp-Fossa Philosophy to Prosthesis Fabrication:

5.11.1. Cusp-fossa contacts are of primary value in restoration problems that directly or indirectly involve natural teeth; for example, single castings, fixed partial dentures, RPDs, and natural teeth opposing a complete denture. (The idea is to reproduce cusp-fossa contacts if they were there originally.)

5.11.2. It may be possible to change cusp-embrasure contacts to the more desirable cusp-fossa variety by appropriately carving wax patterns. There are no particular advantages to developing cusp-fossa contacts for opposing complete dentures.

5.12. Crossbite:

5.12.1. Normally, the buccal cusps of the lower teeth and the maxillary lingual cusps are the occlusal vertical dimension holding (stamp) cusps. In MI, the buccal cusps of the maxillary posteriors horizontally overlap the buccal cusps of the mandibular teeth, and horizontal overlaps in the anterior area are the rule.

5.12.2. A crossbite exists when either or both of the following tooth relationships are present in MI. The normal stamp cusp and shearing cusp relationship found in related cases are reversed and/or the normal horizontal and vertical overlap relationship found between upper and lower anterior teeth are reversed.

5.12.3. A crossbite can occur between a single upper and the opposing lower tooth, a few upper and the opposing lower teeth, or throughout the dentition.

Section 5C—Mandibular Movements

5.13. Vertical Dimension. Vertical dimension is any measurement of vertical distance made between the upper and lower jaw. A mandible can travel and stop anywhere on a path between maximum opening and closure. If a vertical measurement is to have meaning, it should identify a place along the potential path of travel the dentist and the patient can find on demand. The term *vertical dimension* with no further description of conditions is meaningless.

5.14. Occlusal Vertical Dimension. Occlusal vertical dimension is the vertical distance between the upper and lower jaws when natural teeth or denture teeth are in MI. The presence of teeth (natural or artificial) controls how far the mandible can travel vertically toward the upper jaw. When teeth are badly worn or gone, “stops” at the correct occlusal vertical dimension do not exist. A reliable guideline is needed to estimate where the vertical movement of the mandible toward the upper jaw should stop so the dental restorations can be made accordingly.

5.15. Physiologic Rest Position. A physiologic rest position is a measurement of vertical dimension made between the jaws when the muscles controlling the mandible are relaxed. The occlusal vertical dimension in most people with a natural dentition is 2 to 4 mm less than the physiologic rest measurement. This 2 to 4 mm allows the patient to have the teeth apart and out of function when relaxed.

5.16. Estimates of the Occlusal Vertical Dimension. The principle behind speech sound (phonetic) occlusal vertical dimension estimates is simple. In a normal natural dentition, teeth barely miss contacting when "s" and "ch" sounds are spoken. The vertical dimension a person uses to form these sounds stays about the same throughout adulthood, even though the dental arches might show severe wear or complete tooth loss. ***NOTE:*** The physiologic rest position and phonetic occlusal vertical dimension estimate are two reproducible positions on the mandible's vertical path of travel frequently used by dentists to estimate what the correct occlusal vertical dimension might have originally been.

5.17. Errors in the Occlusal Vertical Dimension:

5.17.1. **Open Occlusal Vertical Dimension:**

5.17.1.1. The patient's upper and lower jaws are being held too far apart when natural or artificial teeth meet in MI. Fixed prostheses (such as single crowns, multiple crowns, or fixed partial dentures) can be responsible for this problem when natural teeth are present. An improperly made removable prostheses could cause an open occlusal vertical dimension in people with few or no teeth.

5.17.1.2. An open occlusal vertical dimension usually results from making an inaccurate occlusal vertical dimension estimate or from an error in the construction of the prosthesis. Some of the more common symptoms associated with an open occlusal vertical dimension are soreness of the muscles of mastication, inability to pronounce "s" and "ch" clearly, and teeth making contact noises while the person is talking.

5.17.2. **Closed Occlusal Vertical Dimension:**

5.17.2.1. In the case of a closed occlusal vertical dimension, the patient's jaws are too close together when natural or artificial teeth hit in MI. Possible generalized reasons for such overclosure are as follows: severe wear of natural or artificial chewing surfaces, marked resorption of the residual ridges in a person who has been wearing the same set of complete dentures for years, an erroneous estimate of the correct occlusal vertical dimension during prosthesis construction procedures, or a technical error.

5.17.2.2. Some clues that the occlusal vertical dimension is closed too far are as follows: reduced biting power, excessive space between the teeth when the patient is in physiologic rest position, or a great deal of space visible between upper and lower teeth while "s" sounds are spoken. (Teeth should barely miss.)

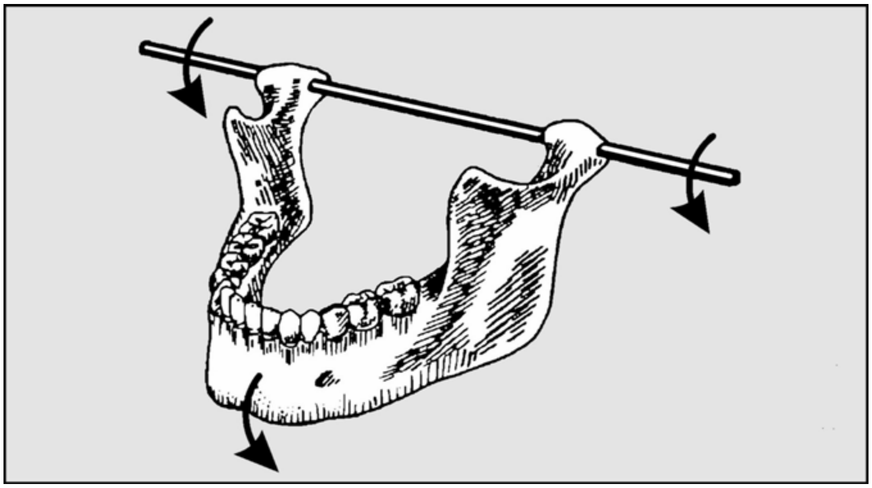
5.18. Types of Mandibular Movements:

5.18.1. The mandible is capable of many different, subtle kinds of movements. When the mandible moves, the condyles most certainly move with it, but the type and direction of condylar movements are not necessarily the same in each joint.

5.18.2. Basic mandibular movements consist of *hinge* (paragraph 5.19), *translatory* (paragraph 5.20), and *lateral* movements (paragraph 5.21). Most of the time a typical mandibular movement is a smooth, fluid blend of two or three of these motions.

5.19. Hinge Movements. Hinge movements consist of either opening or closing motions on a horizontal axis common to both condyles (Figure 5.8).

Figure 5.8. Rotational Movement Around a Hinged Axis.



5.20. Protrusion or Retrusion (Translatory) Movements.

5.20.1. These movements are called translatory (sliding) movements although, in protrusion, incisal guidance causes hinge movement to occur at the same time. In protrusion, both condyles leave their fossae and move forward upon the articular eminences. When the mandible retrudes, both condyles leave the eminences and move back into their respective fossae.

5.20.2. The full envelope of hinge and translatory movements as viewed in the midsagittal plane appears in Figure 5.9. Based on the research of Dr. Ulf Posselt, the picture represents the mandible's range of vertical and anteroposterior movement, which is three dimensional. Observe that the teeth are slightly separated, with the edge of the lower incisor at the "a" position in the diagram. Although the diagram happens to be superimposed over a lower incisor, it applies to any point on the body of the mandible. The features of this diagram, as marked in Figure 5.9, are as follows:

5.20.2.1. Number 1--contact between upper and lower teeth when the condyles are in centric relation.

5.20.2.2. Number 2--MI.

5.20.2.3. Number 3--edge-to-edge incisor contact.

5.20.2.4. Number 4--closure to a negative horizontal and vertical overlap between upper and lower incisors.

5.20.2.5. Number 5--maximum protrusion.

5.20.2.6. Letter a--physiologic rest position.

5.20.2.7. Letter b--maximum opening.

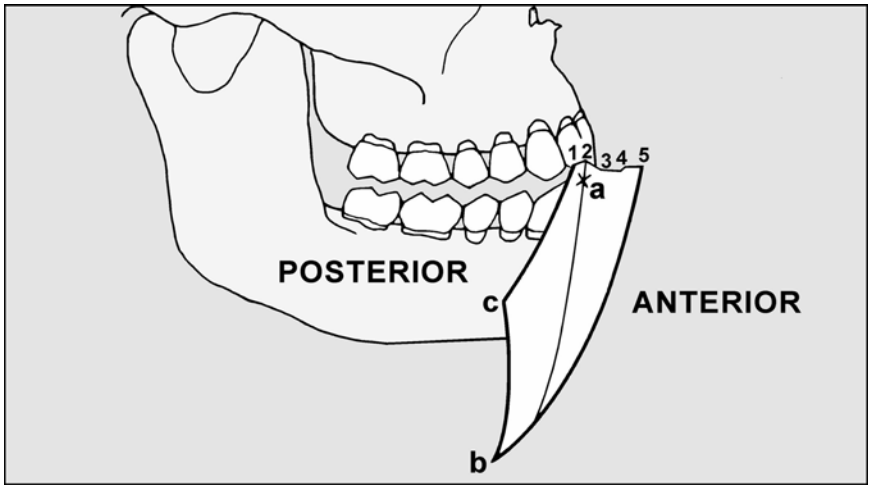
5.20.2.8. Path 2ab--path of *habitual* opening. (***NOTE:*** The physiologic rest position is a place on this path.)

5.20.2.9. Path 1cb--most *retruded* path of opening the mandible is capable of taking. From "1" to "c," the condyles are in centric relation and the mandible is making a pure opening movement. The pure hinge opening in the centric relation position can last for as far as one inch, as measured between the edges of the upper and lower central incisors. Between "c" and "b," the mandible continues to open, but is also translated forward. This means the condyles leave the fossae and move on to the eminences.

5.20.2.10. Path 5b--most protruded path of opening the mandible is capable of taking.

NOTE: Although Paths 2ab, 1cb, and 5b in Figure 5.9 are described as "opening" paths, they are also "closing" paths.

Figure 5.9. Anteroposterior and Vertical Movements.



5.21. Right and Left Lateral Movements. The side to which the mandible moves is called the *working side*; the side opposite the working side is called the *nonworking side*. The condyle on the working side is called the working or rotating condyle. By exclusion, the other condyle becomes the nonworking or orbiting condyle. A general description of lateral mandibular motion (Figure 5.10) is as follows:

5.21.1. As the mandible moves to the side, the cusps and incisal edges of the opposing teeth must clear one another. Also, the eminence on the nonworking side is probably lower than the fossa on the working side. The conclusion is that the mandible opens, at least slightly, to make a lateral movement.

5.21.2. The working side condyle rotates in its fossa (Figure 5.10-A).

5.21.3. The nonworking (or balancing) side condyle translates forward and medially down its eminence and produces a protrusion of the nonworking side. Because the nonworking condyle follows a limited arc of travel around the working condyle, the nonworking condyle is said to be orbiting the working condyle (Figure 5.10-B).

5.21.4. There is a total shift (or *mandibular translation* [MT]) or sideshift of the mandible and its condyles toward the working side (Figure 5.10-C). Two fundamental kinds of MT, progressive and immediate, can occur.

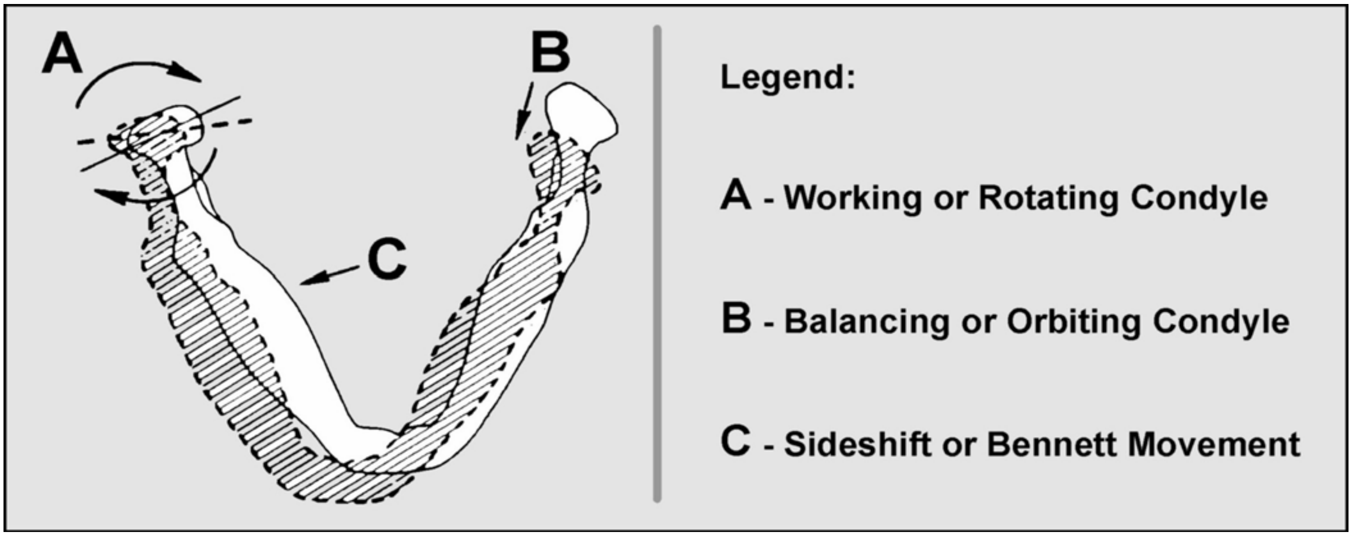
5.21.4.1. *Progressive* MT is characterized as the working condyle rotating and moving laterally while the balancing condyle moves forward and medially, all as a single integrated movement.

5.21.4.2. *Immediate* MT takes place prior to the working condyle's rotation or the balancing condyle's translation. It occurs immediately prior to the occurrence of progressive MT once the lateral excursion begins.

5.21.4.3. MT of the mandible takes different directions of travel from person to person (and sometimes from right to left sides in the same person).

5.21.5. The *Bennett angle* (lateral condylar inclination) is the angle the orbiting condyle makes when a sagittal plane passes through its fossa, as viewed in the horizontal plane. The orbiting path's angle to the sagittal plane averages 12 to 15 degrees. This angle is the combined result of the balancing (nonworking) condyle advancing medially, plus any sideshift that takes place.

Figure 5.10. Typical Lateral Movement.



5.22. Arrow Point or Gothic Arch:

5.22.1. When test lateral movements are made with the casts of a patient's mouth mounted in an articulator (a device that simulates mandibular motion), the maxillary and mandibular stamp cusps move out of MI and follow predictable routes across opposing chewing surfaces.

5.22.2. The incisal edges of lower anterior teeth also travel well-defined paths as they pass over the lingual surfaces of upper anterior teeth. The intersection of a stamp cusp's working excursion and its nonworking excursion produces a Gothic arch or arrow point. The MI position is at the apex.

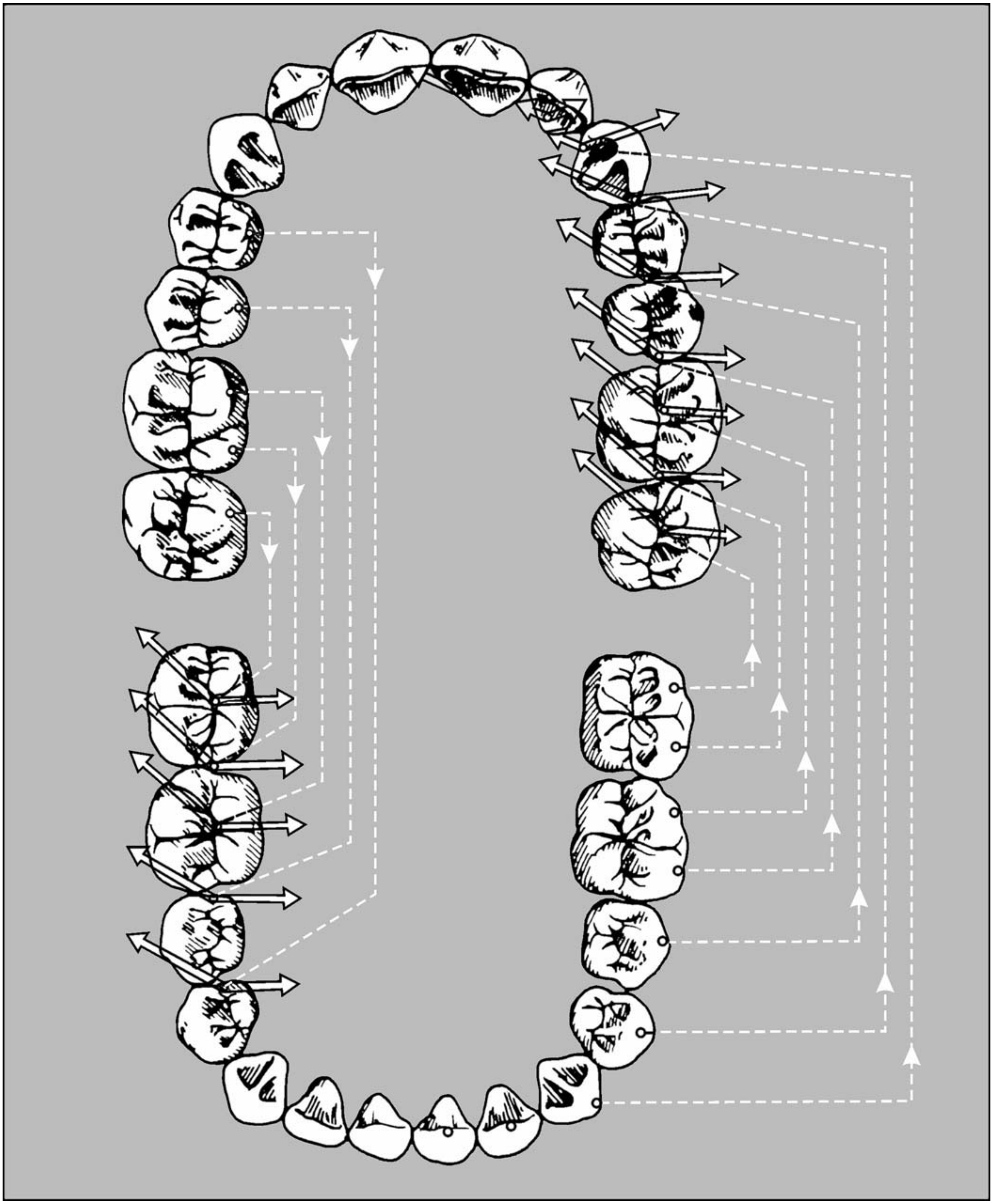
5.22.3. Stamp cusp routes are diagrammed in Figure 5.11. The arrow points generated by maxillary stamp cusps crossing mandibular chewing surfaces are directed *forward*. Arrow points generated by mandibular stamp cusps and incisal edges on maxillary tooth surfaces are directed *backward*.

5.22.4. When the arrow point patterns in the mouths of a number of patients are analyzed, the findings indicates the angle inside an arrow point changes from tooth to tooth and from person to person.

5.22.5. What are some of the major factors that affect the size of the included angle? The farther away a tooth is located from the condyles, the greater the angle within the arrow point. As the distance between the condyles increases, the Gothic arch angle decreases (and vice versa). As the amount of mandibular translation increases, an arrow point's included angle gets larger.

5.22.6. Persons having mostly progressive MT have working and nonworking paths that intersect at a precise point. Persons having immediate MT show comparative blunting or rounding at the intersection of the working and nonworking paths.

Figure 5.11. Stamp Cusp Arrow Point Tracings.



5.22.7. This information emphasizes that every stamp cusp has a specific working and nonworking track for leaving the MI position, the tracks proceed in directions unique to each cusp, and no obstruction (interference) to a stamp cusp's lateral movement should appear along those tracks.

5.22.8. When chewing surfaces are fabricated for a prosthesis on an articulator, the alignment of occlusal ridges and grooves will be dictated by the lateral movements of stamp cusps in and out of MI (Gothic arch tracks). If the ridge and groove alignments, as developed in the articulator conflict with the patient's true lateral movements after the prosthesis is delivered, then unanticipated, harmful cusp collisions could possibly occur. The following questions should be answered to develop properly aligned ridges and grooves for the chewing surfaces of a prosthesis:

5.22.8.1. How closely does the articulator simulate the patient's actual MT?

5.22.8.2. Is the maxillary cast positioned (articulated) on the articulator the same way the maxilla relates to the glenoid fossae?

5.22.8.3. Does the articulator's intercondylar distance match the patient's distance?

5.23. Occlusal Disharmony. The disastrous effect of occlusal disharmony is best explained by comparing the temporomandibular joint and mandibular movement with the lever systems.

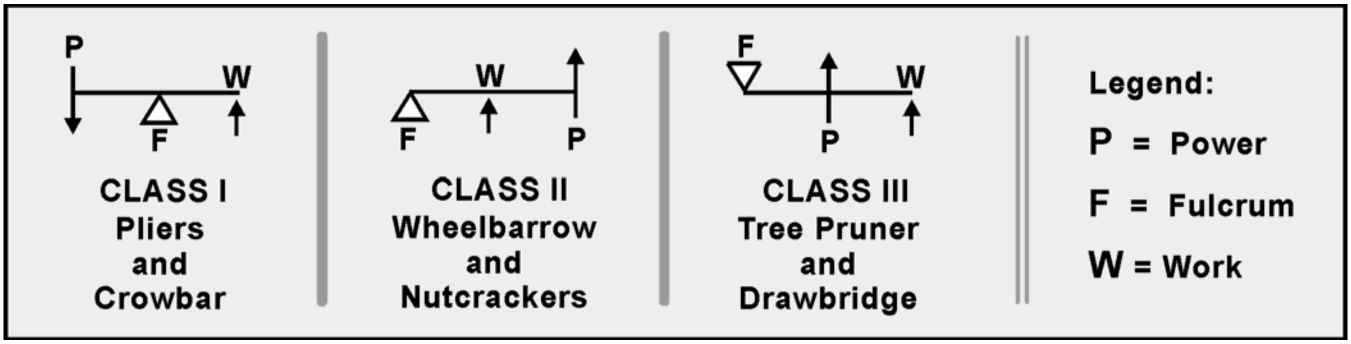
5.23.1. **Classes of Lever Systems.** Each lever system consists of a rigid bar in contact with a fulcrum, one point on the bar for the application of force and another point on the bar for the application of a load. There are three classes of lever systems; Class I, II, and III as follows:

5.23.1.1. **Class I Lever System.** As shown in Figure 5.12, a Class I lever system consists of a rigid bar across a fulcrum . Force applied to one end of the bar moves a load on the other end (like pliers or a crowbar). This is a very efficient system because the working force transmitted to the load can be multiplied simply by moving the fulcrum closer to the load and further away from the point of applied force.

5.23.1.2. **Class II Lever System.** A Class II lever system consists of a rigid bar with a fulcrum at one end, a load in the middle, and a force applied to the other end. A wheelbarrow is an example of a Class II lever system (Figure 5.12). This system is less efficient than the Class I lever system because the load is shared between the fulcrum and the applied force.

5.23.1.3. **Class III Lever System.** A Class III lever system consists of a rigid bar with a fulcrum placed at one end, a load applied to the other end, and working force applied in the middle like a tree pruner or drawbridge (Figure 5.12). The normal mandibular jaw is a Class III lever system in both the anteroposterior and cross- arch directions. This system is less efficient than either the Class I or II systems because more force must be applied to do the same amount of work.

Figure 5.12. Lever Systems.

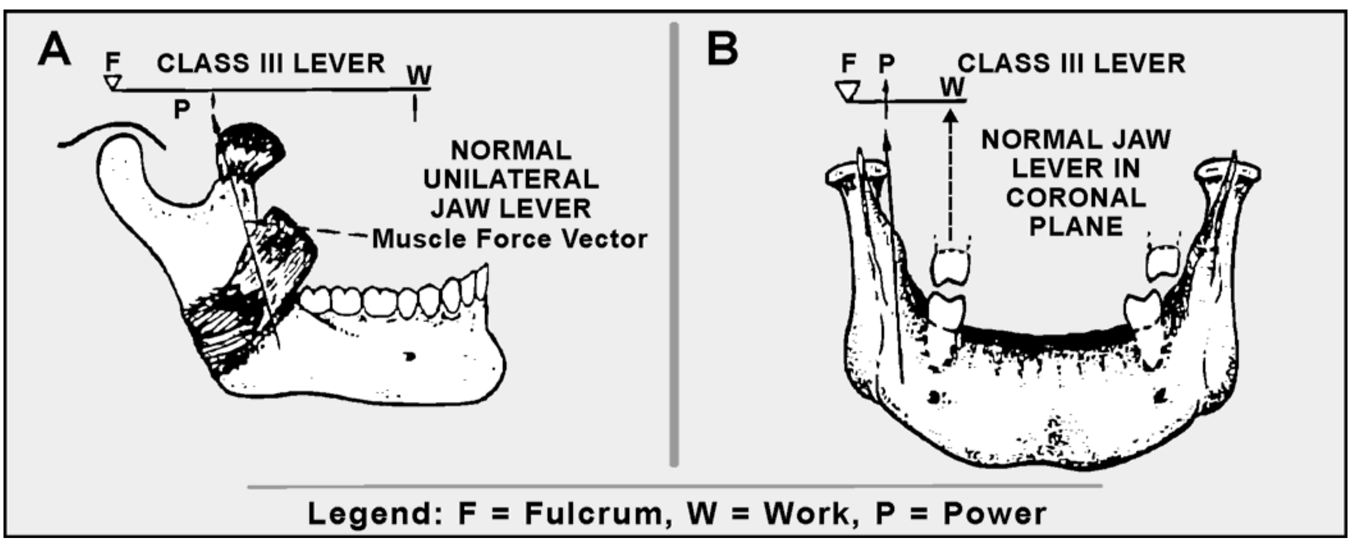


5.23.2. **Nondestructive Lever System (Figure 5.13):**

5.23.2.1. When people chew on the right or left side or bite with their anterior teeth, a Class III lever system normally develops (Figure 5.13-A). In this system, the teeth closest to the point of applied force receive the greatest impact. The teeth farther away from the point of applied force receive a progressively lesser amount of force. This explains why people tend to lose their anterior teeth last, even though the teeth are comparatively weak by structural design. Because the anterior teeth feel decreased muscular force, they receive less stress.

5.23.2.2. The posterior teeth (Figure 5.13-B) are close to the point of applied force in both the anteroposterior and cross-arch directions. Consequently, they transfer more of the applied force to the load and are under more functional stress than the anterior teeth. They are well able to support the added stress because the large surface area of their multiple root structure stabilizes them and transfers the functional stresses more evenly to the alveolar ridges.

Figure 5.13. Nondestructive Lever System.

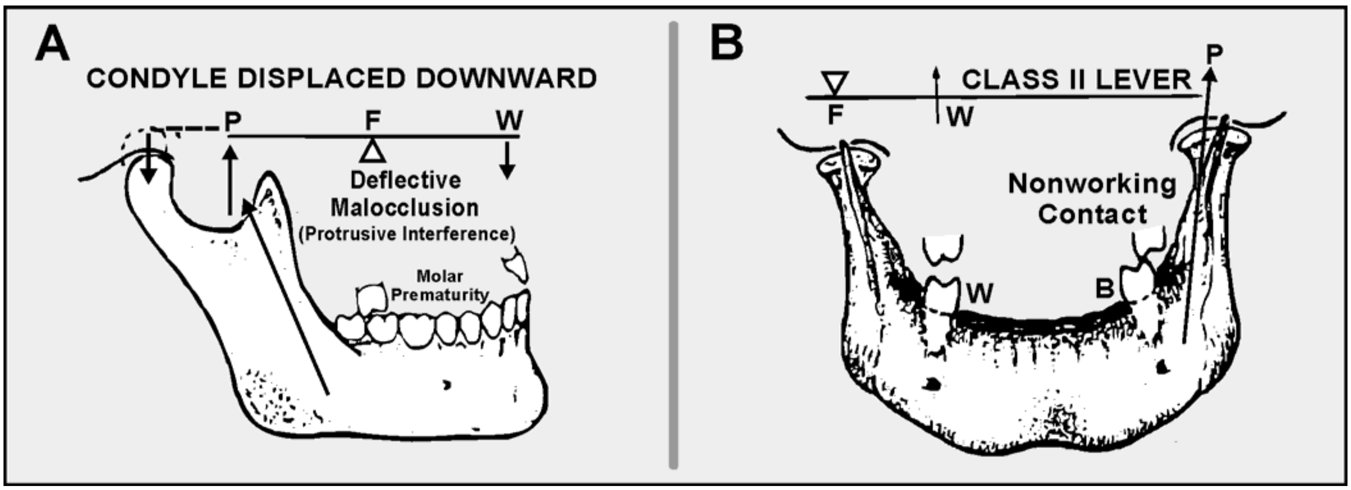


5.23.3. **Destructive Lever System (Figure 5.14).** Faulty occlusal contacts can change the nondestructive Class III lever system to a destructive Class I or II lever system by changing the relationship of the fulcrum and working points as follows:

5.23.3.1. **Class III to Class I Lever System.** If a posterior nonworking contact occurs during the protrusive biting function, the fulcrum point moves from the temporomandibular joint to the point of faulty contact (Figure 5.14-A). The closing muscle force vector (P) is now posterior to the tooth fulcrum (F). The work (W) is still done in the area of the anterior teeth. This condition is particularly harmful because it results in incisal stress not in line with the long axis of the working (anterior teeth).

5.23.3.2. **Class III to Class II Lever System.** If a high-lateral nonworking contact occurs when the mandible is moved to the side to chew food, the normal Class III lever system will be changed to the Class II lever system (Figure 5.14-B). In this instance the work (W) is still being done on the working side, but the premature nonworking contact (B) triggers a more forceful closure of the muscles (P) on the nonworking side. This changes the normal Class III lever system to the destructive Class II lever system and puts an unusual amount of stress on the teeth with the undesired contact.

Figure 5.14. Destructive Lever System.



Section 5D—Functional Articulations

5.24. Lateral and Translating Excursions:

5.24.1. Angle’s classification deals with three basic ways that teeth come into MI. However, there are at least seven ways that natural or artificial teeth actually function in lateral and translating excursions. Four of the functional articulation schemes occur in surveys of people who have natural teeth. Technicians intentionally organize the other three patterns when they construct complete dentures (see Chapter 7).

5.24.2. There are very distinctive characteristics that set the functional articulation schemes apart from one another. The individual patterns of articulation are based on contact differences between upper and lower teeth during working, nonworking, and protrusive excursions. The following paragraphs 5.25 through 5.28 show the functional articulations found in people having natural teeth.

5.25. Group Function (or Unilateral Balanced Articulation). The tooth contact characteristics of unilateral balanced articulation are as follows:

5.25.1. **Anterior Teeth.** In MI, anterior teeth have a horizontal overlap of 1 to 2 mm as well as vertical overlap and 1 to 2 mm.

5.25.2. **Working Side.** The upper and lower anterior teeth on the working side touch. The lingual inclines of maxillary buccal cusps should be in even contact with the buccal inclines of the mandibular buccal cusps.

5.25.3. **Nonworking Side.** There is no contact between upper and lower teeth.

5.25.4. **Protrusive.** There is edge-to-edge contact between upper and lower anteriors. Posterior contact may or may not be present. It varies from person to person.

5.26. Mutually Protected Articulation (or Anterior-Guided Articulation). In a mutually protected articulation, the anterior teeth are at least partly responsible for causing separation between opposing posterior teeth on the working side and during protrusive excursions. This movement protects the posterior teeth during excursions. The anteriors characteristically show moderate to steep vertical overlap and minimal horizontal overlap. The posterior teeth take the occlusal load when the teeth are at MI. This protects anterior teeth and completes the mutual protected articulation.

5.26.1. **Anterior Teeth.** In MI, anterior teeth have a horizontal overlap of 0.0 to 0.5 mm and a vertical overlap of 2 mm or more.

5.26.2. **Working Side.** The upper and lower anterior teeth on the working side make contact. There is no contact between upper and lower posteriors.

5.26.3. **Nonworking Side.** No contact develops between upper and lower teeth on the nonworking side.

5.26.4. **Protrusive.** When the anteriors contact edge to edge, there is no posterior tooth contact.

5.26.5. **Canine-Guided Articulation.** This form of articulation is a common variety of anterior-guided articulation where the only teeth making contact on the working side are the upper and lower canines. All other features of anterior-guided articulation are unchanged.

5.27. Delayed Anterior-Guided Articulation. This form of articulation shows group function and anterior guided articulation in the same working movement.

5.27.1. **Anterior Teeth.** In MI, anterior teeth have a horizontal overlap of 1 to 2 mm and a vertical overlap of 2 mm or more. (Delayed anterior-guided articulation has the horizontal overlap characteristic of group function and vertical overlap associated with anterior-guided articulation.)

5.27.2. **Working Side.** The working movement begins with the opposing posterior teeth on one side sliding across one another in group function. The last part of the movement shows anterior guided articulation. That is, sufficient contact develops between upper and lower anterior teeth to cause separation of opposing posteriors.

5.27.3. **Nonworking Side.** There is no contact between upper and lower teeth.

5.27.4. **Protrusive.** There is edge-to-edge contact between upper and lower anteriors. There is no posterior tooth contact.

5.28. Asymmetrical Pattern of Articulation. This pattern of articulation shows group function going to one working side and anterior-guided articulation going to the other.

5.28.1. **Anterior Teeth.** In MI, the anterior teeth have a horizontal overlap of 0.0 to 0.5 mm on the anterior guided side and 1 to 2 mm of horizontal overlap on the group function side. The anterior teeth in MI have a vertical overlap of 2 mm or more on the anterior-guided side and a vertical overlap of 1 to 2 mm on the group function side.

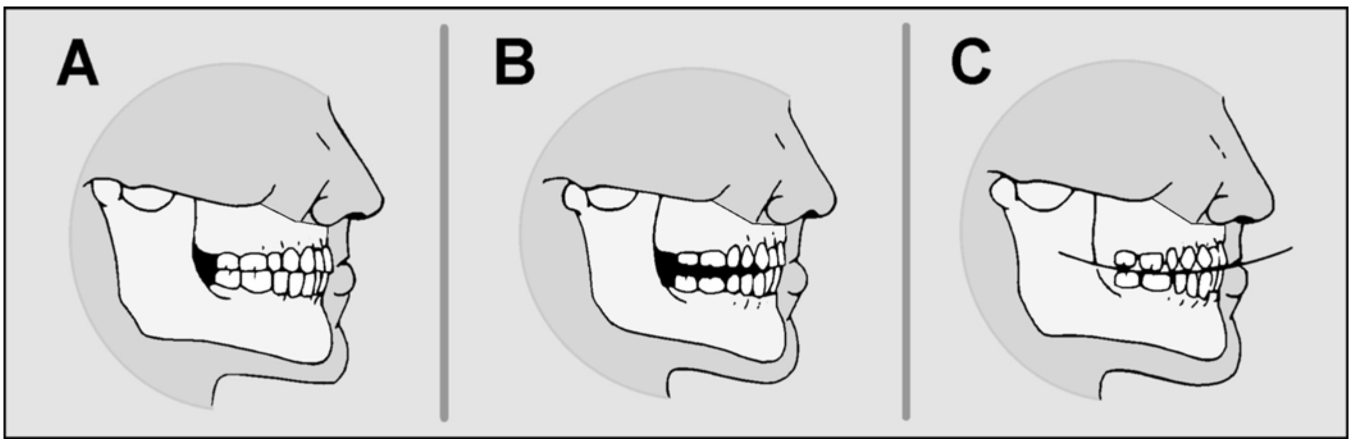
5.28.2. **Working Sides.** One working side demonstrates tooth contact patterns characteristic of group function; the other shows tooth contacts found in anterior-guided articulation.

5.28.3. **Nonworking Sides.** There is no contact between upper and lower teeth on either nonworking side.

5.28.4. **Protrusive.** Protrusive contacts are so variable that no general pattern can be described. ***NOTE:*** The single consideration common to all forms of articulation in the natural dentition is the absence of nonworking side contacts. Nonworking contacts involving natural teeth routinely cause pain in the interfering teeth and the temporomandibular joint. These contacts also cause destruction of a tooth's bone support.

5.29. Christensen's Phenomenon. Christensen's phenomenon is the space that occurs between opposing occlusal surfaces during mandibular protrusion (Figure 5.15). The anterior teeth are responsible for the disclusion of the posterior teeth during the protrusive movement.

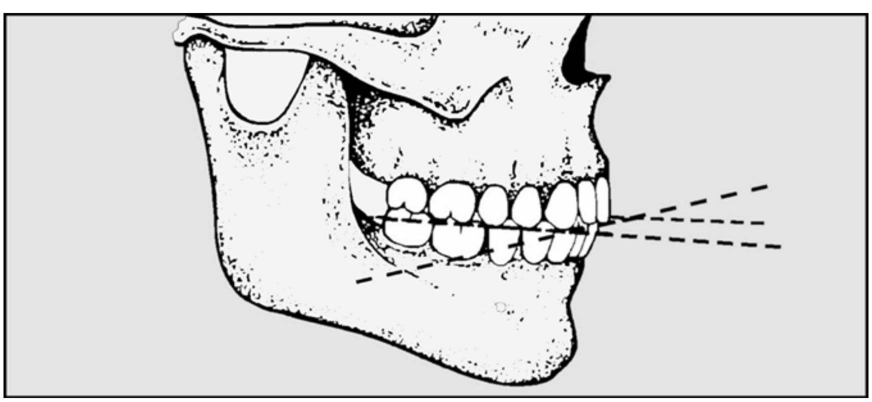
Figure 5.15. Christensen's Phenomenon.



5.30. Major Determinants of Articulation. Major determinants of articulation include the occlusal plane, occlusal curve, condylar angle or direction, and incisal guide angle, as follows:

5.30.1. **Occlusal Plane.** The occlusal surfaces of the premolars and molars of both the upper and lower jaws in opposition establish the occlusal plane (Figure 5.16).

Figure 5.16. Occlusal Plane.

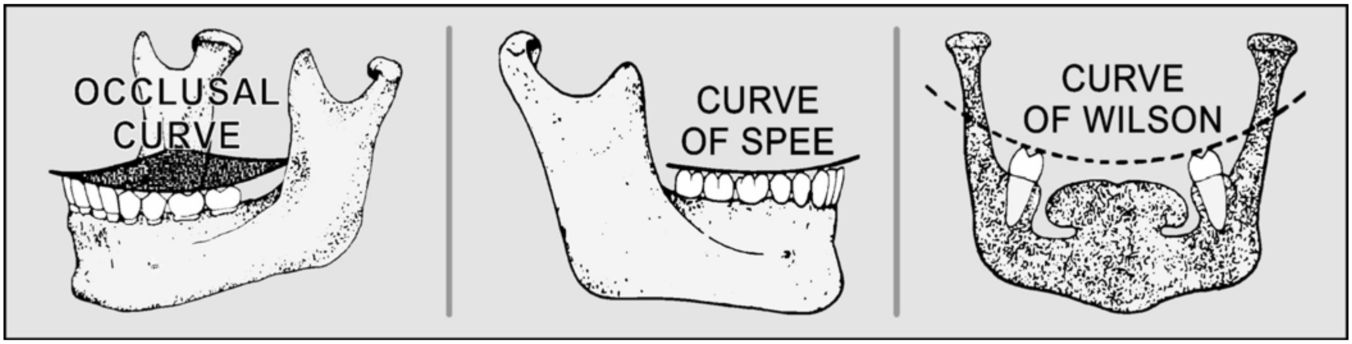


5.30.2. **Occlusal Curve.** The occlusal curve consists of the following two parts:

5.30.2.1. **Anteroposterior Curve.** The anteroposterior curve is the anatomic curve established by the occlusal alignment of the teeth (from the canine through the buccal cusps of the posterior teeth), when viewed from the side. It also is called the Curve of Spee (Figure 5.17).

5.30.2.2. **Curve of Wilson.** The Curve of Wilson is the lateral component of the occlusal curve when viewed from the anterior (Figure 5.17).

Figure 5.17. Occlusal Curve.



5.30.3. **Condylar Angle of Direction.** The angle or direction of the condyle as it traverses the contours of the glenoid fossa dictates the cusp height of teeth. A steep eminence inclination would permit longer cusps; a shallow eminence inclination would *require* shorter cusps.

5.30.4. **Incisal Guide Angle.** The incisal guide angle of an articulator is determined by the amount of horizontal and vertical overlap the anterior teeth exhibit. As the overlap increases, the length of the cusp may be longer. Consequently, as the overlap decreases, the cusp length *must* be shorter. The condylar inclination and anterior guidance may be dependent on each other. The anterior guidance in a healthy occlusion is approximately 5 to 10 degrees steeper than the condylar inclination, which allows for separation of the posterior teeth during a protrusive movement. (See Christensen's Phenomenon in paragraph 5.29.)

Chapter 6

ARTICULATORS AND ARTICULATOR SIMULATION OF HUMAN ANATOMICAL CHARACTERISTICS

Section 6A—Types of Articulators

6.1. Overview. An *articulator* is a mechanical instrument that represents the temporomandibular joint and jaws, to which the maxillary and mandibular cast may be attached to simulate all or some of the mandibular movements. Articulators simulate the positions and movements of the patient's lower jaw in relation to the upper jaw so a prosthesis with proper occlusion can be made. The accuracy of the simulation depends on the accuracy of the dentist's transfer records and the degree of adjustability of the instrument.

6.2. Transfer Records. The following records, detailed in Section 6B are important to the process:

6.2.1. The vertical and horizontal orientation of the upper jaw to both temporomandibular joints.

6.2.2. The patient's actual centric relation, or the dentist's estimate of where centric relation should occur.

6.2.3. The angles that the articulator eminences form with the occlusal plane.

6.2.4. The temporomandibular joint characteristics governing the timing and direction of laterotrusion.

6.2.5. The distance between the patient's condyles (intercondylar distance).

6.2.6. Relative presence or absence of anterior guidance.

6.3. Articulator Categories:

6.3.1. There are many different kinds of articulators. The primary difference among them is in the number of controls or adjustments they possess.

6.3.2. Articulators having a full range of adjustments can be set to match the patient's guiding anatomical features. As a result, articulator movements come very close to duplicating the patient's actual jaw movements. Articulators with no adjustments are built to move in a statistically average manner, cannot be set to move in any other way, and have a much more limited application.

6.3.3. Based on the adjustability factor, articulators fall into three broad categories; nonadjustable (paragraph 6.4), semiadjustable (paragraph 6.5), and fully adjustable (paragraph 6.6).

6.3.4. Just because an articulator has minimal adjustability does not mean it is inferior. An articulator only becomes inferior when it is taxed beyond its capabilities. On the other hand, a fancy, impressive articulator is still only a machine unless used to its fullest advantage. The dental laboratory technician should become intimately familiar with how all types of articulators work in order to develop the ability to match a job's demands to an articulator's capabilities. Once an articulator is selected, the technician should not use the device beyond its mechanical limitations.

6.4. Nonadjustable Articulators:

6.4.1. **Hinge-Type Articulator.** This variety is the simplest made. It can make a basic opening and closing movement (Figure 6.1). It has no ability to go into lateral or protrusive excursions.

6.4.1.1. Sometimes these devices are called "holding" instruments. Their only function is to hold or maintain the vertical and horizontal relationships between two casts at one mandibular position.

Figure 6.1. Hinge-Type Articulator.

6.4.1.2. Most of the time, hinge instruments are used to make very simple fixed and removable prostheses. The dentist fully expects to correct lateral and protrusive interferences in the mouth at the time the prosthesis is inserted. Examples of these replacements would be a temporary fixed partial denture or an interim RPD.

6.4.1.3. It is possible to make very complicated, "permanent" restorations with a pure hinge instrument. For a hinge instrument to be used this way, the dentist would have to use *functionally generated path techniques* to get adequate cast mountings for the job.

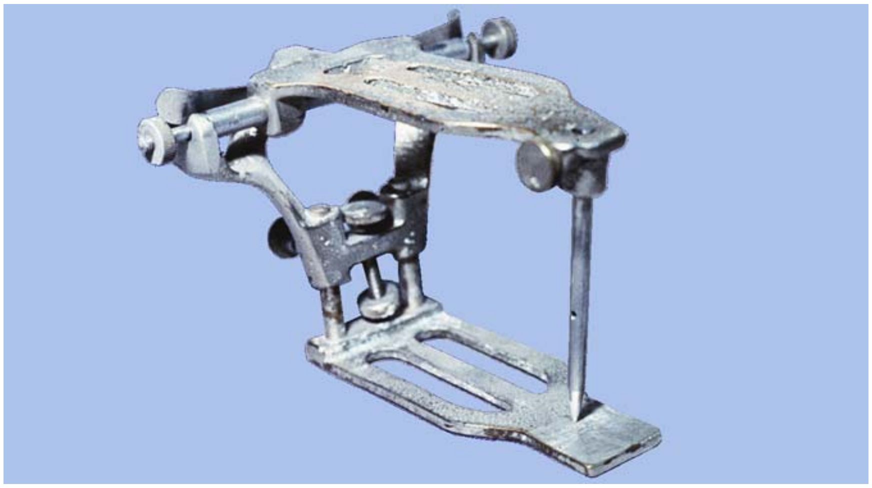
6.4.2. **Fixed-Guide Articulator:**

6.4.2.1. Fixed-guide articulators are machined to produce the lateral and protrusive movements characteristic of a statistically average patient (Figure 6.2). Therefore, if the "average" movements of the articulator match the actual movements of the patient, the patient is in luck.

6.4.2.2. These kinds of articulators are used extensively, and the success rate associated with their use appears to be acceptable. The ability of these articulators to hold vertical and horizontal relationships between opposing casts is their most dependable performance feature. Lateral and protrusive movement paths are only moderately dependable.

6.4.2.3. Functionally generated chewing surface techniques aside, fixed guide articulators should be used for cases where precise duplication of lateral movements is not critical. Examples of these cases are complete crowns for incisor teeth; short span anterior fixed partial dentures; posterior onlays, crowns, and short span fixed partial dentures where anterior guidance is immediate and steep; monoplane complete dentures using 0-degree teeth; and RPD construction for patients with a definite anterior-guided occlusion.

Figure 6.2. Fixed-Guide Articulator.



6.5. Semiadjustable Articulator:

6.5.1. The semiadjustable articulator has enough adjustable features to give fair to good simulation of a patient's actual mandibular movements.

6.5.2. Many articulators in this class can compensate for the angle of a person's articular eminence, horizontal and vertical overlap conditions, and amount of progressive mandibular translation (sideshift). Some have fewer adjustments (no variable progressive sideshift), and some have more adjustments (immediate sideshift, progressive sideshift, and variable intercondylar distance).

6.5.3. These articulators are very versatile and the most frequently used in the Dental Services. They are used for making all forms of removable prostheses and for moderately complicated fixed prosthodontic restorations. Some dentists use the most adjustable of the articulators in this group for complete mouth fixed prosthodontic rehabilitations.

6.5.4. The types of semiadjustable articulators commonly used are the Hanau H2-158 (Figure 6.3), Hanau Wide-Vue (Figure 6.4) and the Whip-Mix (Figure 6.5).

6.5.5. There are two ways (methods) of using semiadjustable articulators from the standpoint of making them match the patient's anatomical features and resultant mandibular movement:

6.5.5.1. **Arbitrary (or Average) Method.** Only those patient factors that are most critical to the success of the case are reproduced on the articulator with the greatest accuracy possible (for example, centric relation, MI, and occlusal vertical dimension). Statistical averages are used to set all remaining articulator adjustments. The so-called "average" settings are supposed to hold true for the majority of the patient population. When a semiadjustable articulator is used in this way, it becomes a fixed guide instrument and has the same limitations.

6.5.5.2. **Semiadjustable Method.** The dentist articulates the patient's casts and sets all articulator adjustments based on actual patient measurements. Two kinds of measurement systems are used; facebow transfer and maxillomandibular relationship records, as follows:

Figure 6.3. Hanau H2-158 Semiadjustable Articulator.

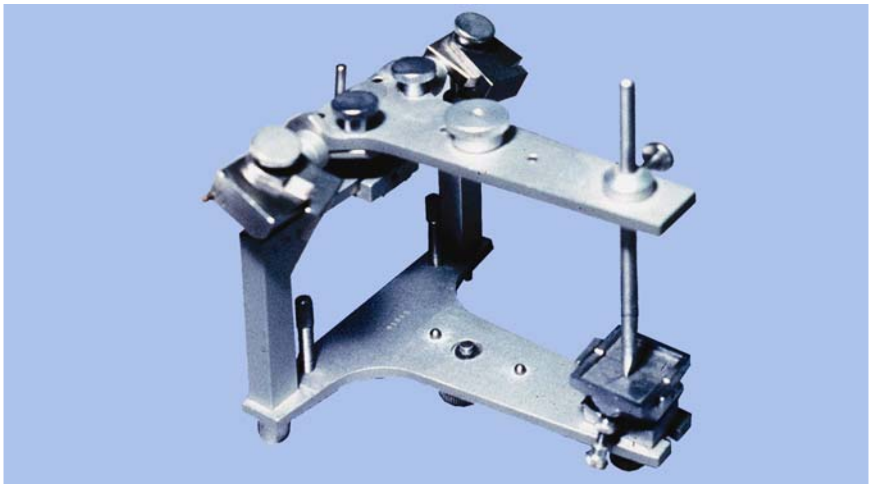
Figure 6.4. Hanau Wide-Vue Semiadjustable Articulator.

6.5.5.2.1. **Facebow Transfer.** A *facebow transfer* is a procedure used to attach a maxillary cast onto an articulator in the same way the maxilla relates to the temporomandibular joints. When the infraorbital canal is used as a third point of reference in a facebow transfer, the maxillary cast is also related to the horizontal plane of the articulator like the patient's maxilla relates to the axis-orbital plane. This transfer, in combination with a maxillomandibular relationship record, allows the opening axis of the patient to be transferred to the articulator.

6.5.5.2.2. **Maxillomandibular Relationship Records.** The articulator's adjustments are set according to three-dimensional methods of measurement called *maxillomandibular relationship records.* There are two types of maxillomandibular relationship records. The first is a template that relates the lower cast against the upper cast in the same way the jaws relate when the record is made in the patient's mouth (for example, centric relation record).

After the casts are mounted, the second kind of maxillomandibular relationship record is used to set articulator adjustments (lateral and protrusive records).

Figure 6.5. Whip-Mix Semiadjustable Articulator.



6.6. Fully Adjustable Articulator:

6.6.1. This category differs from the semiadjustable one because of features like custom-made condyle guides, highly variable intercondylar distance, very close simulation of the timing and direction of laterotrusion, and a capacity to simulate the direction of the rotating condyle (Figures 6.6 and 6.7).

6.6.2. The information needed to accomplish these highly refined adjustments does not come from maxillomandibular relationship records. It comes from mandibular movement tracings or recordings (pantographic tracings or stereographic recordings) made by the patient under the direction of the dentist. The articulator is then programmed to conform to the tracings or recordings.

6.6.3. Fully adjustable articulators are used on the most demanding kinds of cases; that is, detecting and treating patients whose jaw movement patterns are not normal and completing full mouth fixed prosthodontic restorations. ***NOTE:*** A fully adjustable instrument can be used in the fixed-guide and semiadjustable modes if a less adjustable articulator is not available.

6.7. Arcon Versus Non-Arcon:

6.7.1. Some semiadjustable articulators and all fully adjustable articulators are described as being *arcon* in design. The word *arcon* is an acronym for the words ARticulator and CONdyle. It describes those instruments having the condyle elements attached to the articulator's lower member in the same way condyles are an anatomic feature of the mandible in a human skull.

6.7.2. At the same time, the upper member of the articulator carries mechanisms simulating the glenoid fossae of the maxilla. As examples, the Hanau H2-158, Hanau Wide-Vue, and Whip-Mix are semiadjustable articulators of the arcon variety. The Hanau 96H2 semiadjustable articulator is non-arcon in design. Stuart®, Denar®, and TMJ instruments are fully adjustable articulators and, as such, are also arcon in design.

Figure 6.6. Fully Adjustable Articulator (With Pantographic Tracing).

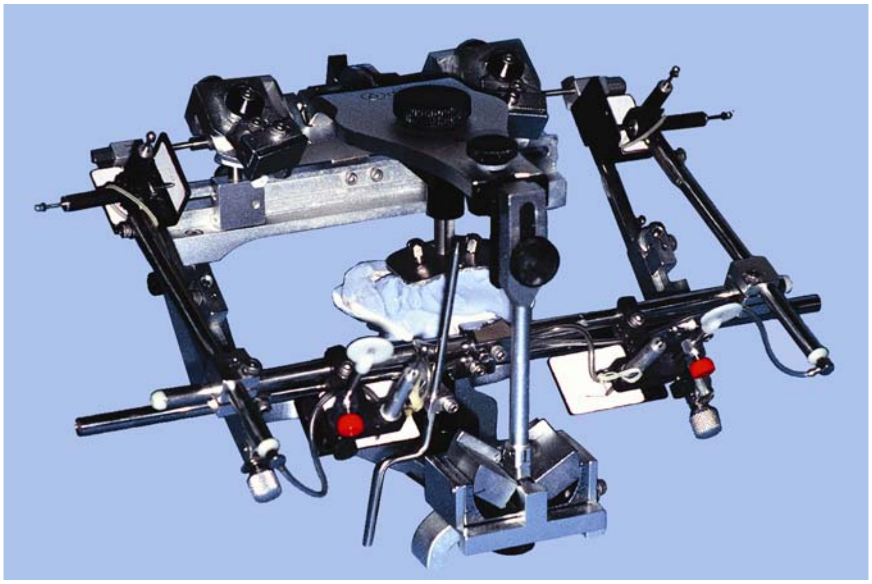


Figure 6.7. Fully Adjustable Articulator (With Stereographic Recording).

6.7.3. What are the advantages of an arcon articulator over non-arcon varieties? One advantage of the arcon articulator is that it is anatomically correct, making it is easier to understand mandibular movements. Another advantage of the arcon design is that the condylar inclination is at a fixed angle relative to the occlusal plane. When the arcon designed articulator is opened, the angle between the condylar inclination and the occlusal plane remains constant.

6.7.4. Perfect reproduction of mandibular movement has always been an elusive goal. Once programmed, the arcon articulator is capable of mandibular movements that are closer to the patient's own movements. This small advantage is so important that most articulators are designed as arcon articulators.

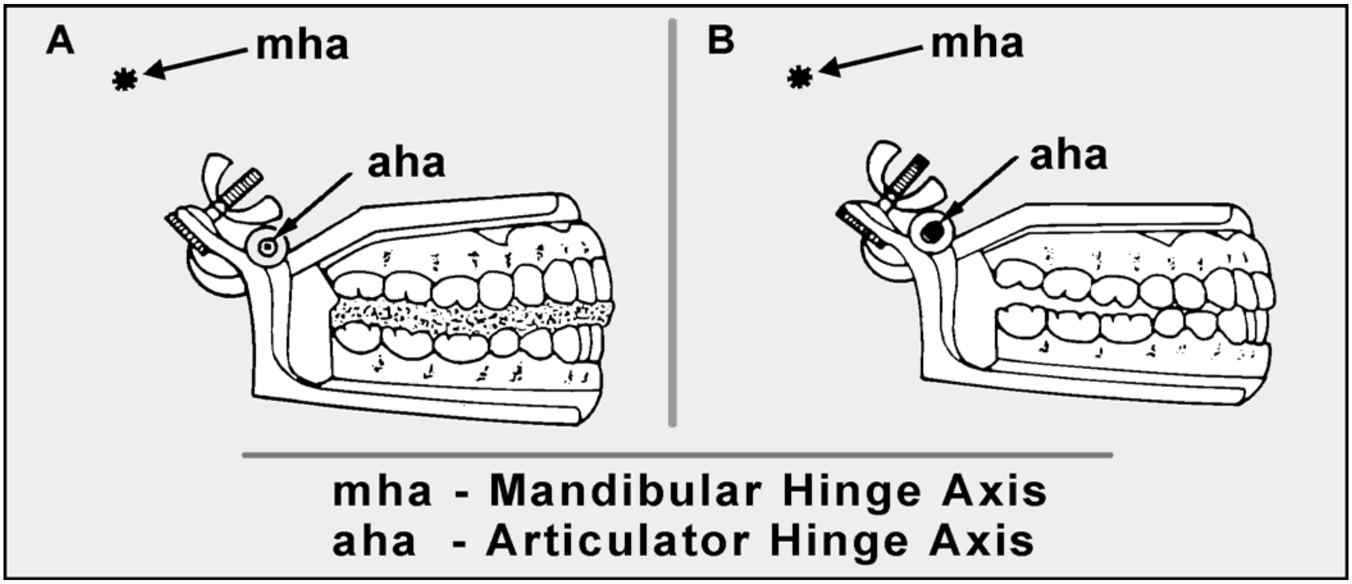
6.8. Limitations Based on Design:

6.8.1. **Nonadjustable Articulators.** Nonadjustable articulators, like the ones in Figures 6.1 and 6.2, are small instruments that cannot effectively reproduce mandibular movements due to the following design limitations:

6.8.1.1. The distance from the teeth to the center of rotation (axis), which passes through the condyles location, is considerably shorter than in the skull. Consequently, the patient's hinge axis is different than the articulators, causing a change in the arc of closure.

6.8.1.2. As the mandible moves up and down in the terminal hinge position, the cusp tip moves along an arc with the center of rotation located at the *transverse horizontal axis* shown in Figure 6.8 as the mandibular hinge axis (mha). If the distance between the transverse horizontal axis and the cusp tip differs from the *patient to the articulator,* the arc of closure would be different (steeper or shallower), producing an error.

Figure 6.8. Mandibular Hinge Axis (mha) Versus Articulator Hinge Axis (aha).

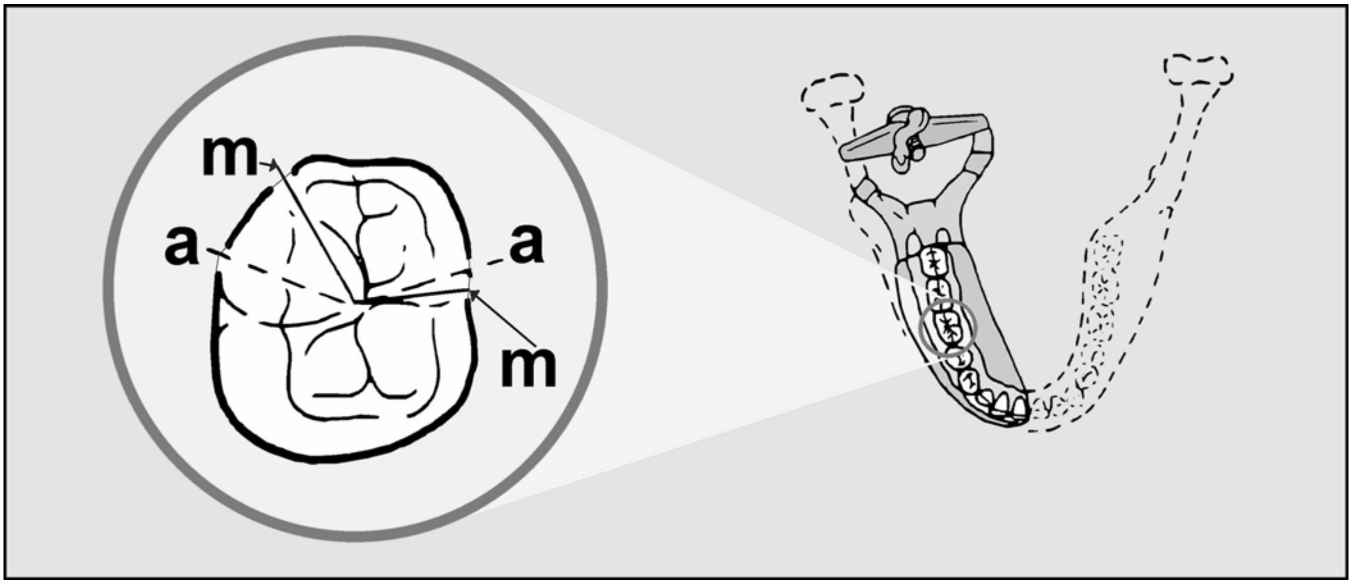


6.8.1.3. Drastic differences between the arc of closure on the articulator and the patient's mouth may affect the placement of cusps, ridges, and grooves on the occlusal surfaces. For example, when casts are related using a thick interocclusal record, the teeth occlude in a different intercuspal position on the *articulator* than in the *patient's mouth.* This results in an occlusal interference between the mesial inclines of the maxillary teeth and the distal inclines of the mandibular teeth.

6.8.1.4. If the casts are mounted in MI, without an interocclusal record, the arc of closure difference does not present a problem. The significance of "an arc of closure" depends on whether the occlusal vertical dimension is being altered. Remember, nonadjustable articulators are designed to hold and reproduce accurately only one position. If any changes in occlusal vertical dimension are foreseen, it is best to graduate to a semiadjustable articulator with appropriate facebow transfer and maxillomandibular relationship records.

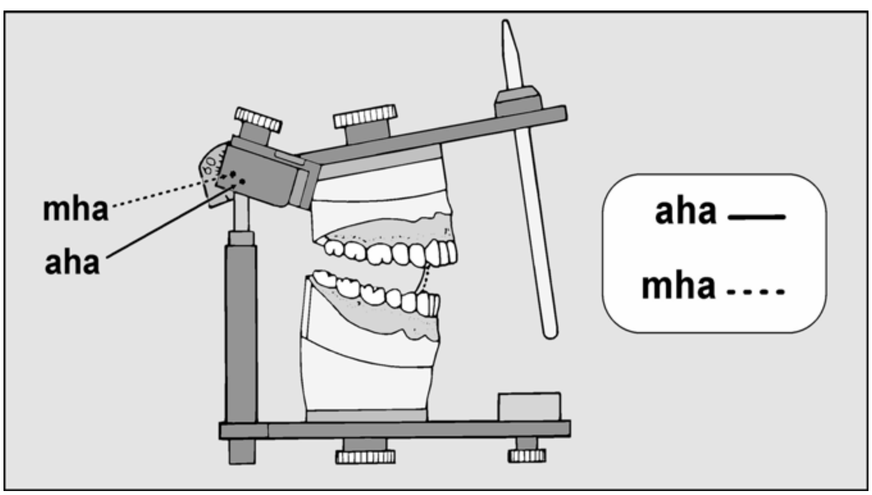
6.8.1.5. The articulator's design also effects the pathways of teeth as they travel in lateral excursions. As the distance between the condyles increases (intercondylar width), the Gothic arch angle decreases (and vice versa). This effect is even more evident when a small hinge-type articulator is used (Figure 6.9). On such small instruments, the discrepancy between the paths traveled by a cusp on the instrument and in the mouth can be sizable, particularly on the balancing side. The result is an increased possibility of incorporating a balancing occlusal interference. ***NOTE:*** There are nonadjustable articulators approximately the same size as semiadjustable articulators. Do not assume every "nonadjustable" instrument has the same design limitations as the ones previously mentioned.

Figure 6.9. Articulator Versus Mandible Gothic Arch Tracings.



6.8.2. **Semiadjustable Articulator.** A semiadjustable articulator is an instrument of larger size and more closely approximates the distance from the axis of rotation to the teeth. When casts are articulated using a facebow transfer, the arc of closure produced on the articulator resembles the arc in the patient's mouth and any resulting error is slight (Figure 6.10). Placing the casts *closer to* or *farther away* from the condyles has only a small effect during lateral excursions (Figure 6.11).

Figure 6.10. Effect of Hinge Axis Location on a Semiadjustable Articulator.

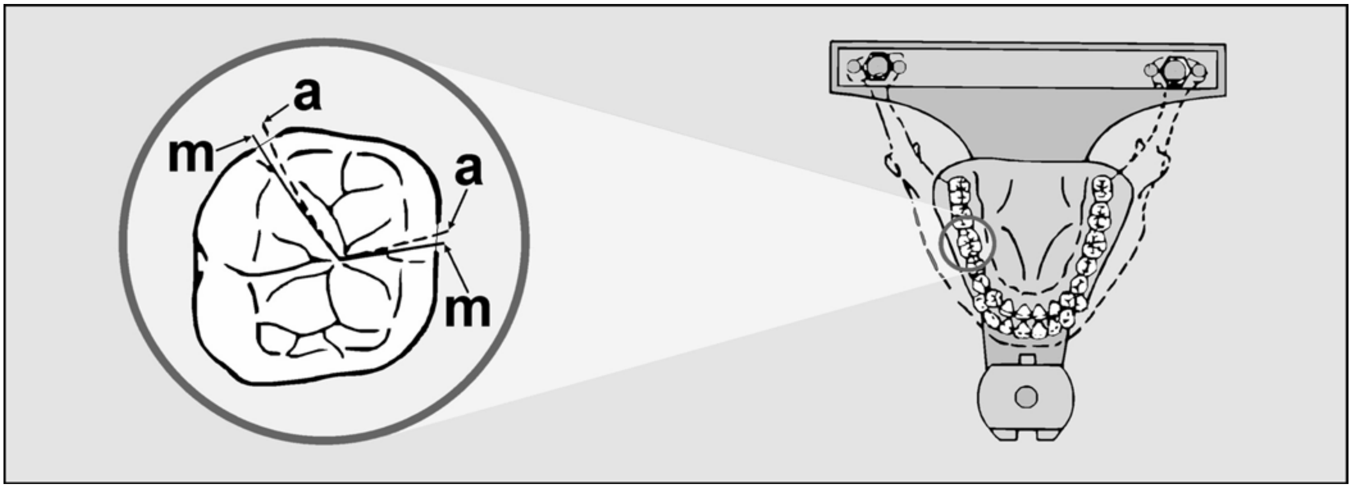


6.9. Hanau H2-158 Articulator. The parts of this articulator are listed below (and in Figure 6.12):

6.9.1. **Upper Member (A).** The upper member is the articulator equivalent of the upper jaw.

6.9.2. **Lower Member (B).** The lower member is the articulator equivalent of the lower jaw.

Figure 6.11. Effect of Hinge Axis Location on a Gothic Arch.



6.9.3. **Mounting Plate and Lockscrew (C and D).** Mounting plates are used for fixation of the patient's cast to the upper and lower members of the articulator. Mounting plates are keyed. The cast and its mounting plate can be removed from the articulator during work and can be replaced in the identical position.

6.9.4. **Condylar Shaft (E).** The condylar shaft is the articulator equivalent of the opening and closing axis of rotation existing between the two condyles of the mandible.

6.9.5. **Post (F).** The post is the articulator equivalent of a ramus of the mandible.

6.9.6. **Horizontal Condylar Guidance and Lockscrew (G and H).** The condylar guidance contains a condylar slot that is the articulator equivalent of the glenoid fossa and articular eminence. By rotating the guidance, the condylar slot can be oriented at different angles. The lockscrew holds the slot at a chosen angle.

6.9.7. **Horizontal Condylar Indication (I).** The horizontal condylar inclination contains a scale (-20 degrees to + 60 degrees) showing the angle at which the condylar slot is inclined to the horizontal plane.

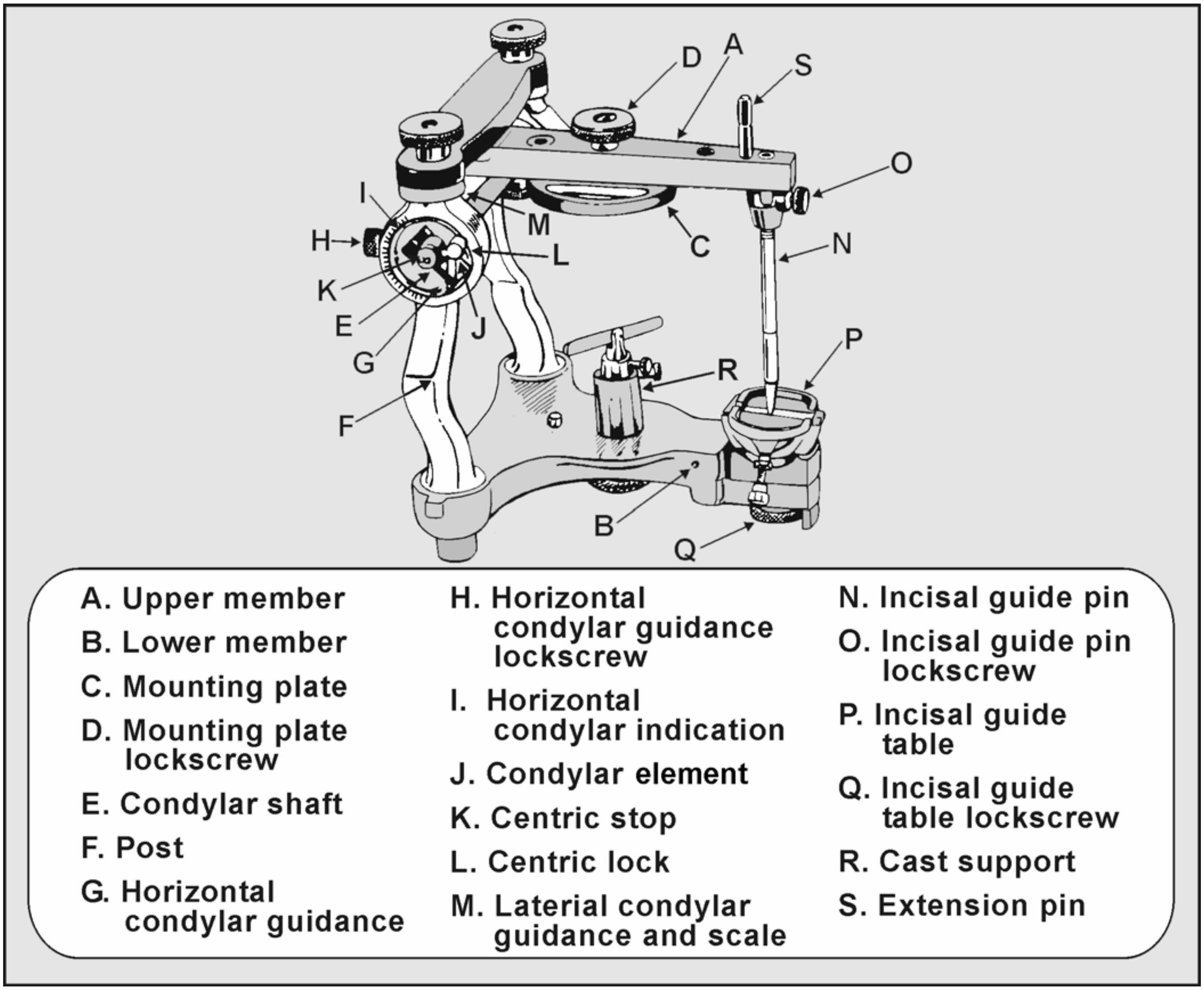
6.9.8. **Condylar Element (J).** The condylar element, the ball that travels within the condylar slot, is the articulator equivalent of the condyle of the mandible.

6.9.9. **Centric Stop (K).** The centric stop, a seat for the condylar element, is found in the posterior part of the condylar slot. After the maxillary and mandibular casts are mounted, the centric stop represents the position the condyle occupied within the temporomandibular joint when the maxillomandibular relationship record was made.

6.9.10. **Centric Lock (L).** The centric lock is used to lock the condylar element against the centric stop.

6.9.11. **Lateral Condylar Guidance and Scale (M).** Lateral condylar guidance is a progressive side shift control. The lateral condylar guidance mechanism on the Hanau H2-158 articulator rotates laterally in and out. It rotates relative to a lateral condylar guidance scale found on the top of the upper member. The scale reads between 0 and 30 degrees. When the lateral condylar indication is higher, the progressive side shift is greater, and vice versa.

Figure 6.12. Parts of the Hanau H2-158 Articulator.



6.9.12. **Incisal (Anterior) Guide Pin and Lockscrew (N and O).** The incisal guide pin is a means of controlling the occlusal vertical dimension after the casts are mounted. The occlusal vertical dimension can be held constant or changed if needed.

6.9.13. **Incisal (Anterior) Guide Table and Lockscrew (P and Q).** The incisal guide table helps preserve existing horizontal and vertical overlaps between upper and lower anterior teeth. This table can help develop proper horizontal and vertical overlaps when these tooth relationship factors are inadequate or absent.

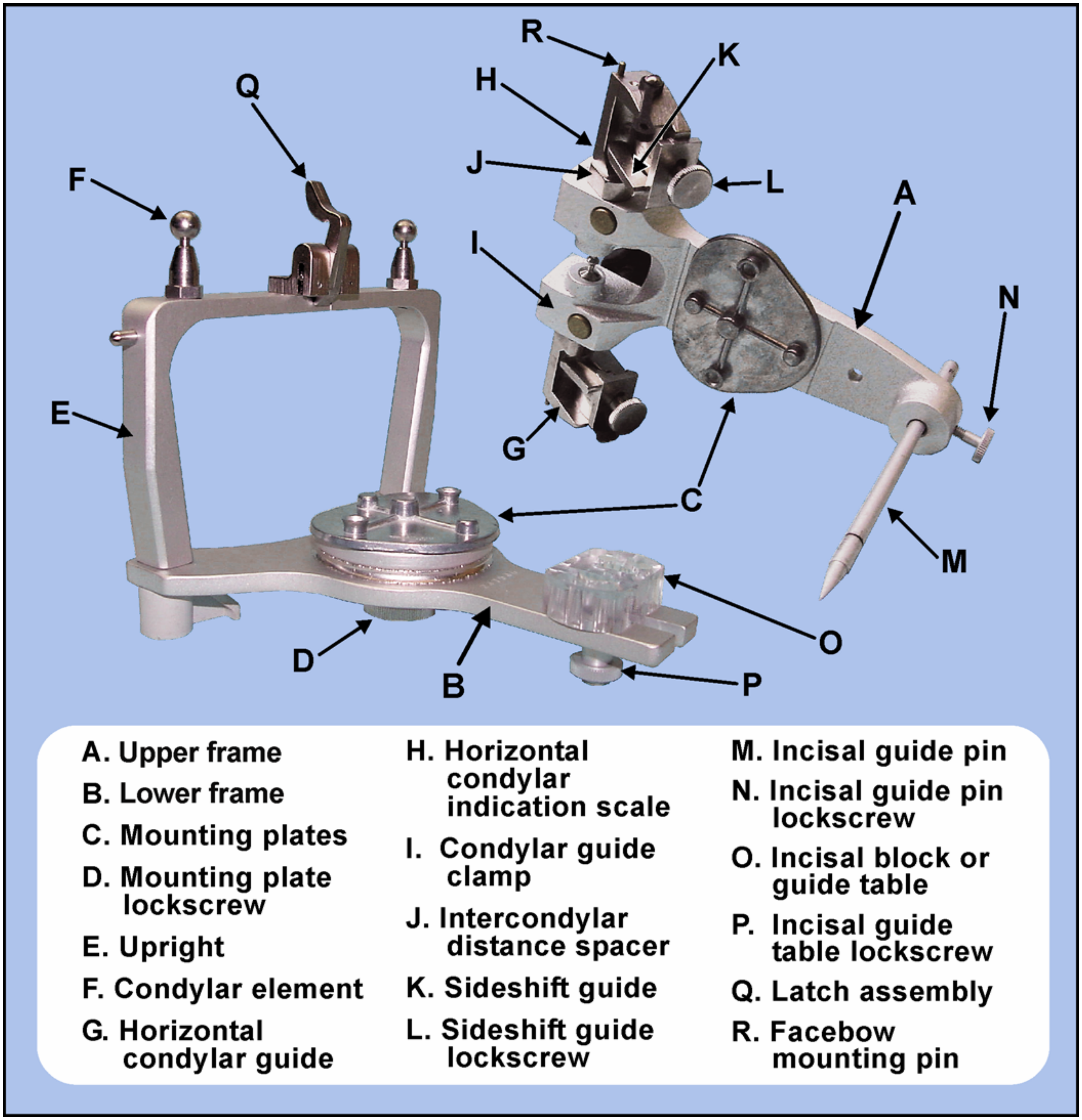
6.9.14. **Cast Support (R).** The cast supports helps stabilize the maxillary cast as it is being mounted to the upper member of the articulator.

6.9.15. **Extension Pin (S).** The extension pin provides support to the upper member when the upper member is opened 180 degrees.

6.10. Whip-Mix Articulator. The parts of this articulator are listed below (and in Figure 6.13):

6.10.1. **Upper Frame (A).** The upper frame is the articulator equivalent of the upper jaw.

Figure 6.13. Parts of the Whip-Mix Articulator.



6.10.2. **Lower Frame (B).** The lower frame is the articulator equivalent of the lower jaw.

6.10.3. **Mounting Plates and Lockscrew (C and D).** The mounting plates are used for fixation of the patient's casts to the upper and lower frames of the articulator. Like Hanau mounting plates, Whip-Mix plates are keyed and can be removed and accurately replaced.

6.10.4. **Upright (E).** The upright is the articulator equivalent of a ramus of the mandible.

6.10.5. **Condyle Element (F).** The condyle element is the articulator equivalent of the condyle of the mandible. Whip-Mix condyle elements can be adjusted to three interelement (intercondylar) distances; small (88 mm), medium (100 mm), and large (112 mm).

6.10.6. **Horizontal Condylar Guide and Condylar Indication Scale (G and H).** The condylar guide is the articulator equivalent of the patient's glenoid fossa and articular eminence. The scale shows the angle at which the condylar guide is inclined to the horizontal plane.

6.10.7. **Condylar Guide Clamp and Lockscrew (I).** One of the functions of the clamp and lockscrew is to maintain the condylar guide at selected inclinations.

6.10.8. **Intercondylar Distance Spacers (J):**

6.10.8.1. When the condyle elements are adjusted to small, medium, or large settings, the condylar guides have to travel in or out with them. The alignment of the condylar guides over the condyle elements has to be very precise, and the intercondylar distance spacers are responsible for the alignment. The spacers are placed on the shaft that holds the condylar guide suspended from the condylar guide clamp. Although no spacer is placed on the shaft for the *small* condyle element setting, one is used per side for the *medium* condyle element position and two are used per side for the *large* setting.

6.10.8.2. Because the intercondylar spacers are specific for the Whip Mix articulator they are packaged for, they should not be interchanged or used with another Whip Mix articulator. When not in use, the spacers should be placed on the incisal guide pin to insure they remain with that articulator.

6.10.9. **Lateral Condylar (or Sideshift) Guide and Lockscrew (K and L).** The sideshift guide and scale are the articulator's sideshift controls. A standard Whip-Mix articulator (Model 8500) comes equipped with sideshift guides that only allow adjustable progressive sideshift. Another Whip-Mix model, the 2000 series, comes with curvilinear eminentia, a 7 1/2 degree progressive sideshift, and adjustable immediate sideshift guides.

6.10.10. **Incisal (Anterior) Guide Pin and Lockscrew (M and N).** The incisal guide pin is a means of controlling the occlusal vertical dimension once casts are mounted. The occlusal vertical dimension can be held constant or changed if needed.

6.10.11. **Incisal (Anterior) Guide Table and Lockscrew (O and P).** The incisal guide table helps preserve existing horizontal and vertical overlaps between upper and lower anterior teeth. The incisal guide table can also help develop proper horizontal and vertical overlaps when these tooth relationship factors are inadequate or absent.

6.10.12. **Latch Assembly (Q).** The latch assembly is a device that centers the upper member over the condyle elements in a centric position when immediate sideshift guides are used. With the centric latch engaged, the upper member is secured to the lower member.

6.10.13. **Facebow Mounting Pin (R).** The earpieces of a facebow attach to the pins when mounting a maxillary cast using the direct facebow mounting technique.

Section 6B—Transferring Patient Information That Controls Mandibular Movements to Semiadjustable Articulators

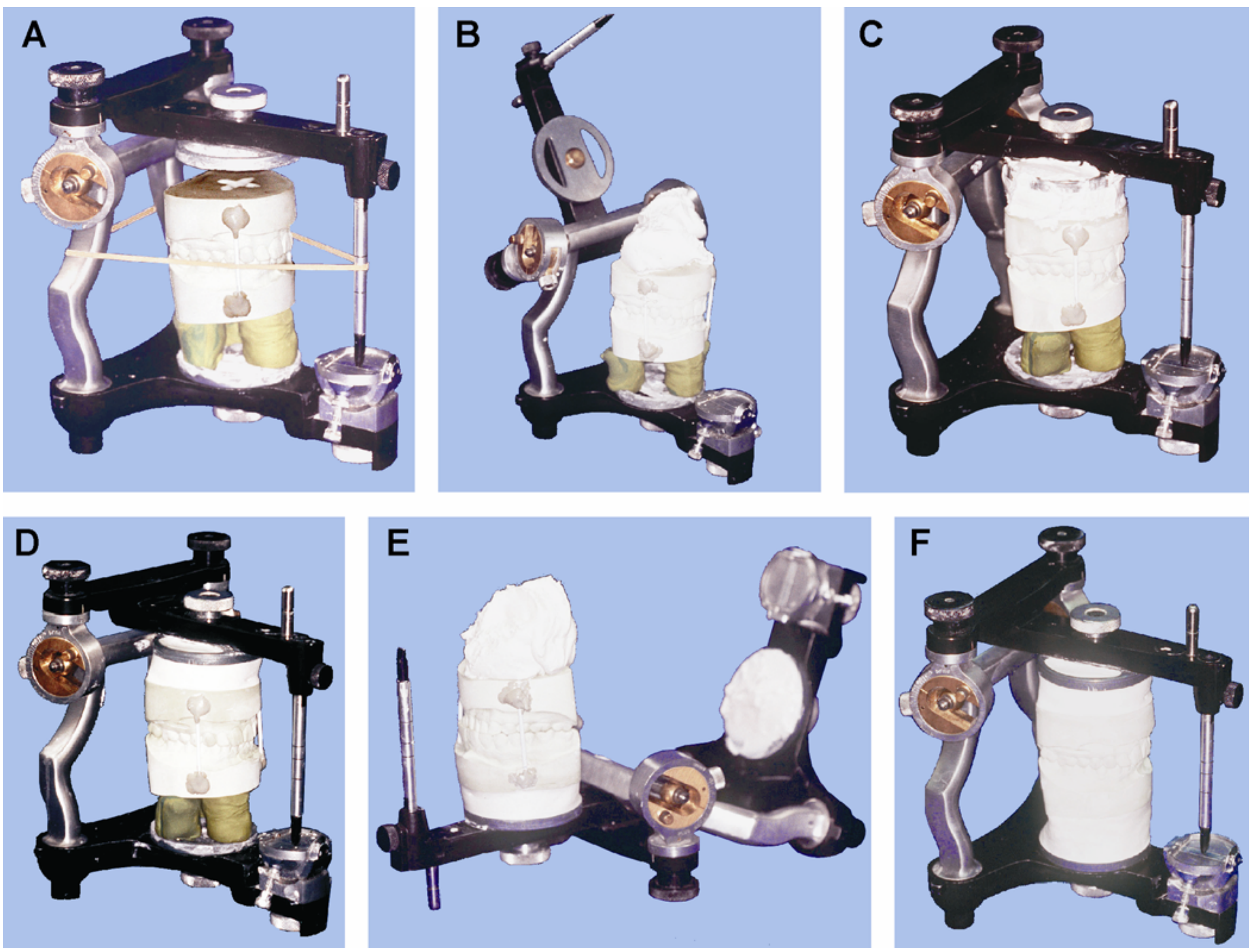
6.11. Vertical and Horizontal Orientation of the Maxilla to Both Temporomandibular Joints. Adequate simulation of the vertical and horizontal orientation of the maxilla depends on how the maxillary cast relates to the condylar elements of the articulator when the cast is mounted to the upper member. Three methods may be used to establish the orientation of the maxillary cast to the articulator. They are the average method, the arbitrary facebow transfer method, and the kinematic axis facebow transfer method. The average method is discussed in paragraph 6.12 and the arbitrary facebow transfer method is discussed in paragraph 6.13. (The kinematic axis facebow method resembles the arbitrary facebow method enough that it will not be discussed further.)

6.12. Average Method:

6.12.1. **Hanau H2-158:**

6.12.1.1. To mount a cast with this method, first place a rubber band around the condylar posts and the anterior guide pin (Figure 6.14). (Ensure the top of the guide pin is flush with the upper member.) Then position the band on the pin's lower mark and make the band parallel to the articulator's horizontal plane.

Figure 6.14. Average Mounting of a Maxillary Cast in a Hanau H2-158 Articulator.



6.12.1.2. Using compound, sticky wax, or glue, secure the maxillary and mandibular cast together in MI or with a centric relation record. Orient the occlusal plane of the maxillary cast, using clay or wax support to fall on the plane of the rubber band. (If the maxillary cast represents a complete denture case, make the plane of the maxillary occlusion rim conform to the plane of the rubber band.)

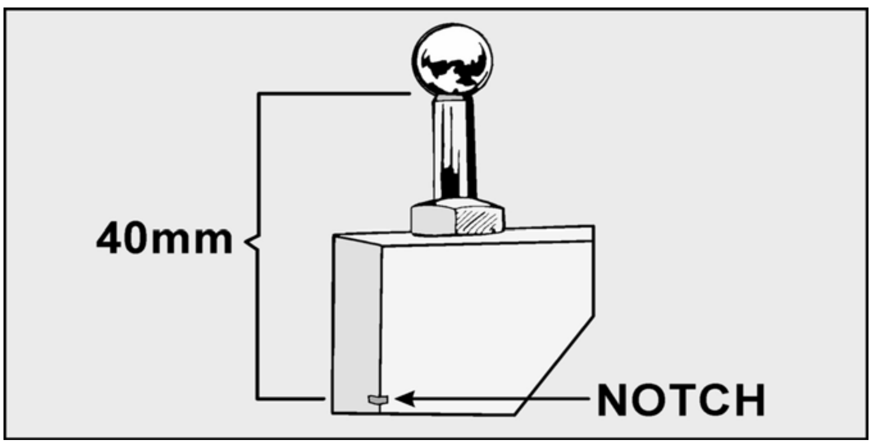
6.12.1.3. Next, center the maxillary cast under the mounting plate while aligning the cast midline behind the incisal guide pin. The cast can now be attached to the plate with dental stone. Orienting the maxillary cast in this way results in the following: the maxillary plane of occlusion is parallel to the horizontal plane of the articulator, the occlusal plane is the average vertical distance away from the temporomandibular joints, and the midline between the two maxillary central incisors is the average horizontal distance away from the two temporomandibular joints.

6.12.2. **Whip-Mix:**

6.12.2.1. This articulator was never intended to be used as a fixed-guide instrument. It has no convenient reference marks for average mounting of an upper cast (anterior guide pin reference grooves).

6.12.2.2. However, to use the articulator in this way, measure 40 mm down the lower frame from the under surface of a condyle ball and engrave a discreet mark (Figure 6.15). Do this on the left and right lower frame uprights. Then place a rubber band around the two engraved marks and around the anterior guide pin.

Figure 6.15. Notched Whip-Mix Upright.



6.12.2.3. The front part of the rubber band can now be adjusted so the band is parallel to the horizontal plane of the articulator (Figure 6.16). Once the rubber band is positioned, perform an average upper cast mounting as for the Hanau H2-158.

6.13. Arbitrary Facebow Transfer Method:

6.13.1. Mounting an upper cast for the semiadjustable or fully adjustable modes is done with a facebow transfer. A facebow is a caliper-like instrument that relates an upper cast to the condyle elements of an articulator in the same way a patient's upper jaw relates to the temporomandibular joints (Figure 6.17).

6.13.2. Mounting an upper cast in this way is much more accurate than using statistical averages (Figure 6.18). One advantage is that small alterations can be made to the occlusal vertical dimension without remounting the case. Another advantage is that the lateral tooth contact relationships developed for a prosthesis in the articulator are more likely to show up in the same way when the patient moves the lower jaw laterally.

Figure 6.16. Arbitrary (Average) Orientation of a Maxillary Cast to the Condyle Elements of a Whip-Mix.

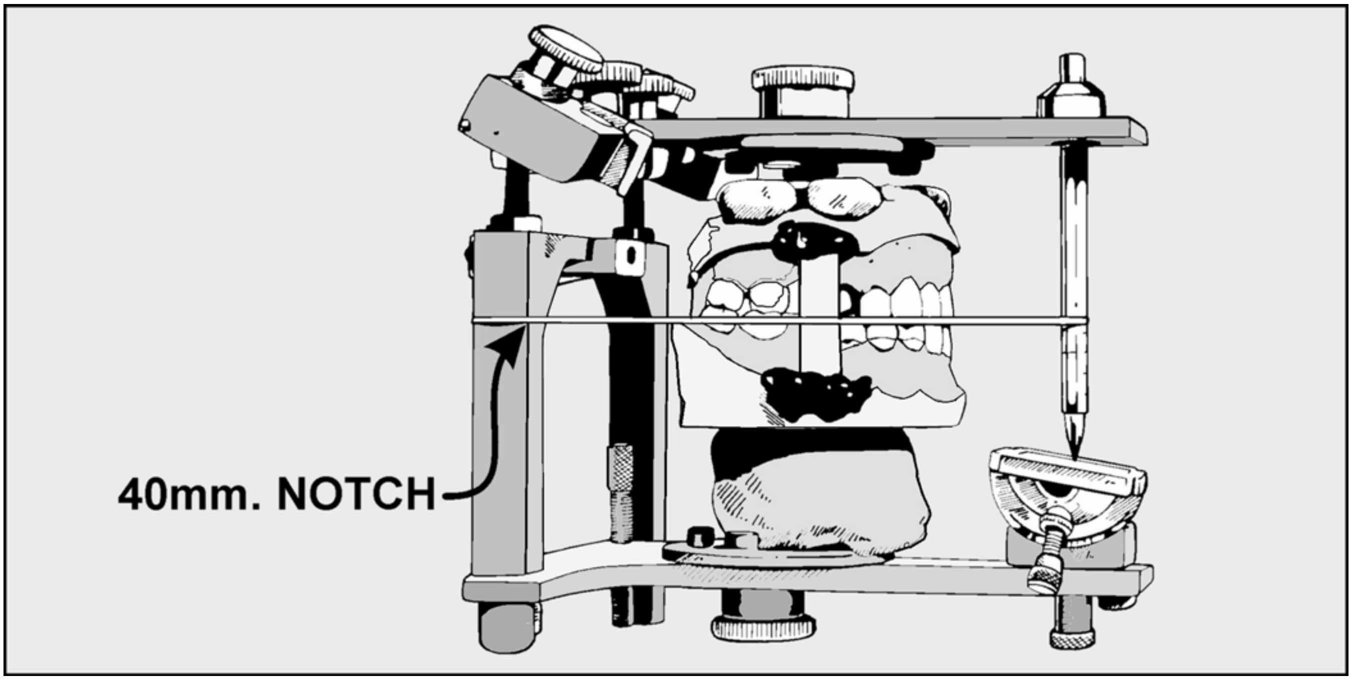
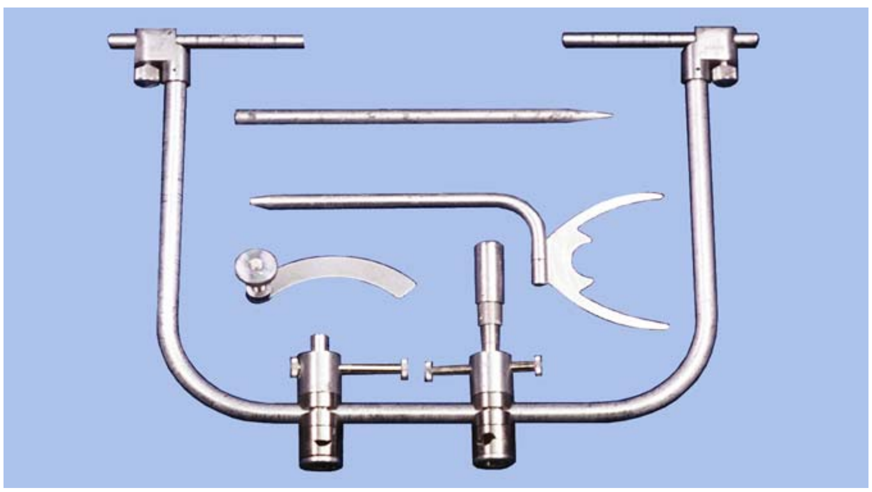


Figure 6.17. Facebow.

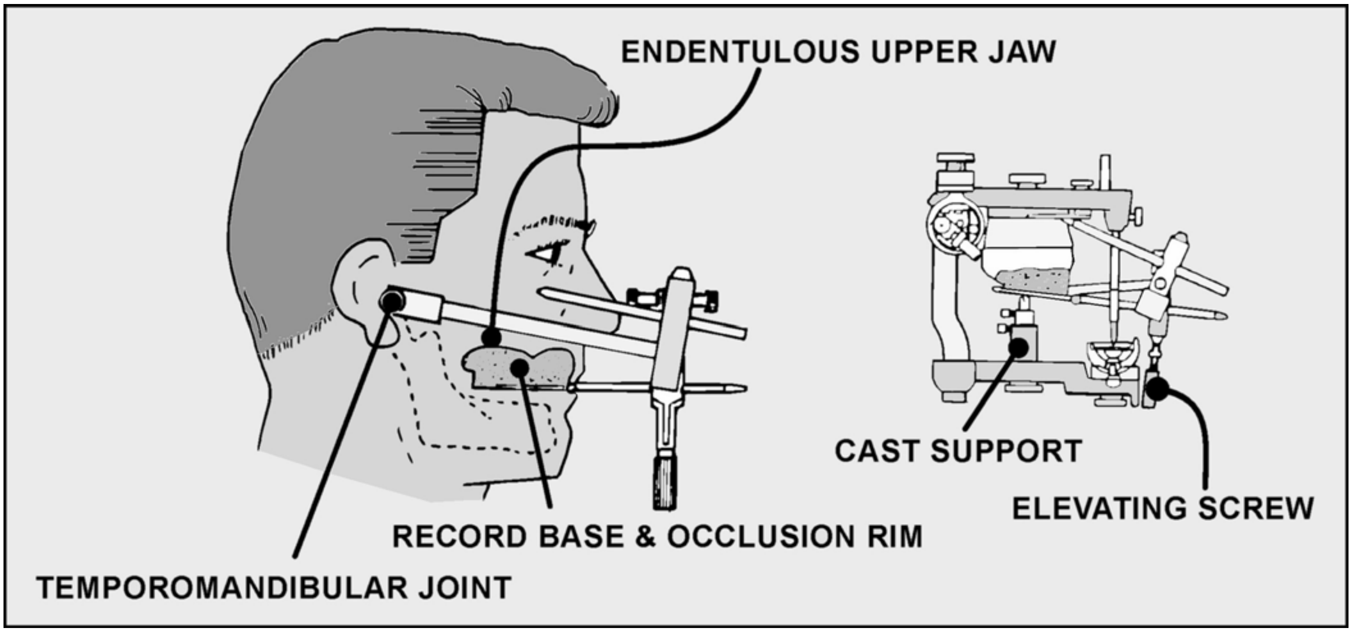


6.13.3. Facebow shapes and mechanics differ slightly from brand to brand. Follow directions in the manufacturer's instructions.

6.13.4. The use of a Hanau H2-158 facebow for mounting an edentulous upper cast in complete denture construction is described in Chapter 7, paragraph 7.47.2.

6.13.5. The use of a Whip-Mix facebow (earbow) for mounting a dentulous upper cast in fixed partial denture construction is described in Chapter 1, Volume 2.

Figure 6.18. Facebow Transfer.



6.14. Centric Relation:

6.14.1. Once the upper cast is mounted, the lower cast must be articulated against it. It is up to the dentist to decide whether maximum intercuspation is adequate for articulating the lower cast or whether the articulation must be done with some form of maxillomandibular relation record.

6.14.2. Every position the mandible can assume in relation to the maxilla has a horizontal and a vertical component. The horizontal component represents the anteroposterior and lateral position of the condyles in the glenoid fossae. The vertical component is the prevailing vertical dimension between the maxilla and mandible (that is, the occlusal vertical dimension or some other vertical distance between the jaws).

6.14.3. When enough natural teeth remain, the casts might be mounted in MI. The way the teeth fit together controls the horizontal position of the lower jaw in relation to the upper, and the natural teeth in contact produce an occlusal vertical dimension. When an acceptable MI is gone, the centric relation position is used to horizontally orient the lower jaw, and the occlusal vertical dimension must be estimated. This situation is typical of complete denture problems.

6.14.4. The dentist records centric relation and the occlusal vertical dimension with a maxillomandibular relationship record (for example, record bases and record rims). The technician uses this record to articulate the lower cast against the upper cast. The use of a maxillomandibular relationship record to orient edentulous casts is described in Chapter 7, paragraph 7.48. For an example of a MI mounting with casts from dentulous patients, see Chapter 8, paragraph 8.40.2.

6.14.5. A complete mouth rehabilitation case requiring multiple crowns or fixed partial dentures involves the same kind of problem. When the dentist is finished preparing the natural teeth, maximum intercuspation is gone. The dentist must supply a maxillomandibular relationship record to mount the mandibular cast. (See Chapter 1, Volume 2, of this manual.)

6.14.6. After the lower cast is articulated against the upper cast, *be acutely aware* that changing the anterior guide pin setting changes the patient's occlusal vertical dimension. In cases where the casts have been mounted at the patient's occlusal vertical dimension (MI or centric relation), the *pin-flush* rule helps eliminate the need for remembering where the anterior guide pin was set.

6.14.6.1. According to the pin-flush rule, the following conditions should be met when the mounting is completed: the casts are at the occlusal vertical dimension, the pin is flush with the top of the articulator's upper member (Hanau) or set at the zero reference line (Whip-Mix), and the pin contacts the anterior guide table.

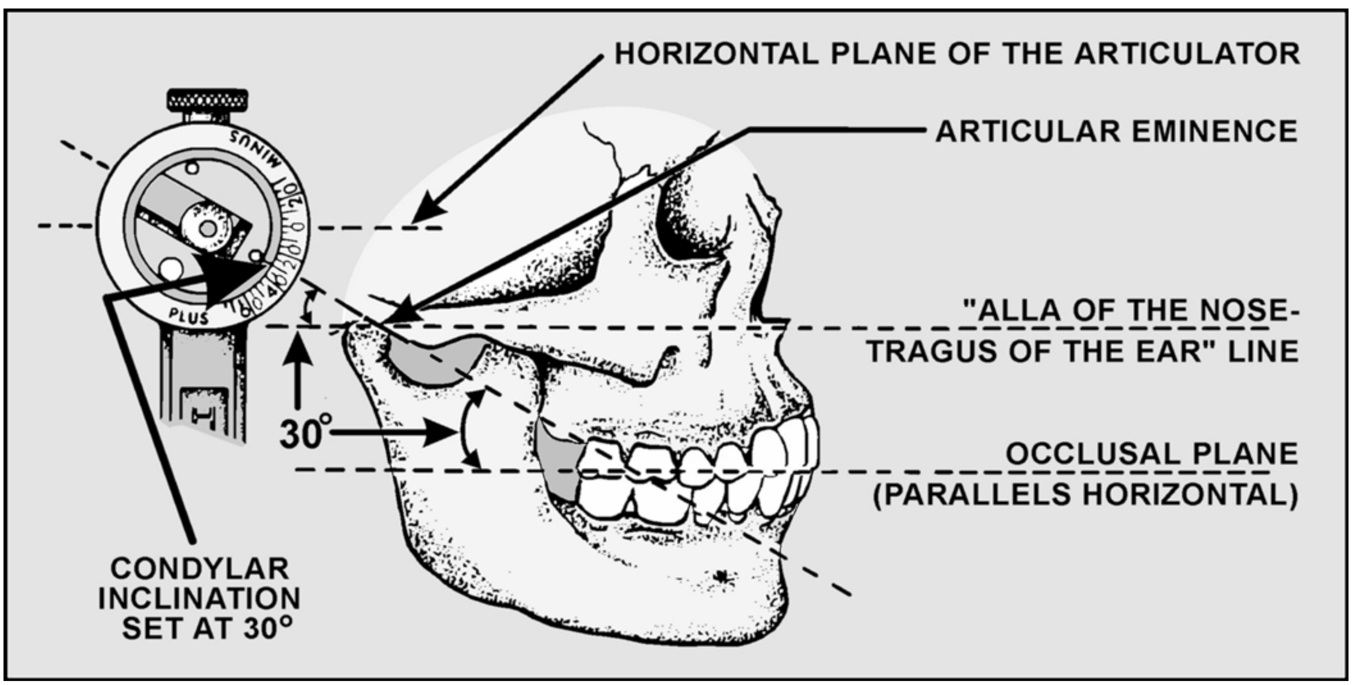
6.14.6.2. The pin-flush rule does not apply to mountings where a maxillomandibular relationship record holds natural or artificial teeth apart at a distance other than the desired occlusal vertical dimension. In these situations, the following steps are performed in order. Mount the upper cast. Open the anterior guide pin by the estimated thickness of the maxillomandibular relationship record. Mount the lower cast. When you finish, remove the maxillomandibular relationship record. Reset the pin at the estimated occlusal vertical dimension and record the pin setting on the base of the upper cast. This will be the patient's actual occlusal vertical dimension.

6.15. Angles the Articular Eminences Form With the Occlusal Plane. The slant of an articular eminence relative to the occlusal plane is a major determinant of a mandibular movement. The angle may be the same, or it may differ from side to side. After the patient's casts are mounted on an articulator, the horizontal condylar guidances should be inclined to match the patient's eminence-to-occlusal plane angles. The average method is discussed in paragraph 6.16; the interocclusal record method is discussed in paragraph 6.17.

6.16. Average Method:

6.16.1. The average setting of the horizontal condylar guidances on the Hanau and Whip-Mix articulators are the same. In the average method, the horizontal guidance is set at the + 30 degree mark when the occlusal plane or plane of a record rim is mounted parallel to the horizontal plane of the articulator (Figure 6.19). The rationale for this procedure is that for the average patient, the angle formed by the articular eminence and the occlusal plane equal + 30 degrees.

Figure 6.19. Average Setting of Horizontal Condylar Guidance.

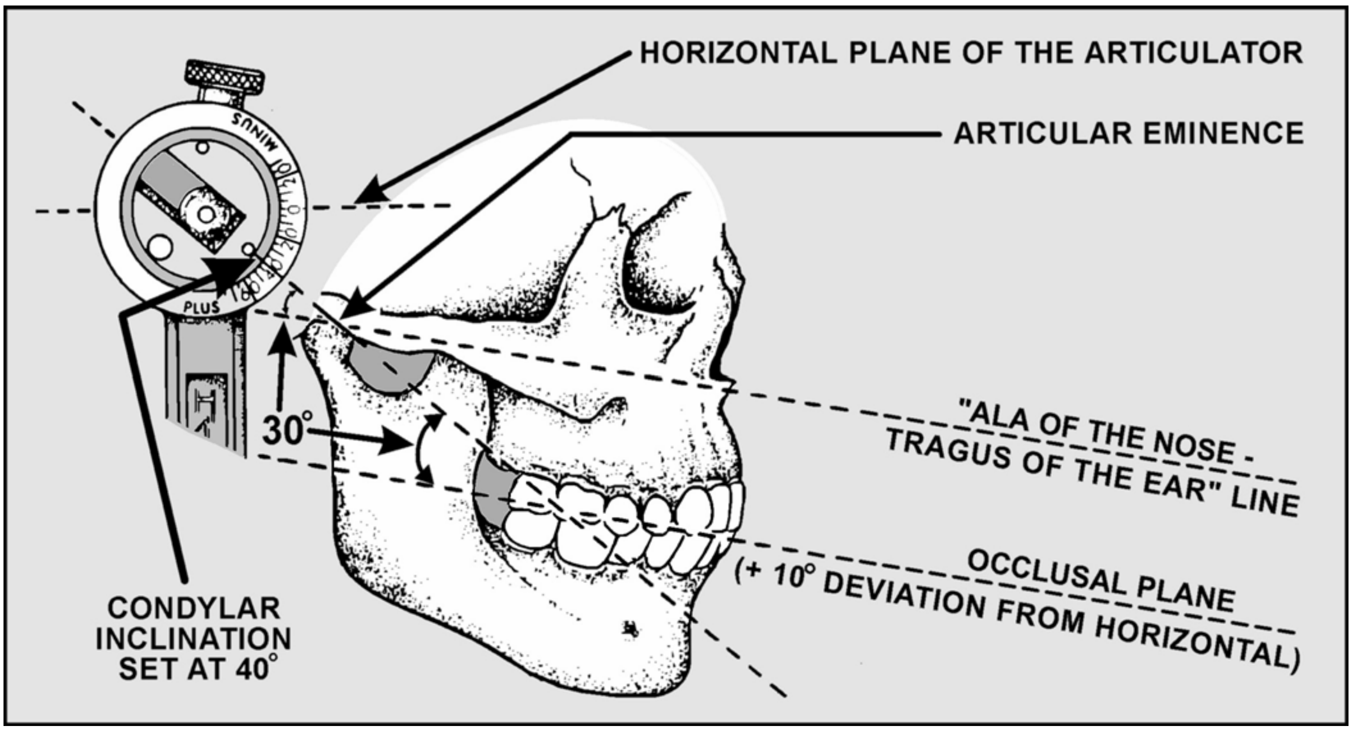


6.16.2. The Hanau and Whip-Mix articulators are machined so a horizontal condylar guidance readout of 30 degrees means the guidance is forming a 30-degree angle with the articulator's horizontal plane. This leads to the conclusion that if a horizontal condylar guidance readout of 30 degrees is supposed to represent a valid average, the occlusal plane or plane of the record rim *must* be mounted parallel to the horizontal plane of the articulator.

6.16.3. If the anterior portion of the occlusal plane or plane of the record rim has been made to deviate downward from parallel with the horizontal, the 30 degree horizontal condylar guidance setting must be increased by the amount of the deviation. For example, if the anterior portion of the occlusal plane or plane of the record rim deviates downward from horizontal by an estimated 10 degrees, the horizontal condylar guidance must be set to read 40 degrees for the guidance and the occlusal plane or plane of the record rim to intersect at the valid average of 30 degrees (Figure 6.20).

6.16.4. If the anterior portion of the occlusal plane or plane of the record rim deviates upward from parallel with the horizontal, a 30-degree horizontal condylar guidance setting must be reduced by the amount of the deviation.

Figure 6.20. Horizontal Condylar Guidance Compensation for an Occlusal Plane Not Horizontally Oriented.



6.17. Interocclusal Record Method:

6.17.1. **Hanau Articulators.** Adjusting the horizontal condylar guidance settings to the patient's actual eminence inclinations requires mounting the maxillary and mandibular casts with a centric relation record or some centric position chosen by the dentist. In addition, the dentist must obtain a protrusive interocclusal relationship record from the patient. The protrusive record will be used to set the horizontal condylar guidance angles. See Chapter 7, paragraph 7.50.2, for a detailed description of this procedure.

6.17.2. **Whip-Mix Articulator:**

6.17.2.1. A protrusive interocclusal relationship record can be used to set right and left horizontal condylar guidances on the Whip-Mix articulator. In this respect, the method differs from directions given for the Hanau H2 -158. After the upper member and cast are seated in the protrusive record, the horizontal condylar guidances are adjusted to touch the tops of the condylar elements.

6.17.2.2. The Whip-Mix articulator is somewhat more versatile than the Hanau H2-158. It accepts almost all lateral interocclusal relationship records, while the Hanau H2-158 does not. Another advantage of the Whip-Mix is that the horizontal condylar guidance and lateral condylar guidances (progressive sideshift) on one side can *both* be set from a single lateral interocclusal relationship record. (Another lateral record is needed to set the other side.)

6.17.2.3. Chapter 1, Volume 2, of this manual contains a further explanation of using lateral interocclusal relationship records in the Whip-Mix technique. Lateral interocclusal relationship records are preferred over a protrusive interocclusal relationship record for setting the horizontal condylar guidances of a Whip-Mix articulator.

6.18. Temporomandibular Joint Characteristics Governing the Timing and Direction of Laterotrusion. The articulator counterpart of this patient factor is the lateral condylar guidance feature of the Hanau H2-158 and Whip-Mix articulators.

6.18.1. **Average Method.** The average setting for the lateral condylar guidance on both Hanau articulators and Whip-Mix articulators is 15 degrees.

6.18.2. **Interocclusal Record Method:**

6.18.2.1. **Hanau Articulators.** The progressive sideshift of some semiadjustable articulators (Whip-Mix) can be set from lateral interocclusal relationship records made on the patient. The problem with a Hanau articulator is that it does not accept all lateral records. To compensate for this apparent lack of versatility, the manufacturer suggests the angle of a person's eminence, occlusal plane, and amount of progressive mandibular translation (sideshift) are related. (For example, the steeper the angle of the eminence, the greater the sideshift.) Hanau devised the following formula to express this supposed relationship: $L = H/8 + 12$. That is, the lateral condylar guidance setting (L) is equal to the angle of the horizontal condylar guidance (H) divided by 8, to which 12 is added.

6.18.2.2. **Whip-Mix Articulator.** The dentist provides a right and left lateral record to set the corresponding horizontal condylar and lateral condylar guidances. (See Chapter 1. Volume 2, of this manual.) A standard Whip-Mix articulator comes equipped with sideshift guides, allowing only progressive sideshift. Four additional sets of guides can be bought, allowing 0.25, 0.50, 0.65, or 1 mm of immediate sideshift in conjunction with progressive sideshift. Using the theory that immediate sideshift increases as progressive sideshift increases, the Whip-Mix Corporation has made suggestions (shown in Table 6.1) for choosing among their range of sideshift guides.

Table 6.1. Suggestions for Choosing a Sideshift Guide.

I T E M	A Lateral Condylar Guidance Reading	B Sideshift Guide
1	0 to 5 degrees	Standard guide (no immediate sideshift)
2	5 to 15 degrees	0.25 mm of immediate sideshift
3	15 to 25 degrees	0.50 mm of immediate sideshift
4	25 to 35 degrees	0.65 mm of immediate sideshift
5	over 35 degrees	1 mm of immediate sideshift

6.19. Distance (Space) Between a Patient's Condyles (Intercondylar Distance):

6.19.1. **Hanau Articulators.** The Hanau articulators have a fixed intercondylar distance (110 mm). The word *fixed* means it cannot be changed. The 110 mm is supposed to represent the amount of space between an average person's condyles.

6.19.2. **Whip-Mix Articulator.** The Whip-Mix 8500 series articulator has condyle elements that adjust to three interelement distances; small (88 mm), medium (100 mm), and large (112 mm). When the distance between the elements is changed, the condyle guidance mechanisms on the upper member must be aligned over the elements. The alignment is controlled by the intercondylar distance spacers. The 2000 and 3000 series have a fixed intercondyle distance of 110 mm.

6.19.2.1. **Average Condyle Position.** When the Whip-Mix articulator is used in the average position, the condyle elements are placed at the *medium* setting (one spacer in place).

6.19.2.2. **Semiadjustable Mode.** In the Whip-Mix system, a facebow transfer serves two purposes. It relates the upper cast to the condyle elements in the same way a patient's upper jaw relates to the temporomandibular joints. In addition, it registers the approximate intercondylar distance. When a dentist uses a Whip-Mix facebow on a patient, the facebow dicates a small, medium, large, or intercondylar distance by an indicator on the front of the facebow. The condyle elements are adjusted to the proper setting before the upper cast is mounted.

6.20. Relative Presence or Absence of Anterior Guidance. Setting an articulator to accommodate this patient factor requires either maintaining existing horizontal and vertical overlaps between upper and lower teeth or developing new ones. The *anterior guide table* is the primary articulator control involved. In setting an anterior guide table, the following important considerations must be weighed:

6.20.1. When casts carrying natural teeth move in and out of MI, stone surfaces rub away. The anterior guide table can be set to help prevent this.

6.20.2. If the patient has sufficient natural teeth present, does the occlusion show group function or anterior guidance? Under ordinary circumstances, the patient's natural guidance patterns should be maintained.

6.20.3. If natural teeth are badly worn or completely missing, will the occlusion be restored to show anterior guidance, group function, or bilateral balance? The dentist analyzes the restorative problem and sets the anterior guide table accordingly or directs the technician to set the proper anterior guidance.

6.20.4. After the table is set, the technician manipulates the horizontal and vertical overlap variables (anterior guidance or lack of it) on the prosthesis to conform to the occlusion scheme chosen. Until the technician develops a sense for the influence of the anterior guide table as a control, he or she should depend on the dentist for guidance.

6.20.5. A mechanical anterior guide table can be used with most articulators. The *chisel edge* of the anterior guide pin is used with the mechanical anterior guide table. This guide table can be used to prevent the abrasion of mounted stone casts and can provide guidance when setting denture teeth, but it cannot provide a permanent record of a patient's anterior guidance.

6.20.5.1. To use the mechanical anterior guide table, mount the maxillary and mandibular casts appropriately onto the articulator. Carefully guide the maxillary cast into straight protrusive movement until the incisal edges of the maxillary incisors are brought into contact with the incisal edges of the mandibular incisors.

6.20.5.2. Rotate the anterior guide table to make contact with the chiseled surface of the anterior guide pin and tighten the locknut. Next, adjust the mechanical anterior guide table for right and left lateral movements.

6.20.5.3. Move the maxillary cast in a right lateral canine to canine guidance position. Elevate the anterior guide table's lateral wing to contact the corner of the chiseled surface of the anterior guide pin and tighten the locknut to maintain the adjustment. Then adjust the left lateral wing in the same manner.

6.20.6. A custom anterior guide table can be made for Whip-Mix and Hanau Wide-Vue arcon articulators. The custom anterior guide table is made using the *rounded end* of the anterior guide pin. The table prevents the possible abrasion of the mounted stone casts during the manipulation of the articulator and can be used as a permanent record of the anterior guidance of the patient.

6.20.6.1. To fabricate a custom anterior guide table, mount the maxillary and mandibular casts appropriately onto the articulator. Lubricate the rounded end of the anterior guide pin with petroleum jelly.

6.20.6.2. Moisten the plastic anterior guide table with one or two drops of acrylic resin monomer. Mix autopolymerizing acrylic resin and place a 10 mm thickness of the acrylic resin on the anterior guide table. Once the acrylic resin reaches its doughy stage, close the articulator until the rounded end of the anterior guide pin penetrates the doughy acrylic resin and touches the anterior guide table.

6.20.6.3. Move the maxillary member of the articulator into a protrusive movement until the maxillary and mandibular anterior teeth meet end to end. Establish right and left lateral border movements to an end to end position of the teeth. Make all excursive movements while the acrylic resin is still doughy and contour any excess acrylic resin after polymerization is complete.

6.21. Proper Performance of a Lateral Excursion on an Articulator:

6.21.1. When going to the trouble of developing specific lateral contacts between natural or artificial teeth in an articulator, it is reasonable to hope those contacts show up in the same way in the patient's mouth. Reproducing the patient's sideshift in an articulator is one of the most important factors in achieving this goal.

6.21.2. It is not enough to casually grasp the anterior guide pin of an articulator, pushing against it to move the upper member to the side, and call this a lateral excursion. The upper member of the articulator must be moved laterally in a very particular way to guarantee sideshift occurs in the amount corresponding to the lateral condylar guidance setting.

6.21.3. To move the Hanau H2-158 articulator, lock down the working side condyle against the centric stop and place a thumb on the working side condylar guide. To get full sideshift value, move the upper member toward the balancing side and push the condylar guide in the same direction (Figure 6.21). If the movement is done correctly, the shoulder of the condylar shaft will remain in contact with the external surface of the balancing condylar element during the entire course of the upper member's lateral travel. Also, a space will develop between the condylar element and the brass stop external to the element on the working side. The space represents the full amount of sideshift the lateral condylar guidance setting allows (Figure 6.22).

6.21.4. To produce a proper lateral movement in a Whip-Mix articulator, place your thumb on the working side horizontal condylar guide and push the back end of the upper member toward the balancing side. Simultaneously, move the front part of the upper member in the same direction with your other hand. The objective is to keep the balancing side condyle element in contact with its sideshift plate during the entire lateral excursion (Figure 6.23). The sideshift is the amount of space between the working side condyle element and the sideshift plate.

6.22. Hanau Wide-Vue Series of Articulators:

6.22.1. The Hanau Wide-Vue series of arcon articulators consists of eight basic models. The Wide-Vue models 183-1 through 183-4 have a closed condylar track, and the maxillary and mandibular members cannot be separated. The Wide-View II models 184-1 through 184-4 have an open condylar track, and the maxillary and mandibular members can be separated.

6.22.2. The lingual visibility with this series of articulators is excellent. The posterior openness allows tooth positioning and alignment with a minimum of visual obstruction from the body of the articulator. This type of articulator has a dual-end anterior guide pin which allows the use of a mechanical guide table and the fabrication of a custom guide table.

Figure 6.21. Manipulation of the Hanau H2-158 Articulator To Obtain Full Sideshift Value in a Lateral Movement.

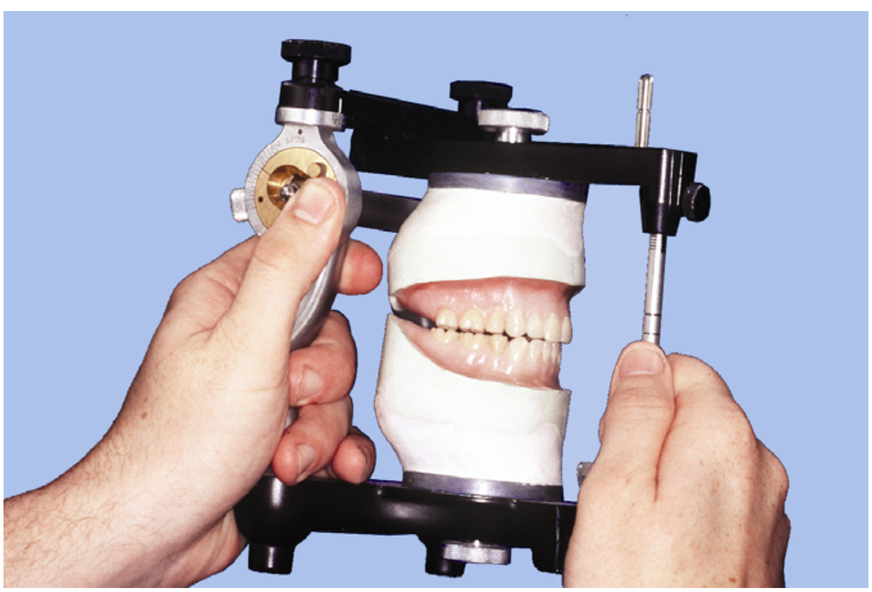
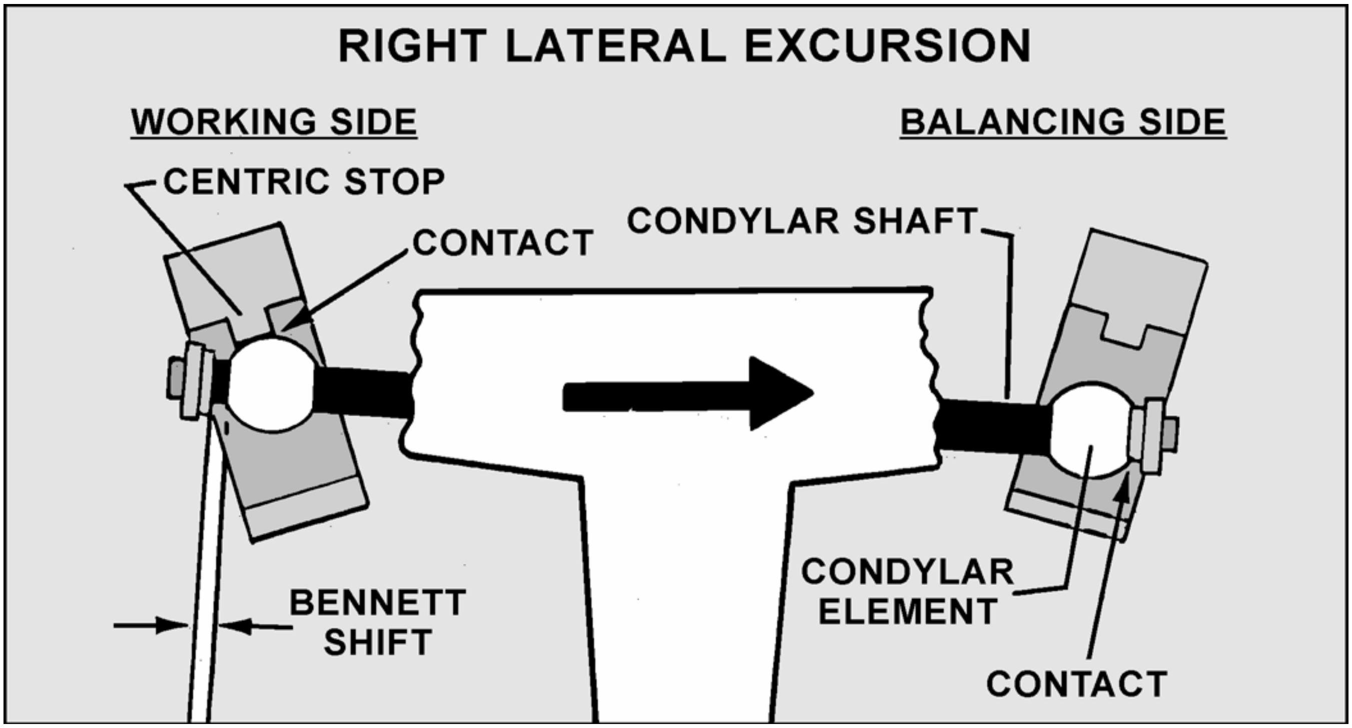


Figure 6.22. Lateral Movement Incorporating Sideshift in the Hanau H2-158 Articulator.



6.23. Whip-Mix 2000-Series of Arcon Articulators:

6.23.1. The Whip Mix 2000-series of articulators consists of four different models; 2200, DB2000, 2240, and 2340.

6.23.2. The 2000-series of articulators have a redesigned frame which allows more space for mounting casts and improved posterior visibility. Also, a curved condylar guide and immediate side shift have been incorporated into this instrument.

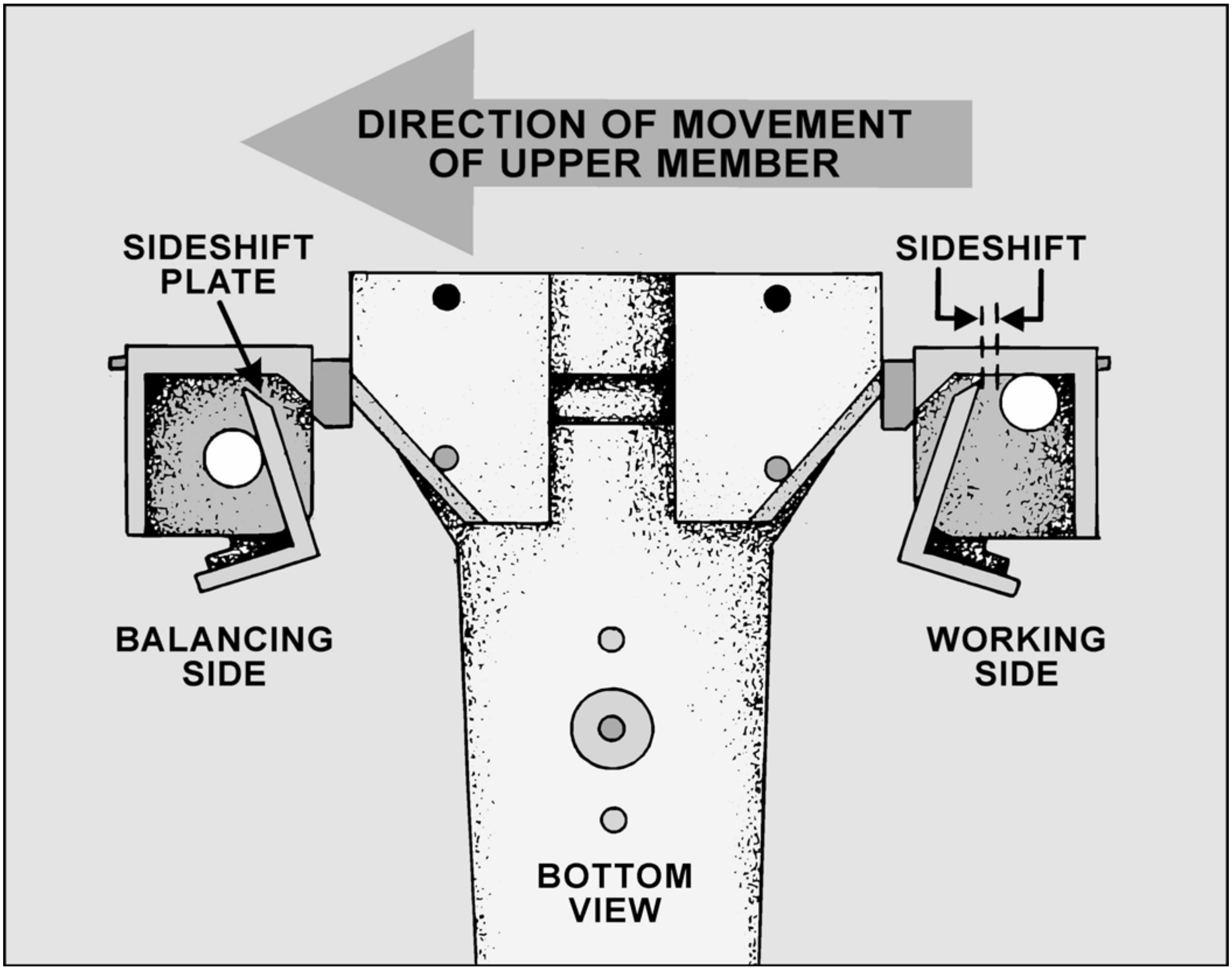
6.23.3. A new centric latch that allows a quick and stable return to the MI position, and a permanent 110 mm intercondylar width has improved the sturdiness of this instrument. Bilateral elastics have been incorporated to hold the maxillary and mandibular members securely together during excursive movements.

6.23.4. A unique and potentially useful innovation is the Accumount mounting system used in the manufacture of Models 2240 and 2340 articulators. During the production of these articulators, a special mounting plate has been attached to the lower frame, using a special fixture and low-fusing alloy.

6.23.5. The relationship between maxillary and mandibular mounting plates has been checked and standardized. The manufacturer states that, because of this unique mounting system, there can be an accurate interchange of mounted casts between two Model 2240 or 2340 articulators. This feature allows the casts mounted on one Model 2240 to be removed from the articulator and transported to a dental laboratory. At the laboratory, the casts are mounted on a second Model 2240 to have the prosthesis fabricated. The dental office and laboratory now require fewer articulators. Also, wear and tear on these sensitive instruments is reduced because they are not being sent through the mail.

6.23.6. Communication between the dentist and the dental laboratory now becomes even more critical. The dentist must provide all the necessary information for programming the articulator if the articulator is to be used effectively in reproducing mandibular movements.

Figure 6.23. Lateral Movement Incorporating Sideshift on the Whip-Mix Articulator.



Chapter 7

COMPLETE DENTURES

Section 7A—Overview

7.1. Introduction. A *complete denture* is a type of removable prosthesis designed to replace *all* of the natural teeth in an arch. The word "all" is used with reservation because a complete denture does not usually replace third molars and some situations require fewer teeth to be used. Patients sometimes need a set of complete dentures, one for each arch.

7.2. Steps in Complete Denture Construction. Complete dentures are fabricated by using a series of steps the dentist and laboratory technician perform as a team (paragraphs 7.2.1 through 7.2.18). Each step must be performed accurately and precisely. A slight error during any procedure can easily result in an unsatisfactory prosthodontic restoration. The major steps in complete denture construction are as follows:

7.2.1. The dentist makes preliminary impressions.

7.2.2. The technician pours diagnostic casts and fabricates custom trays.

7.2.3. The dentist makes final impressions.

7.2.4. The technician pours master casts.

7.2.5. The technician makes record bases with occlusion rims on the master casts.

7.2.6. The dentist uses the record bases with occlusion rims to determine the amount of facial muscle support the patient needs. The dentist then contours the occlusion rims to make a centric relation and occlusal vertical dimension jaw relationship record.

7.2.7. The technician uses a jaw relationship record to mount master casts in an articulator. A jaw relationship record, as received from the dentist, is a cast-mounting template.

7.2.8. The technician constructs a wax trial denture on the record bases, using the prescribed denture teeth.

7.2.9. The dentist checks the trial denture in the patient's mouth for appearance and tooth contact relationships. The patient approves (or disapproves) the trial denture.

7.2.10. The technician makes all changes directed by the dentist.

7.2.11. After the patient and dentist approve the trial denture, the technician prepares it for investing. That is, the technician creates a uniformly thick palatal vault area and perfects the surface contours of the wax trial denture.

7.2.12. The technician creates a mold by flasking the wax dentures into denture flasks.

7.2.13. The technician removes the record base material and wax (boilout procedures) by heating and then separating the flasks and pouring boiling water over the cast to remove the wax.

7.2.14. The technician packs the molds with denture base resin and cures the resin.

7.2.15. The technician recovers cured dentures from the molds and remounts the dentures in the articulator to correct the occlusion.

7.2.16. The technician corrects processing errors (selective grinding).

7.2.17. The technician finishes and then polishes the dentures.

7.2.18. The dentist delivers the dentures to the patient.

7.3. Normal Denture Construction Procedures. The technician's role is to pour impressions, trim casts, and finish dentures as part of normal denture construction procedures.

7.3.1. In complete dentures, an impression is an accurate, negative likeness of a highly specific intraoral area.

7.3.2. A cast is a positive likeness poured from an impression. When pouring an impression, there is a serious potential for omitting important impression features. After the gypsum product used to pour a cast sets, it is customary to trim the excess. It is very crucial to discriminate between cast areas that are excess and areas that are important to the success of the denture.

7.3.3. After processing the dentures in resin on the casts, finish and polish the dentures, using highly abrasive substances. During finishing, be extremely careful not to inadvertently change the shape of a denture border. If this happens, it no longer corresponds to the original impression.

7.4. Relationships Between Impressions, Casts, and Dentures. Standard impression-cast-denture relationships are illustrated in Figures 7.1 and 7.2. For example, the buccal frenum of the mouth produces a buccal notch in the impression. When the impression is poured, a buccal frenum is visible on the cast. When the denture is made, the cast produces a buccal notch in the border of the denture.

7.5. Denture-Bearing Areas:

7.5.1. In the maxillary arch, the denture-bearing areas are the *residual ridge* and *hard palate.* The border extensions of a maxillary complete denture are limited by the *labial sulci, buccal sulci, pterygomaxillary notches,* and *vibrating line.*

7.5.2. The denture-bearing areas of the mandible are the *residual ridge, retromolar pads,* and *buccal shelves.* The border extensions of a mandibular complete denture are determined by the *labial sulci, buccal sulci, lingual sulcus, posterior extent of the retromylohyoid space,* and *posterior extent of the retromolar pads.* ***NOTE:*** The negative and positive likenesses of these anatomical landmarks must be maintained throughout the impression-cast-denture-process.

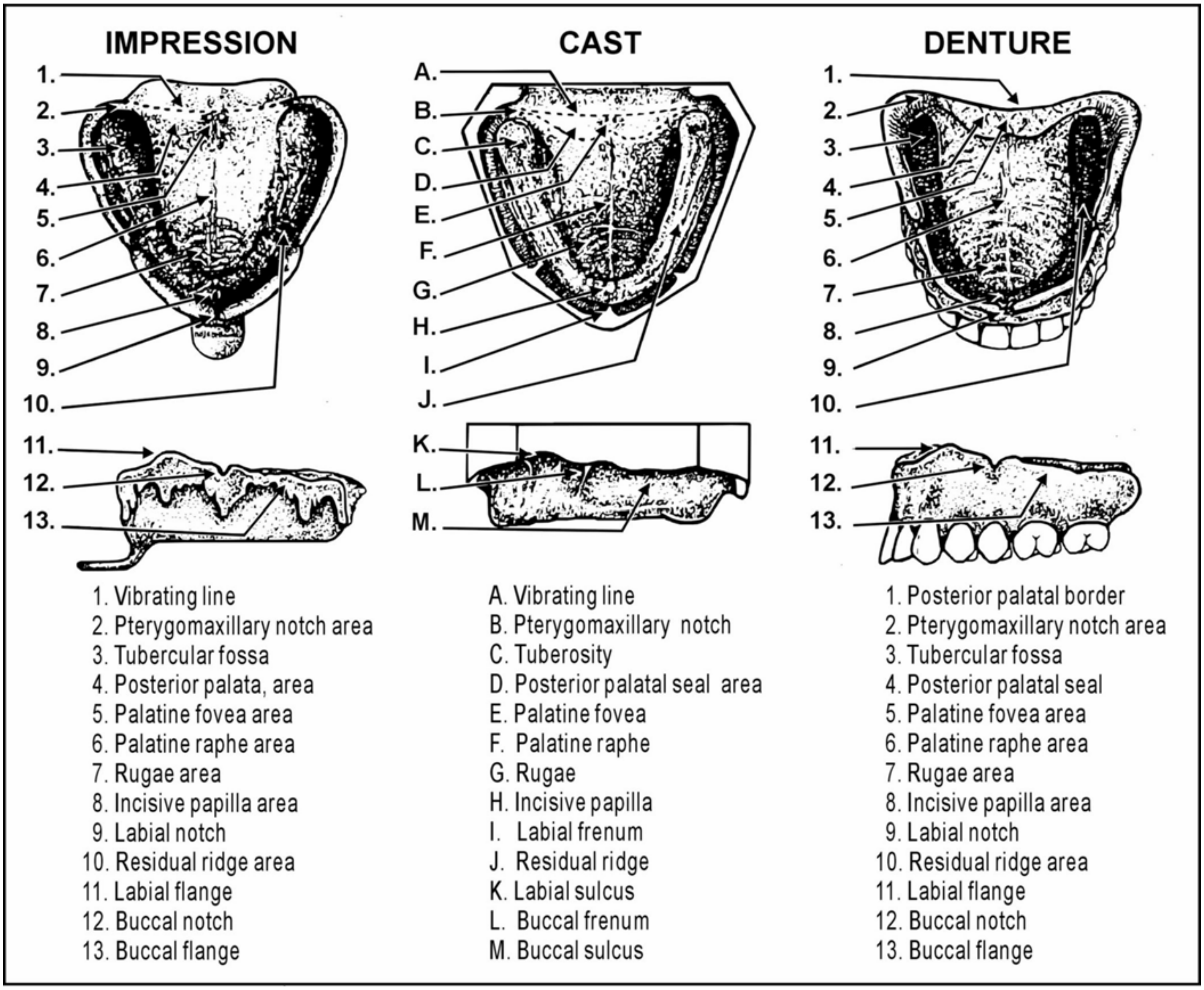
7.6. Muscles Shaping Impression Borders. The muscles responsible for shaping impression borders (flanges) are listed in Figure 7.3.

Section 7B—Functional Occlusions Organized for Complete Dentures

7.7. Complete Balance:

7.7.1. According to the fourth edition of the *Glossary of Prosthodontic Terms,* complete balance is "the simultaneous contacting of the maxillary and mandibular teeth on the right and left in the posterior and anterior occlusal areas in centric and eccentric positions, developed to lessen or limit a tipping or rotating of the denture bases in relation to the supporting structures." In simpler language, just about all of the teeth are supposed to be able to contact everywhere in centric occlusion and eccentric positions. In order to achieve this elusive ideal, dentures must be fabricated with a *compensating curve* (Figure 7.4).

Figure 7.1. Indentification of Maxillary Arch Impressions, Casts, and Dentures.

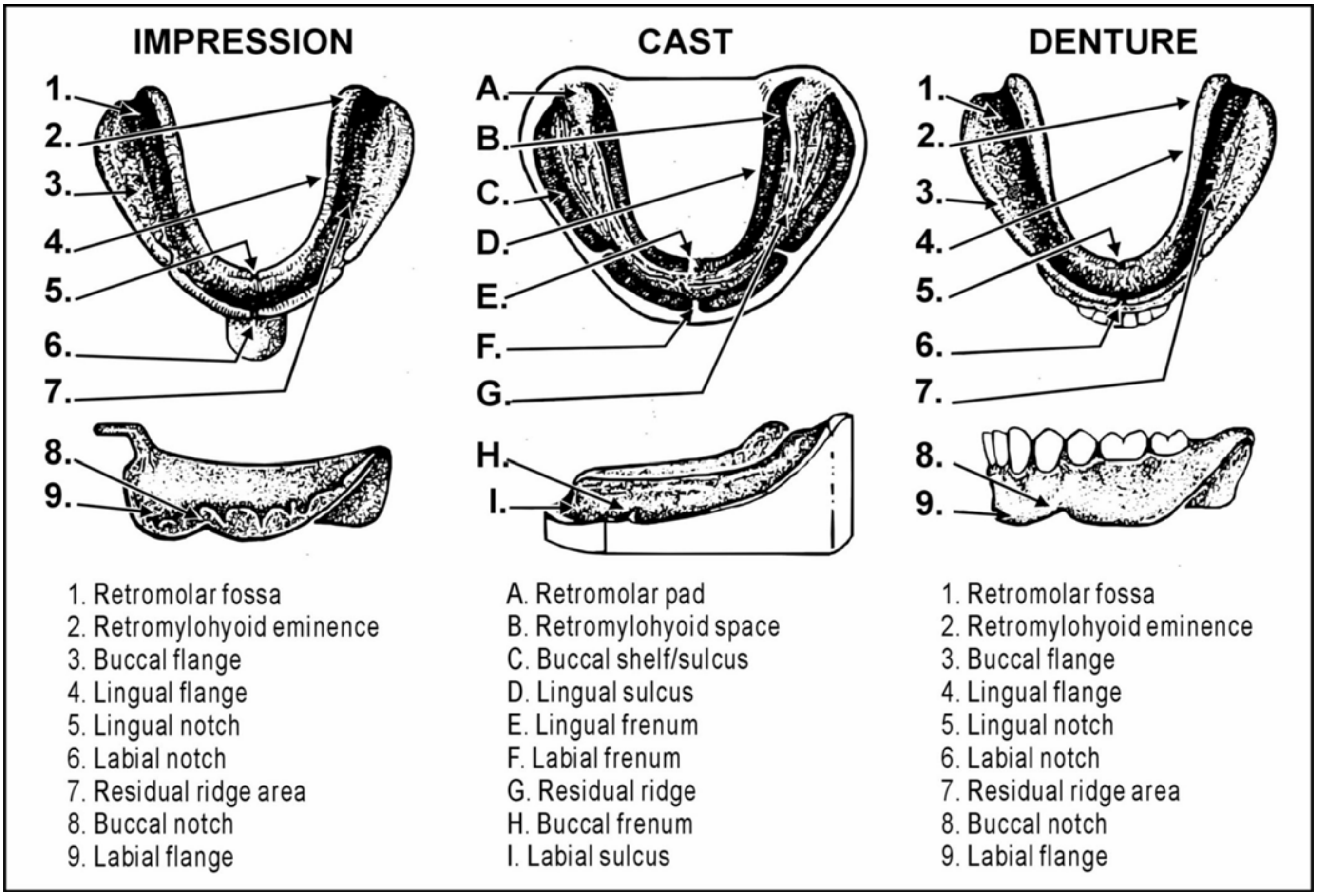


7.7.2. A compensating curve is an alignment of occluding surfaces and incisal edges along definite anteroposterior and lateral curvatures for purposes of developing complete balance in dentures. The lateral component of the compensating curve is called the *Curve of Wilson;* the anteroposterior component is called the *Curve of Spee*.

7.7.3. In practice, the place where the compensating curve begins varies with each dentist's personal denture philosophy. It also varies with the kind of posterior denture tooth used. For example, the curve used with one manufacturer's teeth starts in the first premolar region; a curve appropriate for a different tooth form begins in the first molar area. (When in doubt, read the directions.)

7.7.4. One major reason a compensating curve is necessary is the presence of the *Christensen's Phenomenon* (Figure 7.5). In this phenomenon, the condyles leave their fossae and move down the eminences until the incisors are edge to edge. If the compensating curve in a denture is shallow or absent, the descent of the condyles down the articular eminences shows up as a gap between the teeth posterior to the contacting incisors (Figure 7.5-B). The space is smallest anteriorly and becomes progressively greater posteriorly.

Figure 7.2. Indentification of Mandibular Arch Impressions, Casts, and Dentures.



7.7.5. Recall that the occlusal plane of natural teeth roughly conforms to the surface of a sphere. Then why are balancing side and posterior protrusive contacts usually absent in the natural dentition? There are many possible reasons. Part of the answer might be the existing curvatures are not pronounced enough to overcome the Christensen's phenomenon. Also, steep vertical overlaps between anterior teeth are very influential in causing separation of upper and lower posterior teeth, even though marked curvatures might be present. In Figure 7.5-C, enough of a compensating curve is present so most of the opposing teeth contact in protrusion.

7.8. Tooth Contact Characteristics of Completely Balanced Dentures. A completely balanced denture can be made using teeth with almost any cusp angle, from 0-degree through 33-degree teeth. However, most balanced complete dentures are made with *cusped teeth.*

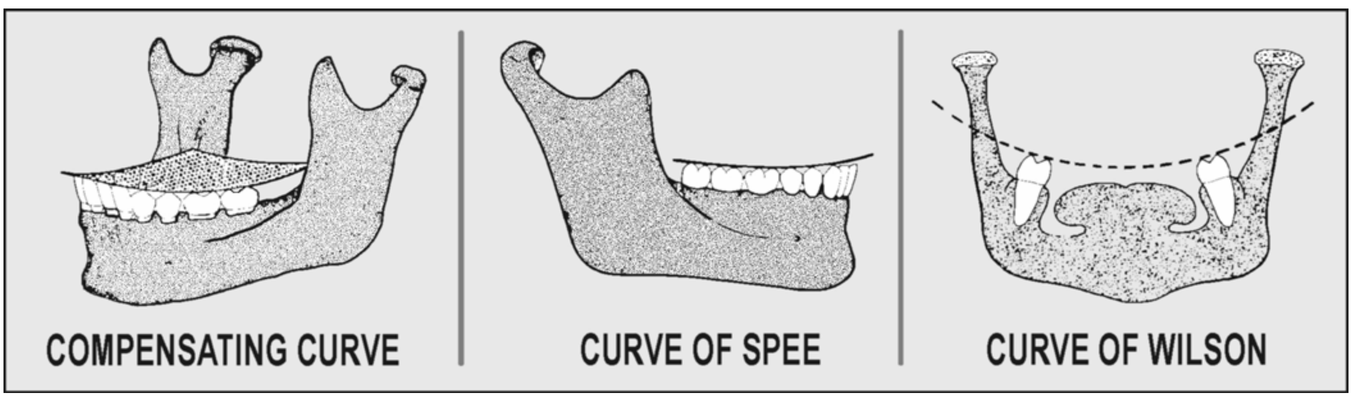
7.8.1. **Anterior Teeth.** In centric occlusion there is about 1 mm of vertical and horizontal overlap between the maxillary and mandibular anterior teeth.

7.8.2. **Working Side.** The maxillary and mandibular anterior teeth on the working side contact each other. The posterior teeth exhibit what is called *cross tooth balance,* which means the lingual inclines of the maxillary buccal cusps are in even contact with the buccal inclines of the mandibular buccal cusps and the lingual inclines of the maxillary lingual cusps are in even contact with the buccal inclines of the mandibular lingual cusps.

Figure 7.3. Muscles Responsible for Shaping Impression Borders.

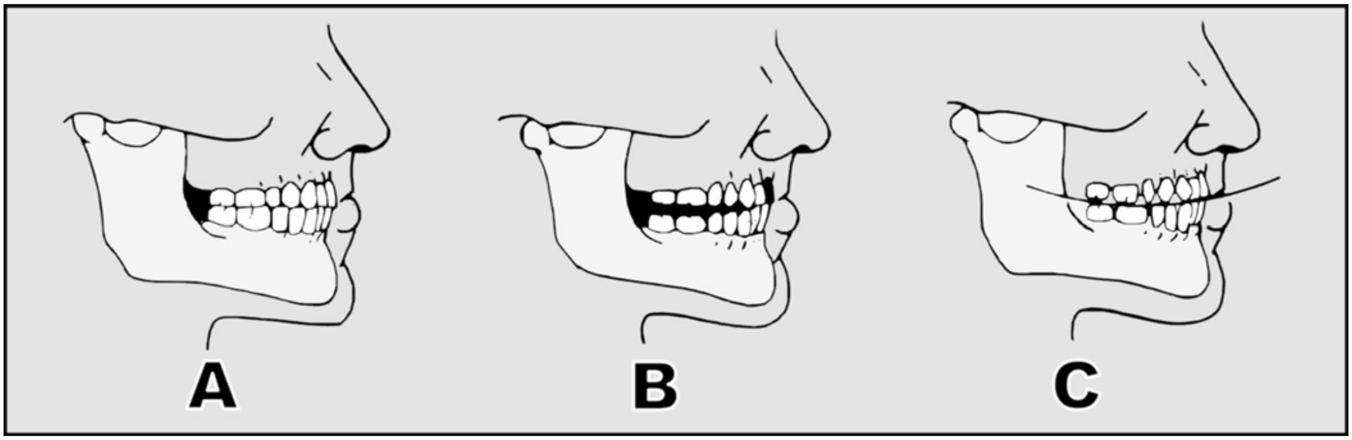
	Muscles	*Impression Feature*
MAXILLA	Orbicularis oris Levator labii superioris Levator anguli oris Zygomaticus Nasal Risorius	Labial flange
	Buccinator	Buccal flange
	Muscles of the Soft Palate	Vibrating line
MANDIBLE	Orbicularis oris Depressor labii inferioris Mentalis Depressor anguli oris Risorius	Labial flange
	Buccinator	Anterior 3/4 of the buccal flange
	Masseter	Posterior 1/4 of the buccal flange
	Mylohyoid and tongue	Anterior 2/3 of the lingual flange
	Palatoglossus and tongue	Posterior 1/3 of the lingual flange (retromylohoid eminence)

Figure 7.4. Compensating Curve.



7.8.3. **Balancing Side.** The buccal inclines of the m axillary lingual cusps are in even contact with the lingual inclines of the m   andibular buccal cusps, and there is no contact between upper and lower anteriors.

Figure 7.5. Christensen's Phenomenon.



7.8.4. **Protrusive.** When the incisors are edge to edge, the posteriors contact just short of a cusp tip to cusp tip relationship.

7.9. Advantages of Completely Balanced Dentures:

7.9.1. Cusped teeth look more natural than 0-degree teeth.

7.9.2. Cusped teeth seem to break up food better than nonanatomic teeth.

7.9.3. Balanced dentures are somewhat resistant to tipping forces. (When a denture "tips," one end pops up while the other stays down.)

7.10. Disadvantages of Completely Balanced Dentures:

7.10.1. Balanced dentures are more difficult to set.

7.10.2. Completely balanced dentures work well for patients with good ridges, but are not as effective for patients with poor ridges. Cusped teeth set for balance are expected to mesh well in centric occlusion. If a patient's residual ridge height is insufficient to support a balanced denture, lateral mandibular movement will cause the lower denture to dislodge and stay behind or the upper denture to lose its seal and travel with the laterally moving lower denture.

7.10.3. Precise records are required to accurately reproduce the mandible's movements on the articulator. This involves a more careful and time-consuming technique.

7.10.4. With balanced dentures and cusped teeth, there is an increase in lateral forces which can be detrimental to the residual ridges.

7.11. Nonbalanced Dentures. The only position in which tooth contacts are deliberately organized is in centric occlusion. Once the dentures leave centric occlusion, any contacts that develop in working, balancing, and protrusive excursions are present by chance. The contacts have not been intentionally programmed into the denture setup. This type of setup is primarily used when a single denture opposes natural dentition or a partially edentulous arch.

7.12. Using Cusped Teeth. In this type of setup, 20-degree (or less) posterior teeth are set along a modest compensating curve in the tightest centric occlusion possible. If an Angle's Class I molar relationship is indicated, there will probably be 1 mm of horizontal and vertical overlap between maxillary and mandibular anterior teeth. Little attention is paid to interferences that might arise in lateral excursions. The questionable value of the setup lies in the fact that, although it is easily and quickly done, these dentures tend to tip and slide in contact positions other than centric occlusion.

7.13. Monoplane Denture Setups Using 0-Degree or Nonanatomic Teeth. In this denture occlusion, 0-degree teeth (no cusps) are set on a flat plane (no compensating curve).

7.14. Tooth Contact Characteristics of Nonbalanced Dentures:

7.14.1. **Anterior Teeth.** In centric occlusion, anterior teeth normally have a vertical overlap of 0.0 mm and 1 to 2 mm of horizontal overlap.

7.14.2. **Working Side.** There are isolated, unprogrammed contacts among a few upper and lower teeth on the working side.

7.14.3. **Balancing Side.** On the balancing side, there is usually no contact between any of the upper and lower teeth.

7.14.4. **Protrusive.** When the incisors are edge to edge, there is no contact posteriorly.

7.15. Advantages of Monoplane Dentures:

7.15.1. Monoplane dentures are somewhat easier to set than completely balanced dentures.

7.15.2. A set of monoplane dentures function well in almost all patients and is the denture occlusion of choice for patients with poor ridges. A set of monoplane dentures minimizes lateral stresses on the residual ridge. Due to the absence of inclined planes, the ridges are subject to vertical pressures which are considered less damaging.

7.15.3. The monoplane principle is the denture occlusion of choice for Class II and Class III jaw relationships. It is also the denture occlusion of choice for crossbite cases.

7.16. Disadvantages of Monoplane Dentures:

7.16.1. The 0-degree teeth don't look as natural as cusped teeth.

7.16.2. The 0-degree teeth might not break up food as well as cusped teeth.

7.16.3. Monoplane dentures have more of a tendency to tip than balanced complete dentures. In fact, the lack of protrusive balance is a special invitation to tipping.

7.17. Lingualized Occlusion. This denture occlusion is very versatile and can use either the balanced or nonbalanced concept. Lingualized occlusion uses cusped maxillary posterior teeth set against 0-degree or shallow cusp mandibular posterior teeth. The maxillary lingual cusps acts as the major functioning cusp occluding onto the mandibular teeth.

7.18. Tooth Contact Characteristics of Lingualized Occlusion:

7.18.1. **Anterior Teeth.** In centric occlusion, the anterior teeth have a vertical overlap of 1 mm and a horizontal overlap of 1 mm.

7.18.2. **Working Side.** The maxillary and mandibular anterior teeth on the working side contact each other. In the posterior, only the lingual inclines of the maxillary lingual cusps are in even contact with the buccal inclines of the mandibular lingual cusps.

7.18.3. **Balancing Side.** On the balancing side, there is no contact between any of the maxillary and mandibular teeth in a nonbalanced setup. In a balanced setup, the buccal inclines of the maxillary lingual cusp contact the lingual cusp of the mandibular buccal cusp.

7.18.4. **Protrusive.** When the incisors are edge to edge, posterior contact is possible provided the Curve of Spee is properly formed.

7.19. Advantages of Lingualized Occlusion:

7.19.1. There is maximized cutting efficiency with minimized lateral forces (denture base slide).

7.19.2. There are improved esthetics over purely 0-degree posterior teeth arrangements.

7.19.3. Maxillary cusp teeth break up food better.

7.19.4. Lingualized occlusion has a limited amount of lateral forces due to the small area of contact between the maxillary lingual cusp and the 0-degree mandibular teeth during lateral excursions.

7.19.5. This occlusion can be used for a wide variety of residual ridge conditions.

7.20. Disadvantages of Lingualized Occlusion. Lingualized occlusion is a compromise between using anatomic and nonanatomic posterior tooth forms. In a nonbalanced setup, the dentures may still tip in contact positions other than centric occlusion due to the lack of balancing contacts.

Section 7C—General Rules for Pouring, Trimming, and Handling Casts

7.21. Impression Considerations To Obtain an Accurate Cast:

7.21.1. Always follow infection control guidelines when pouring and trimming a cast. (For information, refer to Chapter 1, Section 1D.)

7.21.2. Pour the impressions as soon as possible. Keep in mind that alginate impressions should be poured within 10 to 15 minutes after removal from the mouth and all impression materials are subject to distortion.

7.21.3. Remove the mucous film and debris from the surface of the impression with a gentle stream of body temperature water. Some manufacturers suggest “fixing” hydrocolloid impression materials before pouring. An impression made from agar may require fixing by immersing it into a 2 percent solution of potassium sulfate for 5 minutes. This fixing improves the surface detail and hardness of the cast. Most agar products now contain potassium sulfate (an accelerator for the gypsum setting reaction), and soaking is no longer required.

7.22. Pouring Casts:

7.22.1. Carefully follow the manufacturer’s directions when preparing a mix of gypsum product. The *water-to-powder ratio* is absolutely critical. Because gypsum products are easily contaminated by moisture, preweigh them into convenient amounts and store them in airtight containers. Alternatively, purchase preproportioned, sealed packets of gypsum.

7.22.2. Use a proper separator, such as super sep, when pouring one gypsum material against another.

7.22.3. Remember, the primary objective when pouring a cast is to capture all surface detail of the impression in as bubble-free a manner as possible. Use a vibrating table to make a thick, gypsum mix flow into all of the crevices of the impression (Figure 7.6). The usual practice is to pour a small amount of the gypsum product into a corner of the impression and let it slowly advance to the other side.

Figure 7.6. Pouring a Typical Impression.

7.22.4. After covering the entire surface of the impression, progressively larger amounts of the mix may safely be added. There is a rate of vibration that is best for the characteristics of each mix of gypsum and type of impression material. The vibration intensity should be set high enough to make the material move across the surface of the impression. The vibrator is set too high if the impression "jumps" in your hand, if the mix moves so fast it skips over surface detail, or if vibration wave patterns develop on the surface of the mix which can cause entrapment of air.

7.23. Separating, Trimming, and Storing Casts:

7.23.1. Separate a cast from an impression after the heat generated by the final setting reaction dissipates completely (about 45 minutes after pouring). If a cast is not separated from an *alginate* impression before the alginate shows signs of dehydration, the cast will probably show unacceptable surface damage. Do not allow a poured cast to stand in an alginate impression for more than 1 hour.

7.23.2. For a modeling plastic impression (commonly called compound), uniformly heat the material in a water bath (140 ^{o}F) until it softens before attempting to separate the cast from the impression.

7.23.3. Do not trim a cast for at least 2 hours after it has reached the final set.

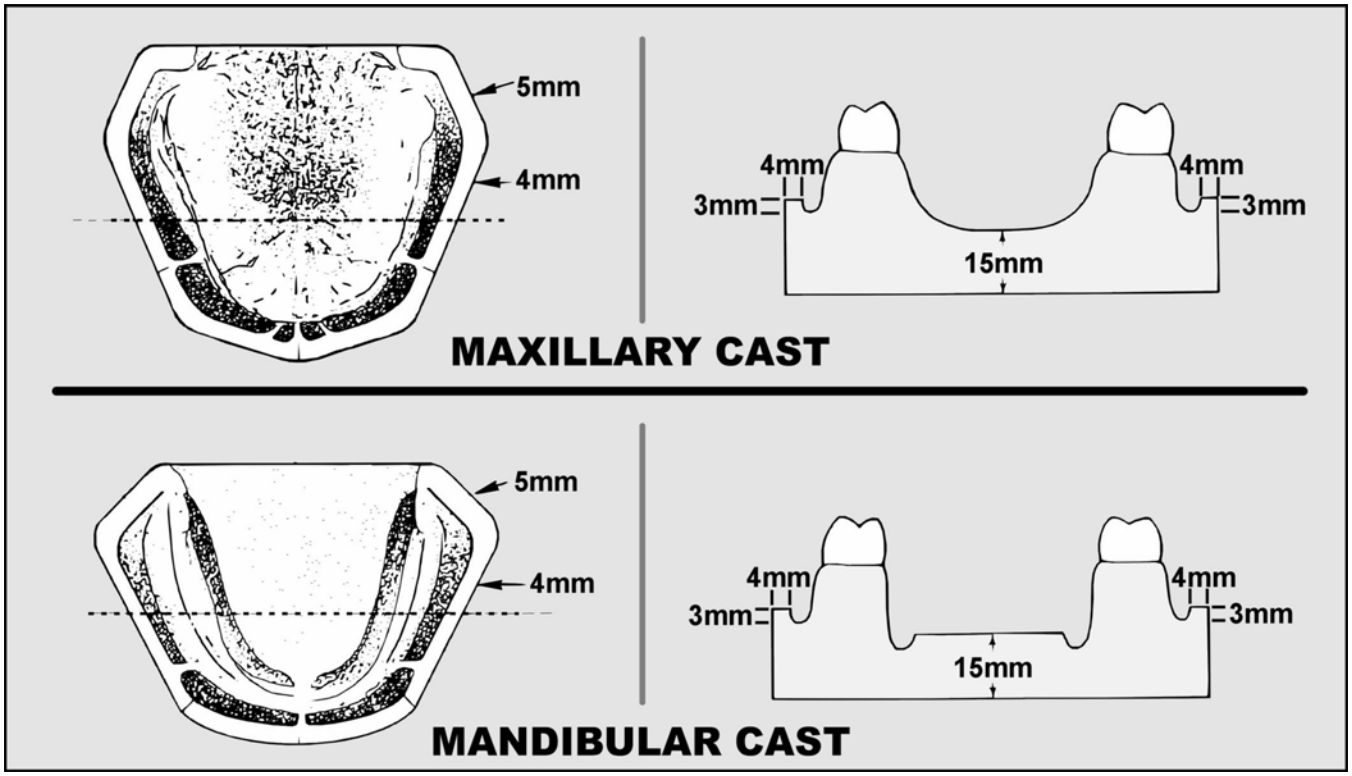
7.23.4. Rinse the cast in a container of saturated calcium sulfate dihydrate solution (SDS) trimming procedure. Never trim a dry cast on a wet model trimmer because the slushy debris coming off the trimming wheel falls on the dry surface and becomes permanently attached to the cast surface. *Use only SDS for soaking or rinsing casts.*

7.23.5. Make sure the cast includes all of the denture support areas and features that define denture borders. Keep the cast free of nodules or voids. When trimming a maxillary cast, follow the general shape shown in Figure 7.7. Cut mandibular cast to correspond with the shape shown in the same figure. Fully represent the sulci areas in the cast, but not more than 3 mm deep. The sulci are routinely protected by a peripheral "land" area or ledge extending 4 mm outward.

7.23.6. Make sure the cast extends 5 mm beyond the ptyerygomaxillary notch areas of the maxillary arch and 5 mm beyond the retromolar pads of the mandibular arch. A cast should be about 15 mm (5/8 inch) thick at its thinnest area (usually the palatal vault of the upper and the tongue space region of the lower).

7.23.7. Store the cast in a safe place to prevent damage.

Figure 7.7. Trimming Maxillary and Mandibular Casts.



7.24. Preliminary Impressions:

7.24.1. Impressions are made by carrying a suitable impression material to the mouth of the patient in a specially shaped container (impression tray). There are two basic kinds of impression trays; *prefabricated* and *custom.*

7.24.2. Prefabricated trays are available in a range of types, shapes, and sizes. Figure 7.8 contains two types--maxillary rimlock (on the left) and maxillary edentulous (on the right). All preliminary impressions are made in prefabricated trays. Technicians make custom trays on preexisting casts. Dentists make preliminary impressions as a first step in many prosthodontic treatment plans. Because casts made from these impressions (diagnostic casts) are used to evaluate the patient's dental problems (diagnosis) as well as to make custom trays, these casts must be made as accurately as master casts.

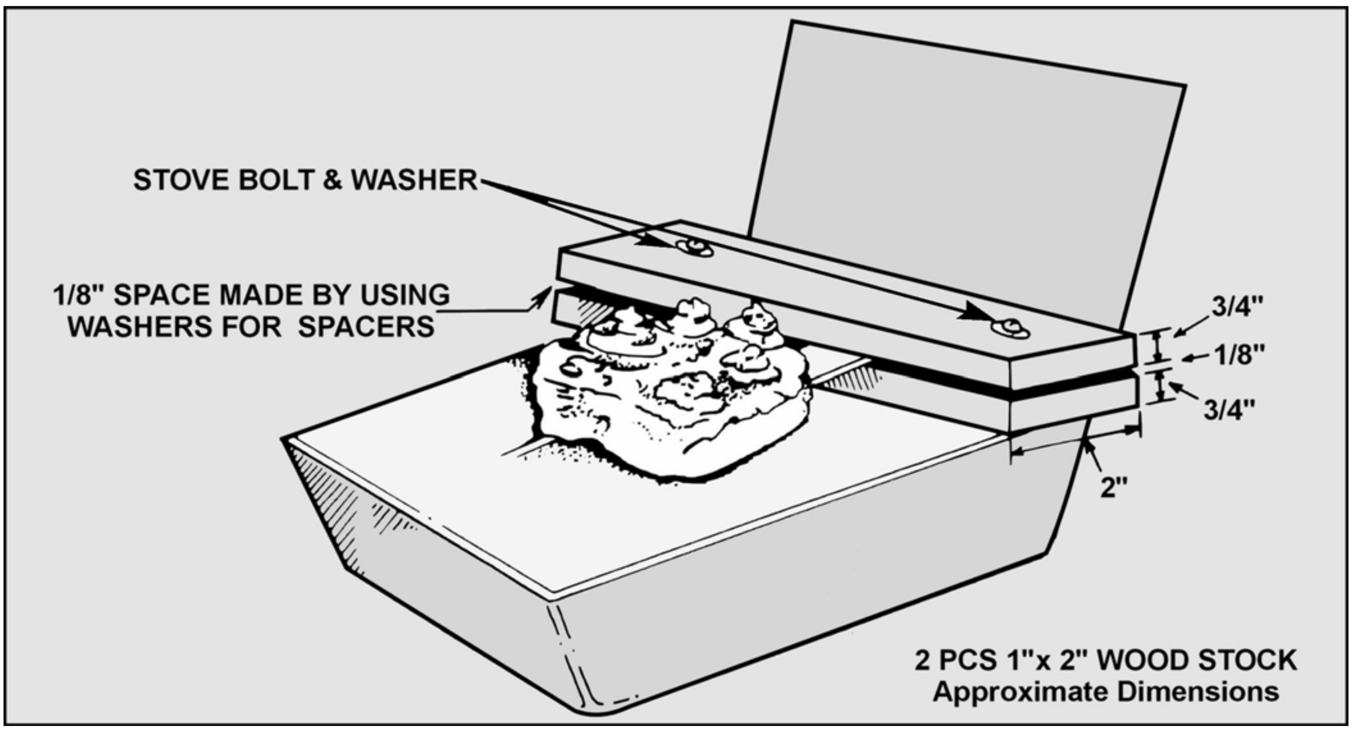
7.24.3. Alginate is the material used to make preliminary impressions. Alginate impressions brought into the laboratory should be poured immediately after disinfection is completed. Alginate impressions begin to distort within 10 to 15 minutes after the material is removed from the patient's mouth. Placing the impression in a 100 percent humid atmosphere (humidor) may retard the distortion. Even if a humidor is available, an alginate impression should be poured within 10 minutes after it is made.

7.25. Two-Step Method of Pouring a Diagnostic Cast:

7.25.1. To help prevent distortion caused by pressure from its own weight, a poured impression may be suspended by the handle from a tray holder (Figure 7.9). In a two-step method, pour the anatomic portion first; then add the base as a second step (Figure 7.10).

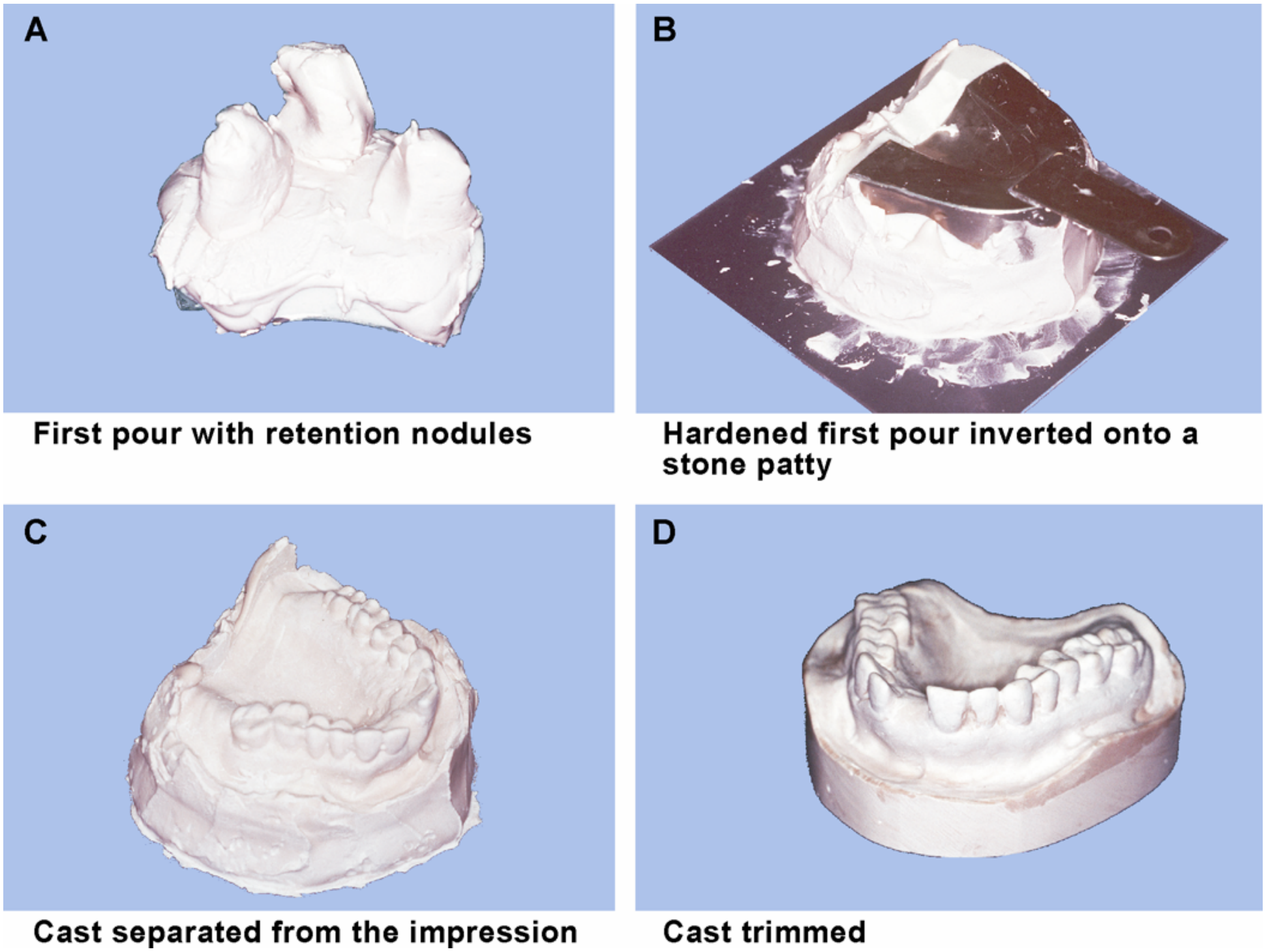
Figure 7.8. Two Types of Prefabricated Trays.

Figure 7.9. Tray Holder.



7.25.2. For the first step, fill the anatomical portion of the impression as described above, to include full-border coverage. To guarantee a union between the two pours, leave nodules and roughened peaks on the surface of the first pour. After the final set, wet the first pour with SDS and invert it into a newly mixed mound of the same material. While it is still soft, shape the mound to the desired size and thickness. This second step forms a base. Build up a base thickness of about 18 mm (1/4 inch). Overbuild the base to compensate for trimming reductions. Separate and trim the cast as previously directed.

Figure 7.10. Two-Step Method of Pouring a Cast.



7.25.3. In a mandibular impression, the second pour tends to creep up over the lingual flanges and lock the tray into the hardened mix. A tray is difficult to remove under these conditions, and the cast may be ruined in the process. To prevent this problem, invert the first pour onto the second mix of material without letting the tray become buried. While the material is still soft, flatten and shape the tongue area of a mandibular impression so the area is relatively smooth and is about 1 mm above (occlusal to) the lingual sulcus.

7.26. One-Step Method of Pouring a Diagnostic Cast. There are quicker ways of pouring diagnostic casts than the two-step method as follows:

7.26.1. Impressions must never be poured, then inverted into a mound of gypsum material to form the entire cast in one step. The material tends to settle toward the base while it is setting, leaving the softer material toward the anatomic areas of the cast, producing a marginally adequate cast. The gypsum mix has a tendency to fall away from important impression borders, and the potential for soft cast surfaces can be greater. In addition, it is difficult to control the thickness of the base and the orientation of the anatomic portion to the base.

7.26.2. An impression may be filled with a mix of gypsum product with enough material stacked up for a base right on top (sometimes called the "upright method"). This technique is more successful with maxillary than with mandibular impressions.

7.26.3. Some dentists request a "high mount" pour of the diagnostic cast. In this method, the impression is poured similar to the upright method, making sure the first pour is at least 15 mm thick in the dentulous areas and 10 mm thick over edentulous areas. Large retention nodules are placed, but no attempt is made to develop a base. After final set and separation of the cast, the retention nodules are flattened slightly. This method is usually used when the dentist will be using the casts to make a diagnostic mounting and will have no need to remove the casts from the mountings.

7.26.4. In general, though, it is best to depend on the two-step method. It will save time in the long run by ensuring the best cast quality.

Section 7D—Custom Trays

7.27. Overview:

7.27.1. Prefabricated trays are made to fit everyone moderately well, but these trays fit no one perfectly. On the other hand, a custom tray provides an impression material carrier which helps the dentist make a more accurate impression than he or she could make by using a stock (prefabricated) tray.

7.27.2. The custom tray is made on a diagnostic cast. The dentist draws the border outlines of the proposed custom tray on the diagnostic cast and gives other design directions (such as handle position, amount and placement of wax spacer if required, and the need for vertical stops). The tray is then made to conform to the design.

7.27.3. Some of the more popular ways of making custom trays are the *self-curing resin dough method* (paragraph 7.28), *vacuum method* (paragraph 7.29), and *light cured material method* (paragraph 7.30).

7.28. Self-Curing Resin Dough Method. This is a bulk method for using resin as opposed to "sprinkle on" methods.

7.28.1. **Preparing the Cast.** First, use baseplate wax to generously fill in all undercuts within the tray area outlined on the cast (Figure 7.11-B). Next paint the cast with two layers of tinfoil substitute to prevent the acrylic resin from sticking.

7.28.2. **Molding the Dough.** Use a simple stone mold to control the shape and thickness of the resin dough (Figure 7.12). This preshaped resin mass results in a tray of consistent quality when adapted to the cast. Once made, the mold may be used indefinitely. Making a mold is a simple procedure following the steps as outlined below:

7.28.2.1. Using two sheets of athletic mouthguard material, cut one sheet the shape of a maxillary arch to include the palate. Cut the other sheet the shape of a mandibular arch not including the tongue space.

7.28.2.2. Place each of the sheets of athletic mouthguard on a slab and pour gypsum 15 mm (5/8 inch) thick over the material to include the edges.

7.28.2.3. Remove the mouthguard material after the stone mix sets and lightly petroleum the recesses.

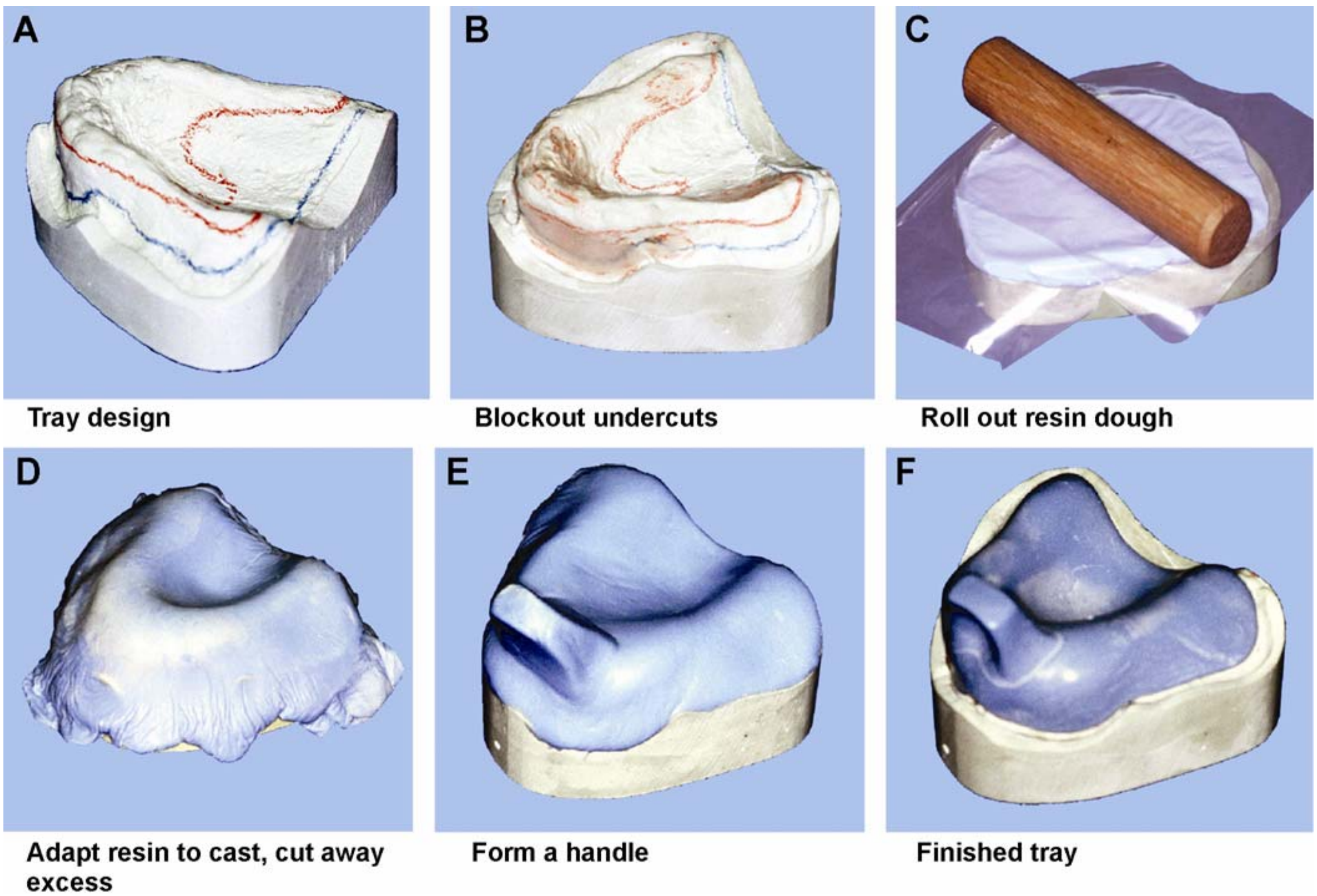
7.28.2.4. Cut a 6-inch length of 1-inch diameter dowel to use as a roller.

7.28.3. **Fabricating the Tray:**

7.28.3.1. Mix the monomer and polymer components of the autopolymerizing resin. Always follow the manufacturer’s monomer-polymer proportioning directions. Allow the mix to set until it reaches a dough-like consistency.

7.28.3.2. Always wear gloves when handling acrylic resin. Lightly coat the glove fingers with petrolatum before handling the dough. Also ensure that the mold is coated with petrolatum. When resin becomes doughy, remove from mixing container and quickly kneed the dough to ensure thorough mixing of the polymer and monomer. Place the resin into the stone mold. Cover the resin with a polyethylene sheet, and then roll out the resin to match the mold’s shape and thickness (Figure 7.11-C).

Figure 7.11. Fabricating a Maxillary Custom Tray (Autopolymerizing Resin).

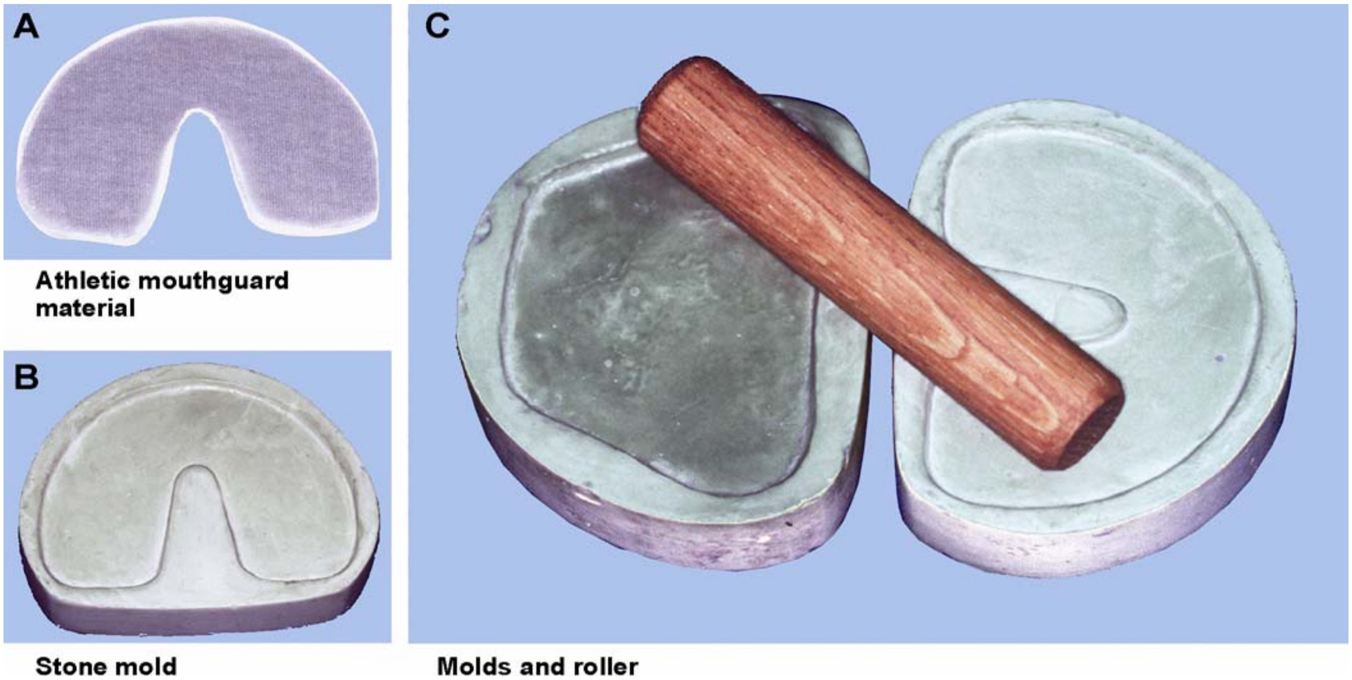


7.28.3.3. Trim away any excess dough and lift the acrylic resin blank from the mold. Store excess acrylic in a jar to use later for fabricating a tray handle.

7.28.3.4. Center the resin over the cast and rapidly adapt the dough to the cast’s surfaces (Figure 7.11-D). Be careful not to create thin spots by pressing too hard. Shape the resin to the borders and cut away the excess with a sharp knife.

7.28.3.5. Attach a handle to the tray (Figure 7.11-E). Ensure the handle is strong enough to withstand considerable force and its shape *does not interfere with lip movements.* If you work fast enough, you should be able to use the unpolymerized excess from the first mix for the handle. If not, mix another small amount of tray resin. When polymerization reaches the dough stage, *form it into an “L.”* Use a few drops of monomer to moisten the attachment site between the handle and the tray. Press the base of the handle onto the moistened area. The fluid monomer should provide good bonding.

Figure 7.12. Baseplate Mold for Autopolymerizing Resin Material.



7.28.4. **Finishing the Tray.** After the acrylic resin has set, remove the tray from the cast. The posterior border of a maxillary custom tray is supposed to extend a short distance onto the soft palate. Mandibular custom trays cover the retromolar pads. Trim the tray's flanges back to the dentist's peripheral border markings. Use an arbor band to remove bulk. Use acrylic finishing stones and burs for finer details. Make sure there are no sharp edges on the tray's borders. ***NOTE:*** Making custom trays from autopolymerizing resin dough gives excellent results. Made this way, the trays are rigid and dimensionally stable. Most of the time, this is the preferred method.

7.29. Vacuum Method. The vacuum method (Figure 7.13) is a viable alternative to the autopolymerizing resin dough method.

7.29.1. **Equipment and Materials.** For this procedure, use a unit capable of vacuum-forming a plastic sheet (thermoplastic vinyl resin). (The commercially available OMNIVAC® unit falls in this category.) Plastic sheets come preformed to fit the machine and in color-coded thicknesses appropriate for different purposes. Custom trays are made from *extra weight* (0. 125 inch) tray material.

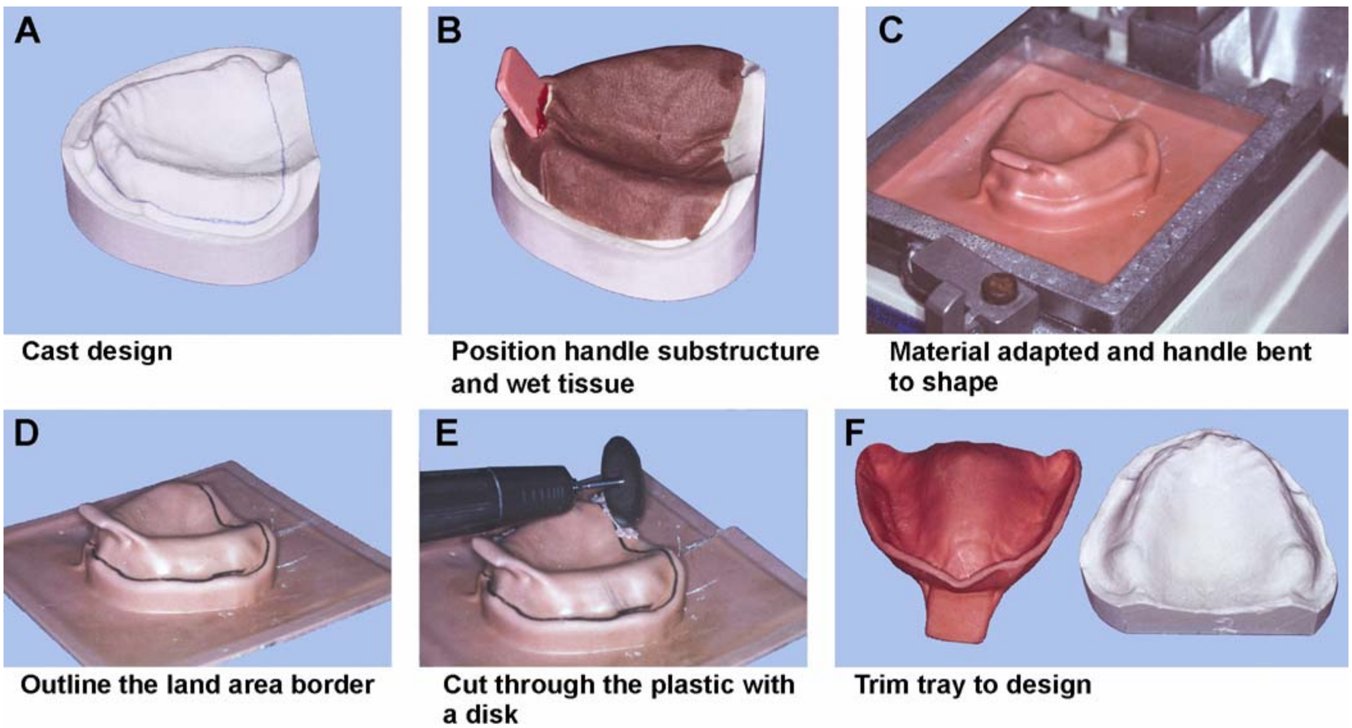
7.29.2. **Cast Preparation.** For a handle, cut a scrap piece of tray material 1-inch long and 1/2-inch wide and round off the corners on one end. Attach the square end to the cast surface with sticky wax. Place it on the anterior residual ridge in the midline and stand it up perpendicular to the cast (Figure 7.13-B). Thoroughly wet the cast with SDS. Block out all undercuts with wet tissue.

7.29.3. **Tray Formation.** Place a sheet of tray material in the sliding carriage of the OMNIVAC and raise the carriage completely. Switch on the heating element and position it directly over the tray material. Place the cast on the vacuum base. When the plastic sheet sags about 1 inch, turn on the vacuum motor. Lower the sliding carriage and bring the tray material down over the cast

(Figure 7.13-C). Swing the heating element aside. Position the impression tray handle at an angle that is 45 degrees to the base of the cast. Turn off the heating element. When the tray material is cool, turn off the vacuum motor.

7.29.4. **Tray Finishing.** Draw a line on the tray material indicating the outer edge of the cast's land area (Figure 7.13-D). Use a separating disc to follow the line and cut through the plastic to the cast (Figure 7.13-E). After completing the cut, separate the tray and the cast from the excess. Lift the tray off the cast. For mandibular trays, use the separating disc to cut away the bulk of the tongue space. ALWAYS WEAR SAFETY GLASSES WHEN USING A SEPARATING DISC. Use an arbor band to trim the border of the tray down to the design. Use an acrylic finishing stone to round the edges. Clean away any remaining tissue or sticky wax.

Figure 7.13. Custom Tray Fabrication by the Vacuum Method.



7.30. Light-Cured Material Method. Light-cured materials are becoming popular because of their ease of use and quickness in making a tray.

7.30.1. A light curing unit is needed to thoroughly cure the material. Materials come prepackaged for consistent size and thickness. The Dentsply International® Triad system is a complete light-cured system for making custom trays.

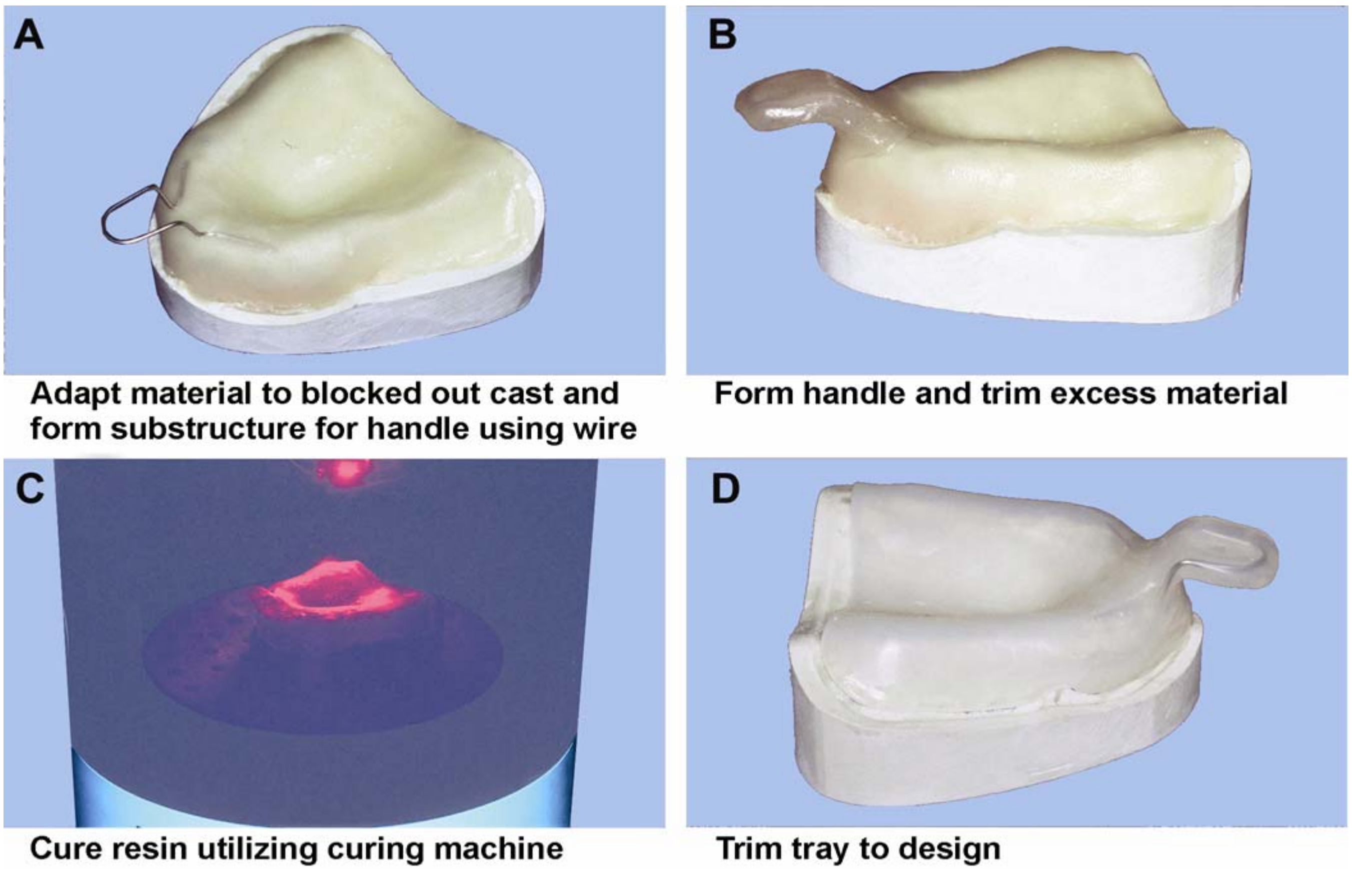
7.30.2. Block out cast undercuts with wax or molding compound. Then apply a separator to the cast.

7.30.3. Adapt the tray material to the cast, being careful not to create any thin areas. Once the tray material is removed from the manufacturer's package, the working time of the material begins. Light in the working area will start the curing process. Position the wire support for the handle in the uncured tray (Figure 7.14-A). Add the material around the wire support to form a tray handle (Figure 7.14-B).

7.30.4. Cure the tray in a light-curing unit for two minutes (Figure 7.14-C). Remove the tray from the cast and apply the manufacturer's air barrier coating on all sides. Cure the tray for an additional 8 minutes.

7.30.5. Finish the tray to the design line with carbide burs, ensuring the peripheral border is smooth and has no sharp edges (Figure 7.14-D). The tray may also be perforated to help retain the impression material.

Figure 7.14. Custom Tray Fabrication by the Light-Cured Method.



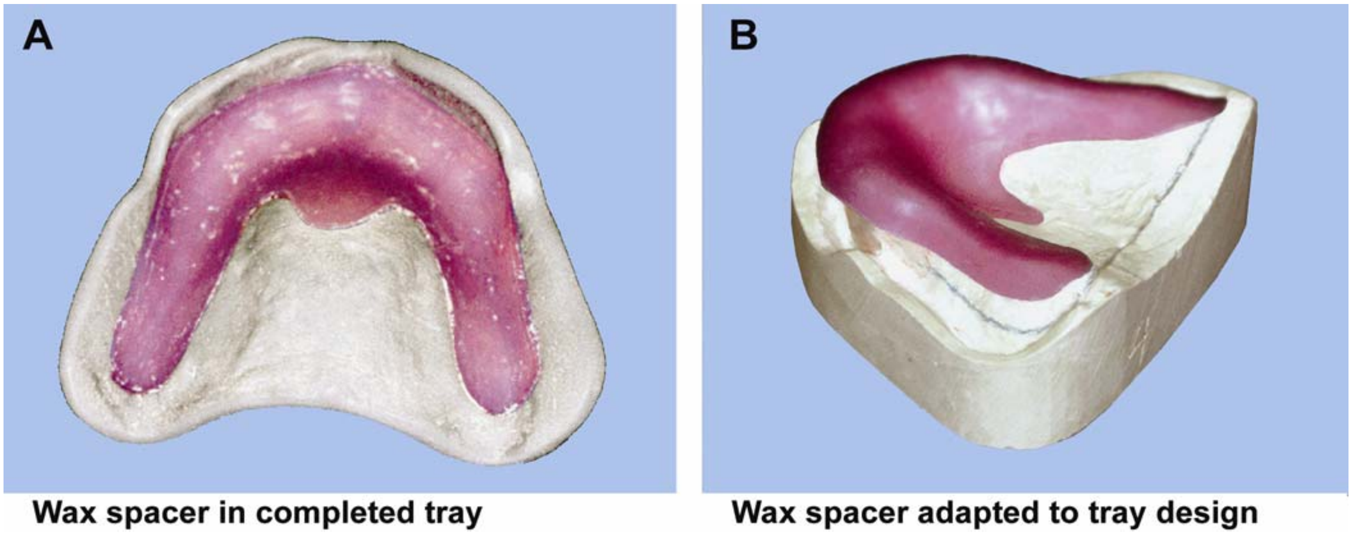
7.31. Custom Tray Spacer Modifications. In the preceding technique descriptions (paragraphs 7.28 through 7.30), the trays were closely adapted to the diagnostic cast. However, more often than not, the dentist prefers a tray that provides room for controlled thickness of impression material (Figure 7.15). *Spacers* used to develop tissue *stops* accomplish this purpose. The stops are made to hold the tray off the cast by a distance equal to the thickness of the spacer. When the spacer is removed and the tray is placed in the patient's mouth, the stops hold the inner surface of the tray out of contact with the patient's tissue. The space between the tray and the tissue is filled with a very accurate, relatively fluid impression material called a *wash* (such as zinc oxide and eugenol paste) or rubber base.

7.31.1. **Self-Curing Resin Trays:**

7.31.1.1. Adapt a layer of baseplate wax to the blockout design line on the diagnostic cast after you fill in the undercuts. If prescribed, cut out four small pieces of the baseplate wax over the crest of the ridge at areas outlined in the molar and canine regions.

7.31.1.2. Apply a tinfoil substitute to the gypsum surfaces of the cast to prevent the acrylic resin from sticking. Apply a *thin* layer of petroleum to the surface of the baseplate wax to make removing the wax from the polymerized tray easier. Use the self-curing dough method to make the tray.

Figure 7.15. Custom Tray Wax Spacer.



7.31.1.3. After the resin is hard, remove the tray from the cast and pull the baseplate wax off the tissue surface of the tray. Some dentists may require the blockout wax to remain in the tray until the final impression is taken. If tissue stops are used, they should appear on the ridge areas where the four pieces of baseplate wax were originally cut out. Trim any excess acrylic resin to the outline border on the cast. Round and smooth the borders of the tray.

7.31.1.4. Be sure to clean away all traces of petrolatum that might be present on the tissue surface of the tray. Shellblasting does this very effectively.

7.31.2. **Vacuum-Formed Trays:**

7.31.2.1. As described in paragraph 7.29.2, use sticky wax to attach the handle to the dry cast. Fill in the undercuts with wet tissue or some other heat-resistant substitute. Adapt one or two layers of wet tissue (about 2 mm thick) to the cast surfaces, including the peripheries. If prescribed, cut four tissue stops through the tissue layer (down to the cast) and place the stops in the second molar and canine regions.

7.31.2.2. Operate the OMNIVAC or similar unit. As soon as the carriage is dropped, use a blunt instrument to adapt the tray material into the tissue stops. Cut away the excess tray material, remove the tray from the cast, and trim it to predetermined borders.

7.31.3. **Light-Cured Tray Method:**

7.31.3.1. Adapt a layer of baseplate wax to the blockout design line on the diagnostic cast after you fill in the undercuts. If prescribed, cut out four small pieces of the baseplate wax over the crest of the ridge at areas outlined in the molar and canine regions. Adapt the tray material to the cast. Position wire support for handle then cure tray for 30 to 45 seconds to "set" the material.

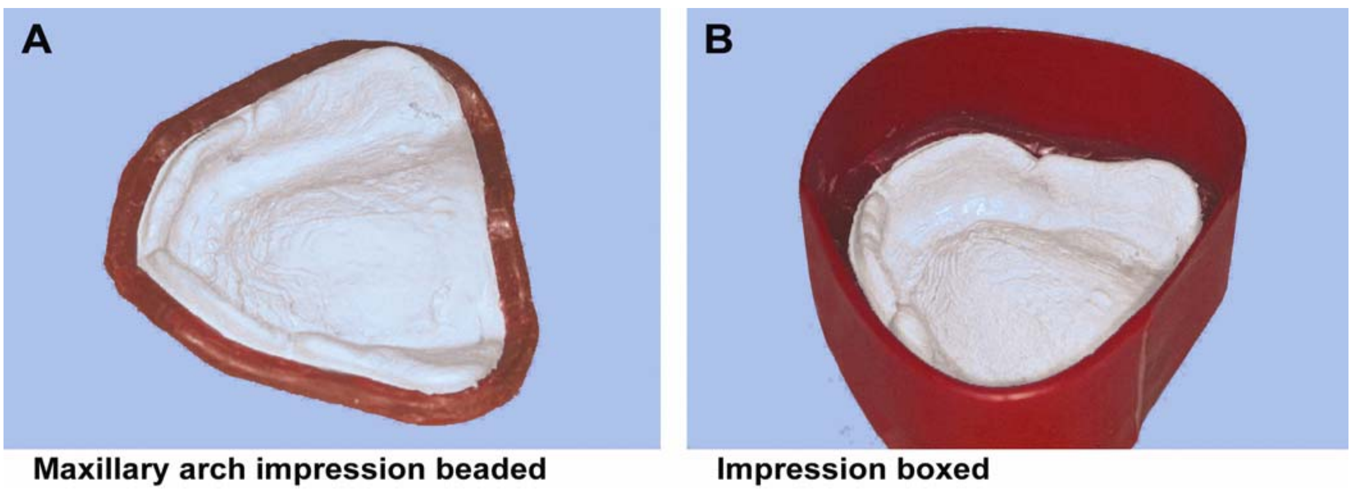
7.31.3.2. Separate the tray and remove wax spacer. This will prevent melting the wax in the curing unit. Add material for the handle and cure tray for 2 minutes. Apply the manufacturer's air barrier coating and cure tray for an additional 8 minutes. Finish the tray to the design line.

Section 7E—Master Casts

7.32. Overview. The dentist uses the custom tray to make a final impression of the patient. In most cases, final, complete denture impressions are boxed before pouring the master cast. *Boxing* the impression represents a way of confining the flow of the stone to control the shape, thickness, and density of the cast. This is the best method to make sure that all peripheral borders are complete. There are several ways to box an impression. The method selected depends on the kind of wash material the dentist used. (See paragraphs 7.33 and 7.34.)

7.33. Wax Bead, Box, and Pour System. This method (Figure 7.16) can be used with all final impression materials, but is particularly suited for elastic materials such as zinc oxide and eugenol paste or impression plaster.

Figure 7.16. Wax Bead, Box, and Pour System.



7.33.1. **Maxillary Impression:**

7.33.1.1. Carefully adapt a strip of utility wax around the impression (3 mm from the edges of the flanges.) Extend the wax strip across the posterior border, about 6 mm behind the vibrating line. Make the beading on one side continuous with the beading on the other. Lute (seal) the wax to the tray with a hot spatula. To avoid possible damage to the impression, seal the beading to the tray from the side *opposite* the flange edges.

7.33.1.2. Build a sidewall around the circumference of the beading to provide an enclosure or "box" into which artificial stone can be poured. Make the sidewall of boxing wax or baseplate wax cut wide enough to extend 15 mm (5/8 inch) above the highest point on the impression. Just as you sealed the beading to the tray from the side opposite the flange edges, do the same when you lute the boxing material to the beading. Water test the assembly for leaks by filling the impression with water. The maxillary final impression is now boxed and ready for pouring.

7.33.2. **Mandibular Impression:**

7.33.2.1. Box the mandibular impression the same way you boxed the maxillary impression. ***EXCEPTIONS:*** From the distal 1/3 of the buccal flange, across the posterior border of the retromolar fossa, and down to the retromylohyoid eminence on each heel, use two thicknesses of utility wax to provide an adequate land area on the resultant cast.

7.33.2.2. Continue the beading wax around the outline of the lingual area 3 mm distant from the edges of the lingual flanges. Fill in the lingual area with baseplate wax luted to the beading. After the impression is boxed, test it for leaks and pour the cast.

7.34. Plaster-Pumice Matrix, Box, and Pour System:

7.34.1. **Overview.** The small amount of force used to mold boxing material around a utility wax bead sometimes alters the shape of a final impression made with an elastic impression material. The plaster-pumice matrix, box, and pour system is appropriate for boxing any kind of final impression, but is particularly suited when using an *elastic impression material*. The matrix is composed of equal volumes of plaster and coarse pumice. Pumice is incorporated into the plaster to weaken the matrix and make separation of the poured cast easier. It is this matrix that supports the tray and edges of a final impression made with an elastic impression material of rubberbase, silicone, etc.

7.34.2. **Maxillary Impression:**

7.34.2.1. With a small piece of clay, support the tray about 12 mm (1/2 inch) off the surface of the table. Take the tray with the attached clay and put it aside. Stack a slushy, yet cohesive, mound of the 50/50 plaster pumice mix on a flat, nonabsorbent surface. Make the patty about 12 mm larger than the diameter of the impression. Place the impression and clay stop into the patty *tissue side* up.

7.34.2.2. Manipulate the matrix mix so 1.5 mm of flange height is visible all the way around, exposing at least 6 mm of the impression's surface posterior to the vibrating line. Ensure enough of the matrix mix remains around the circumference of the impression to create a ledge at least 8 mm wide.

7.34.2.3. Let the matrix achieve initial set. Hold a razor-sharp blade at right angles to the flanges and carefully (and uniformly) cut to expose 3 mm of the flanges. After the matrix reaches final set, trim a 6 mm land area around the circumference with a cast trimmer.

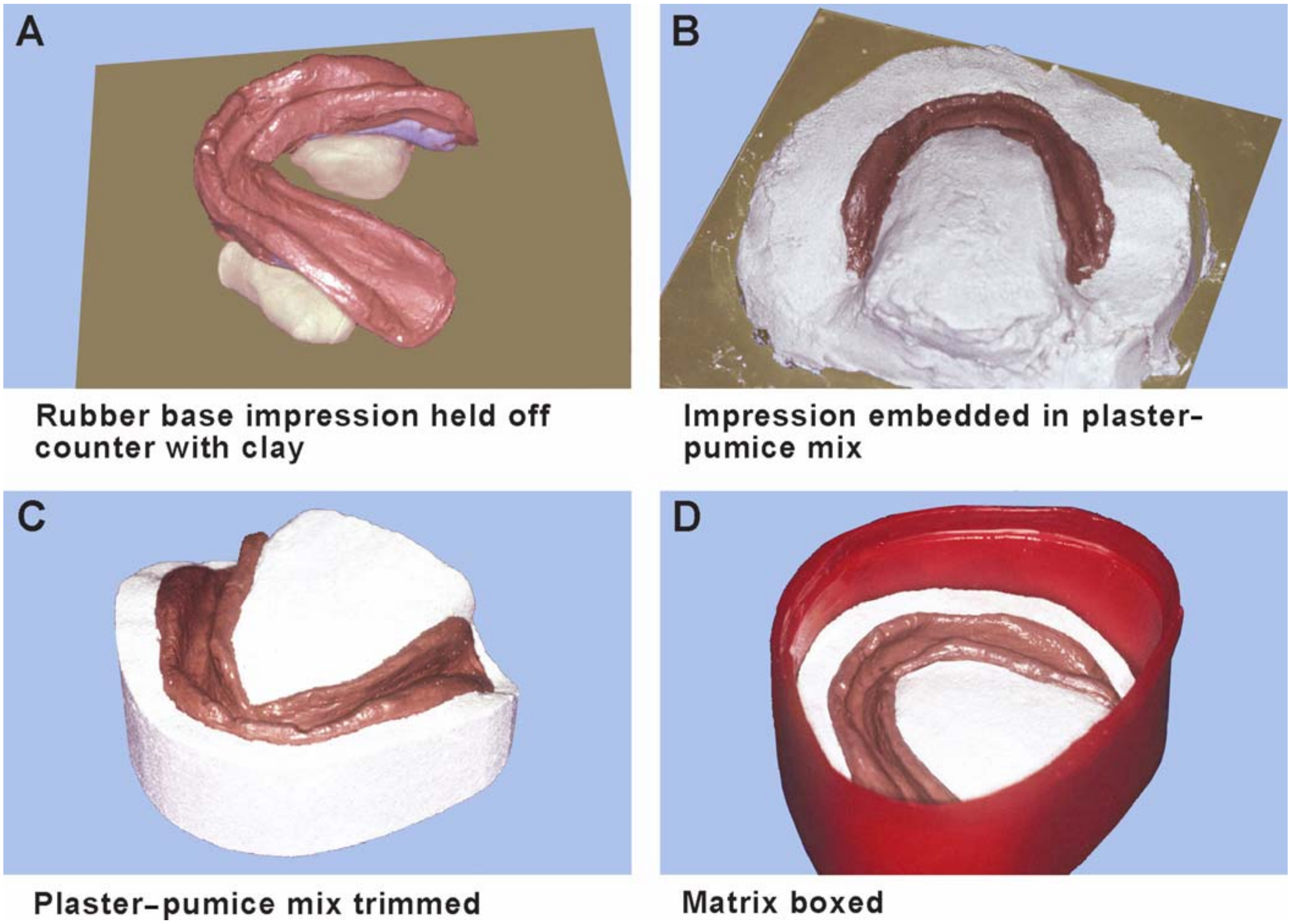
7.34.2.4. Paint the land area with two coats of a suitable stone to stone separator such as Super Sep®. Wrap the matrix with boxing wax that stands 15 mm (5/8 inch) above the impression's highest point and lute the wax to the matrix. Water test the boxed impression for leaks and pour the cast.

7.34.3. **Mandibular Impression:**

7.34.3.1. Box the mandibular impression the same as the maxillary impression. ***EXCEPTIONS:*** Use two pieces of clay—one on the right and the other on the left in the first molar areas—to hold the tray (especially the heels) 12 mm (1/2 inch) off the table (Figure 7.17).

7.34.3.2. Before the matrix reaches its initial set, try to create a smoothly contoured tongue space. Complete the contouring of the tongue space with a sharp knife after the final set. Make a 6 mm wide land area. Extend it from the distal 1/3 of the buccal flange, across the posterior border of the retromolar fossa, and down to the retromylohyoid eminence on each heel. Paint two to three coats of separator onto the land and tongue space regions.

Figure 7.17. Plaster-Pumice Matrix, Box, and Pour System.



7.35. Pouring Master Casts:

7.35.1. Most final impression materials do not require a coating of separator before a cast is poured. *However, impression plaster is the exception.* Pouring a cast against impression plaster without the use of an intervening separator causes the impression and the stone to bond together.

7.35.2. Before pouring a cast, proportion the water and gypsum according to the manufacturer's directions. Spatulate the mixture thoroughly to obtain a homogeneous mix. To obtain a dense, accurate cast, always vacuum spatulate stone for final impressions. Place a small quantity of the mix in the boxed impression on the vibrator and make it flow around the impression. Continue to add small quantities of stone until the tissue surface of the impression is covered; somewhat more rapidly, fill the boxing to the desired level.

7.36. Separating and Trimming Master Casts:

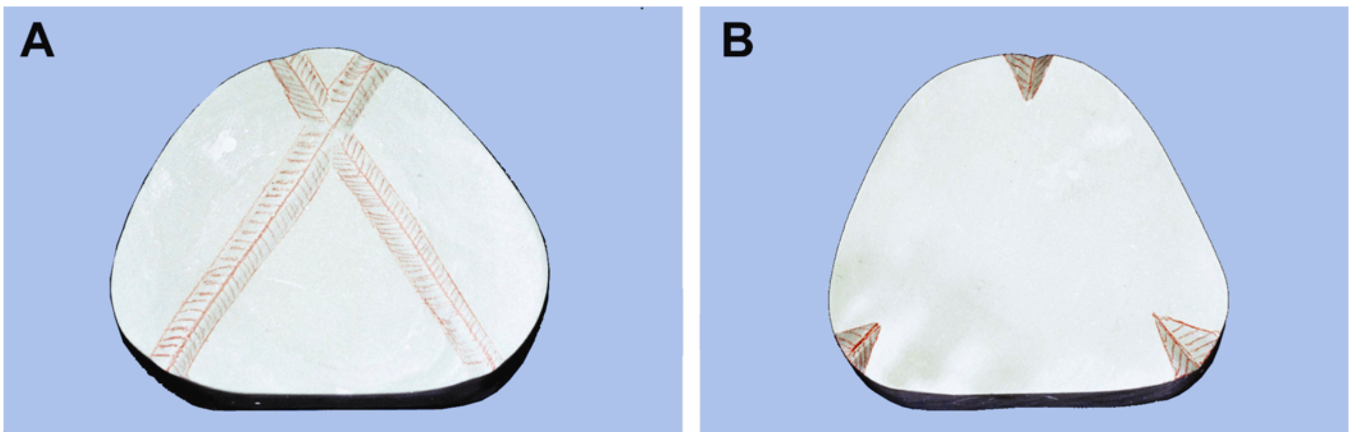
7.36.1. After the stone has final set (according to the manufacturer's directions), remove the boxing materials. If a plaster-pumice matrix was used, the matrix should break away cleanly and easily.

7.36.2. Some dentists make their own modeling plastic trays at chairside to carry corrective wash materials. Others use modeling plastic to form the borders of custom resin trays before they make a final impression. If modeling compound was used in the final impression procedure, place the assembly in 140 °F water for 3 minutes so it will separate. After separating a cast from any kind of impression, always inspect the cast's surface for inaccuracies (irregular voids and positive and negative bubbles).

7.36.3. Casts poured from properly boxed impressions require minimal trimming. Dip the cast in SDS, use the cast trimmer to flatten the base (15 mm thick), and produce land areas of proper dimensions as discussed in paragraphs 7.23.4 and 7.23.5. Rinse the debris from the cast with SDS.

7.36.4. Let the cast dry somewhat and cut *indexing grooves* into the base of the cast. These grooves can assume different lengths and cross-sectional shapes, depending on the wishes of the dentist. Two styles are shown in Figure 7.18. *Do not cut indexing grooves so deeply they compromise the strength of the cast.*

Figure 7.18. Indexing Grooves.



Section 7F—Record Bases With Occlusion Rims

7.37. Characteristics. Record bases with occlusion rims (Figure 7.19) are a combination of a base material that accurately fits the cast (record base) and an arch-shaped wax buildup (occlusion rim) that occupies the space formerly occupied by the patient's natural teeth.

7.38. Primary Uses. Primary uses for record bases with occlusion rims (paragraphs 7.38.1 through 7.38.6) are to:

7.38.1. Help the dentist select and properly position denture teeth. The dentist shapes and positions the labial surfaces of the occlusion rims to approximate the amount of lip support required by the patient. The dentist then adjusts the vertical length of the maxillary occlusion rim to indicate the length of the incisor teeth. Some dentists scribe marks on the occlusion rims as aids in choosing and positioning denture teeth (Figure 7.20). The markings are usually made on the maxillary occlusion rim, but they occasionally carry over onto the mandibular rim.

7.38.1.1. **Midline Marking.** The midline marking represents the center of the patient's face. The incisive papilla is also a good guide.

Figure 7.19. Record Base With Occlusion Rim.

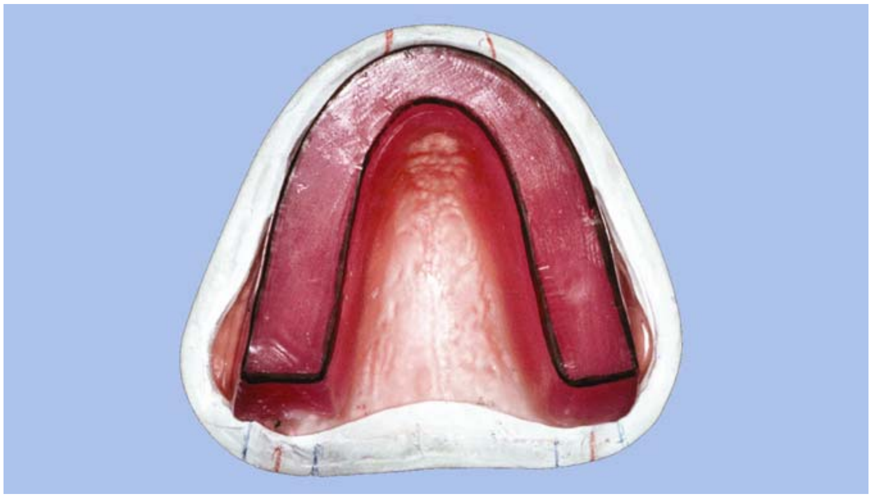
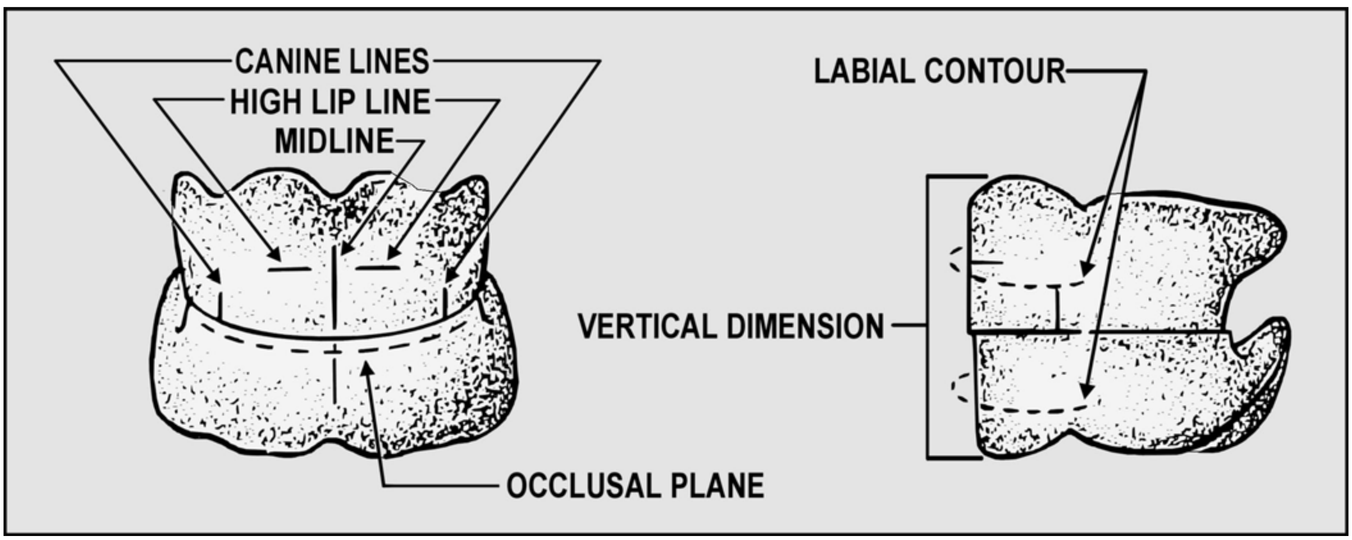


Figure 7.20. Occlusion Rim Markings.



7.38.1.2. **High Lip Line.** Some dentists mark the high lip line on the maxillary rim. This line indicates the level to which the upper lip rises when the patient smiles. It helps determine the gingivoincisal length of maxillary denture teeth so the patient displays a minimum of denture base.

7.38.1.3. **Canine Lines.** Canine lines are placed on the right and left sides. They represent the estimated positions of the long axis of the canines. The distance between the lines is used to select the proper width of the six *anterior* teeth. The usual procedure is to make a measurement around the labial surface of the occlusion rim, from canine line to canine line, and add 8 mm. If a tooth's long axis roughly splits it down the middle, the 8 mm accounts for the distal halves of both canines. In addition, the combined width of the maxillary posterior teeth in a quadrant can be estimated by measuring between the canine line and the mesial beginnings of the maxillary tuberosity.

7.38.2. Help the dentist determine the correct occlusal vertical dimension. (***NOTE:*** If terms like *correct occlusal vertical dimension, centric relation, and physiologic rest* are unfamiliar, refer to

Chapter 5.) A dentist might use the following sequence of steps to determine a patient's correct occlusal vertical dimension. The dentist:

7.38.2.1. Makes it a point to start the procedure with occlusion rims that obviously hold the jaws too far apart. It causes the patient to slur "S" sounds badly and the occlusion rims to hit when he or she attempts to speak.

7.38.2.2. Makes a physiologic rest position measurement and quickly reduces the vertical height of the wax rims to match the measurement.

7.38.2.3. From this point on, very carefully cuts back the height of the occlusion rims and continually tests the patient's speaking abilities.

7.38.2.4. Reaches the correct occlusal vertical dimension when pronunciation of the "S" sound is distinct and the occlusion rims barely miss each other when the sound is spoken.

7.38.3. Enable the dentist to make a combined occlusal vertical dimension and centric relation record. This is a type of lower to upper jaw relationship record consisting of occlusion rims locked together at the correct occlusal vertical dimension estimate in centric relation. The dentist:

7.38.3.1. Makes an estimate of the correct occlusal vertical dimension as described above.

7.38.3.2. Positions the mandible in centric relation.

7.38.3.3. Keys or seals occlusion rims together and, ideally, makes a facebow transfer. The dentist removes the entire assembly from the patient's mouth and gives it to the technician.

7.38.4. Enable the technician to use the occlusal vertical dimension and centric relation record made from the record bases with occlusion rims to mount the patient's casts on the articulator (Figure 7.21).

7.38.5. Act as a matrix or foundation for arranging denture teeth.

7.38.6. Develop a wax trial denture on the record bases. Before a denture is processed in plastic, the dentist uses the wax trial denture to verify that jaw relations and denture esthetics are correct.

Section 7G—Record Bases

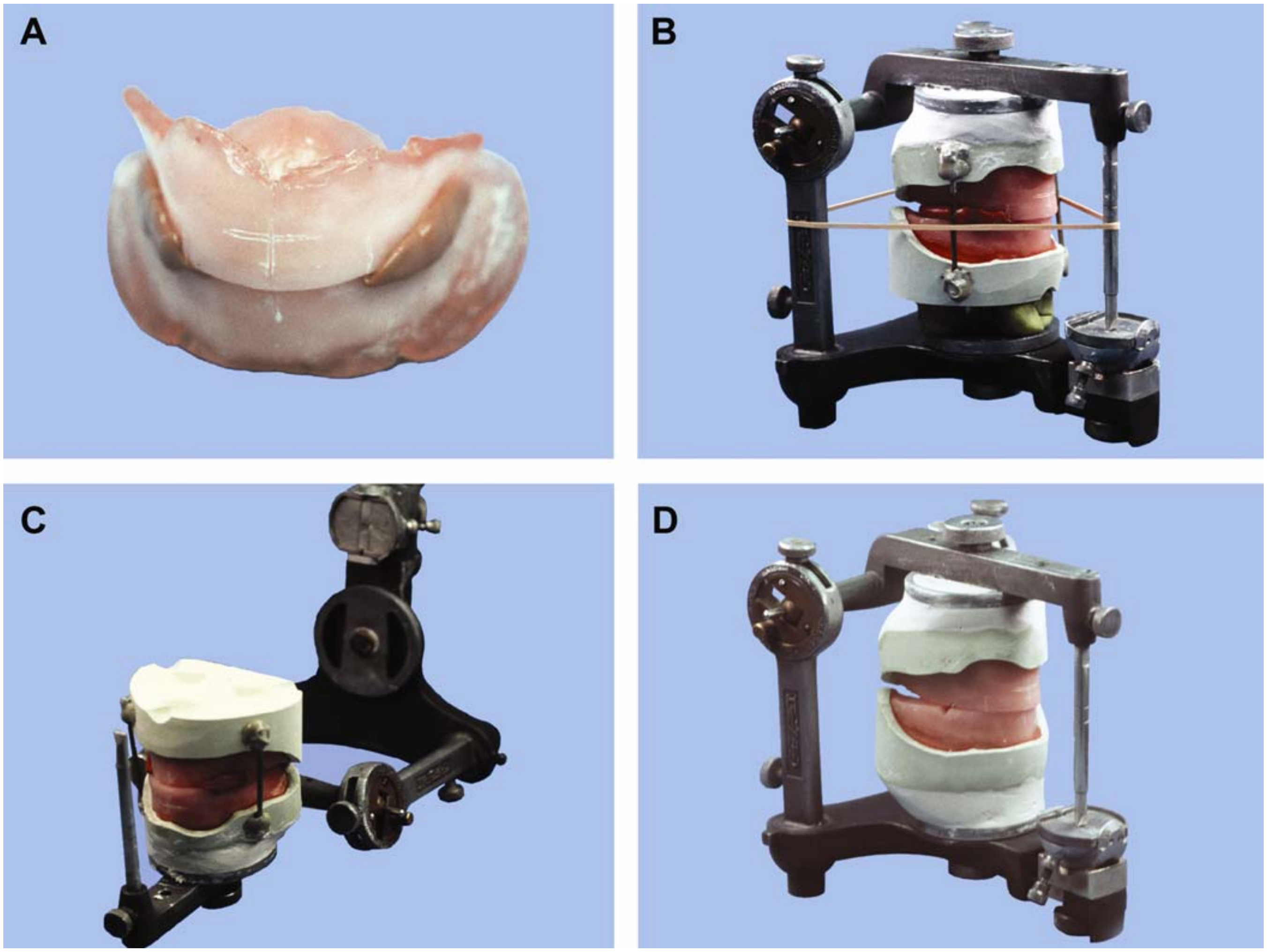
7.39. Construction Characteristics. To be used successfully, record bases should have certain construction characteristics because they are made to cover the identical surfaces the completed dentures cover.

7.39.1. The bearing areas in the maxillary arch are the *residual ridges* and *hard palate.* Maxillary record base borders are defined by the *labial sulci, buccal sulci, pterygomaxillary notches,* and *vibrating line.* The dentist should have marked the vibrating line on the cast.

7.39.2. The bearing areas in the mandibular arch are the *residual ridges, retromolar pads,* and *buccal shelves.* Mandibular denture base borders are defined by the *labial sulci, buccal sulci, lingual sulcus, retromylohyoid spaces,* and *posterior extent of the retromolar pads.*

7.39.3. An accurate fit is vital. A record base must be made to fit a cast *exactly.* Once adapted to cast contours, the record base must keep its shape without breaking.

Figure 7.21. Use of Record Bases With Occlusion Rims to Mount Casts.



7.39.4. Record bases can be made from either light-cured material or autopolymerizing resin, but autopolymerizing resin is preferred because it is stronger and more stable.

7.39.5. In keeping with mandatory requirements for strength and stability, some mandibular record bases may need to be reinforced with a "U" shaped piece of coat hangar wire. The wire is adapted to the lingual sulcus area of the residual ridge, anterior to the right and left premolar regions. It is then embedded in the substance of the record base.

7.39.6. Last, but definitely not least, record bases must be neat, clean, and smooth enough to place in the patient's mouth without causing discomfort.

7.40. Fabricating an Autopolymerizing Acrylic Record Base:

7.40.1. **Sprinkle-On Method (Figure 7.22):**

7.40.1.1. Use wax to block out the undercuts. Paint a tinfoil substitute onto the tissue surfaces and land areas of the master cast. After the tinfoil substitute dries, use a spoon-shaped instrument or a shaker to sprinkle autopolymerizing acrylic resin evenly over a section of the cast.

Figure 7.22. Sprinkle-On Method of Making an Acrylic Resin Record Base (Mandibular Arch).

7.40.1.2. Use a medicine dropper to moisten the polymer with monomer. Do not bathe the polymer with monomer because such a mixture will flow uncontrollably. The suggested sequence of application is labial and buccal flanges, lingual and palatal areas, and finally the ridge crests.

7.40.1.3. Continue the application until the cast surface is uniformly covered. Let the resin polymerize under water in a pressure pot with 110 ^{o}F water at 15 lb/in^{2} for 10 minutes. Trim and round the border of the record base with an arbor band or acrylic bur.

7.40.1.4. The finished record base should be 2 to 3mm thick with the exception of the crest of the residual ridge, which should be thinned to aid in tooth setting. The peripheral roll should also be full and rounded to conform to the sulcus of the cast.

7.40.2. **Bulk Resin With a Wax Form Method:**

7.40.2.1. Start by blocking out undercut areas with wax. Loosely adapt one sheet of baseplate wax to the cast. Extend the borders of the wax just shy of the peripheral rolls. Remove the sheet wax form and set it aside. Apply a coat of tinfoil substitute.

7.40.2.2. Mix a 2:1 ratio of polymer to monomer. (***NOTE:*** 20 cc of polymer to 10 cc of monomer should be enough for most record bases.) Let the mix set until it develops some body. Place the resin into the peripheral roll areas first; put the remaining resin in the wax form and position it on the cast. Push down on the wax form lightly and evenly until the resin layer is thinned uniformly 1 to 2 mm thick under the wax form. Ensure the peripheral roll is full and trim away excess resin on the outside of the wax form.

7.40.2.3. After the resin has set in a pressure pot with 110 ^{o}F water at 15 lb/in^{2} for 10 minutes, carefully remove the record base from the cast. Trim excess resin from the record base with a cherry stone or an arbor band. ***NOTE:*** Do not polish acrylic resin record bases. The heat generated by polishing procedures often causes warpage.

7.41. Fabricating a Light-Cured Record Base (Figure 7.23):

7.41.1. Block out any undesirable undercuts on the master cast and apply a coating of manufacturer's separator. Carefully adapt the record base material to the cast.

7.41.2. Ensure the peripheral roll is full and do not over thin material over the crest of the ridge. If wax is used as undercut relief, cure the record base in the curing unit for one minute to "set" the material. Then remove the record base from the cast and remove any wax remaining on the record base to prevent melting of the wax during curing.

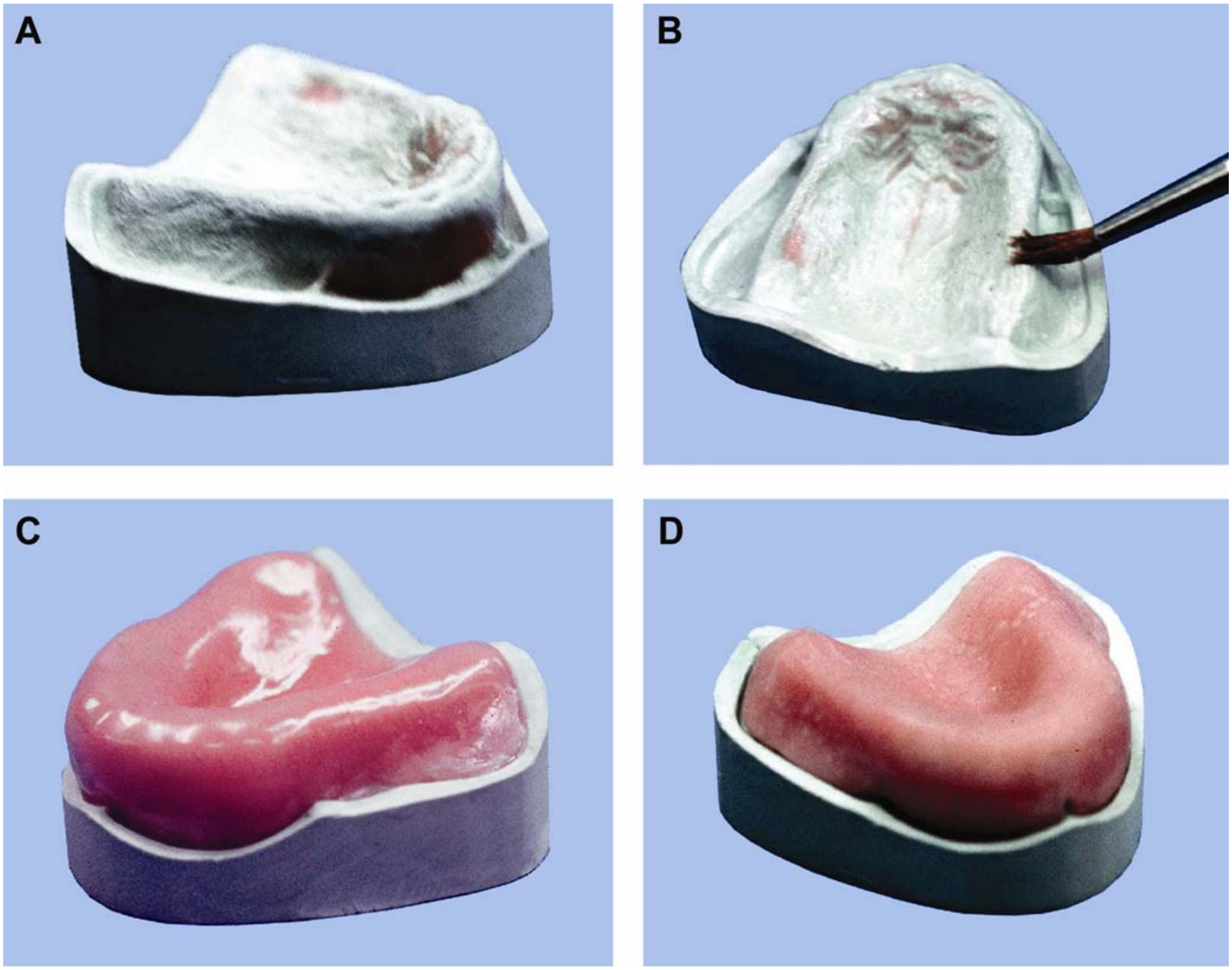
7.41.3. Apply the manufacturers air barrier coating to all surfaces and cure the record base for an additional 9 minutes. Finish any excess material from the borders leaving the peripheral roll full and rounded.

7.42. Stabilizing Record Bases. Record bases are subject to distortion and may require stabilizing procedures to ensure a good fit. *Stabilization* usually means lining the tissue surface of a record base with a secondary substance that reproduces cast contours better than the original record base material. This improves the fit, both on the cast and in the mouth. Common stabilizing substances are zinc oxide-eugenol paste, rigid self-curing acrylic resin, and resilient self-curing resin.

7.42.1. **Stabilization Using Rigid Lining Materials.** These substances are used on casts with no natural undercuts or where existing undercuts are blocked out. The following two methods can be used on acrylic resin record bases:

7.42.1.1. **Zinc Oxide-Eugenol Paste Stabilization.** Block out cast undercuts with wax. Apply a *thin* layer of petrolatum to the tissue surfaces of the cast, and adapt a sheet of .001-inch tinfoil to the cast's contours. A piece of cotton roll makes an effective burnisher and will not tear the tinfoil if used carefully. Mix zinc oxide-eugenol impression paste according to the manufacturer's directions and spread it evenly over the tissue surface of the record base. Place the record base over the tinfoiled areas of the master cast and seat firmly. Hold it in place until the paste sets. Remove the record base from the cast. The zinc oxide-eugenol paste will have stuck to both the record base and the foil, with the foil remaining attached to the record base. Trim and smooth the lose edges of the foil.

Figure 7.23. Method of Fabricating a Light-Cured Record Base.



7.42.1.2. **Rigid, Self-Curing Acrylic Resin.** Fill in cast undercuts with the wax. Paint on the tinfoil substitute. Trim the record base 2 mm short of contact with the peripheral border of the cast. Pour a polymer-monomer mix (use a 2:1 ratio) of self-curing resin on the tissue surface of the record base and spread it evenly. Seat the record base firmly on the cast and allow it to set for 30 minutes. Remove the record base from the cast and trim away the rough edges.

7.42.2. **Stabilization Using Resilient Autopolymerizing Resin.** Record base stability is inversely proportional to the amount of blockout performed on a cast. As the amount of blockout increases, the stability of the record base decreases. A record base adapted to fit into moderate undercuts, which springs in and out of those undercuts *without* permanently deforming, is close to being ideal. An excellent way to meet this requirement is to make a record base that is a combination of rigid and resilient autopolymerizing resins. The resilient resin completely fills in moderate undercuts. The rigid resin forms the body of the record base, and the two kinds of resin bond at their interface. As shown in Figure 7.24 and the following subparagraphs:

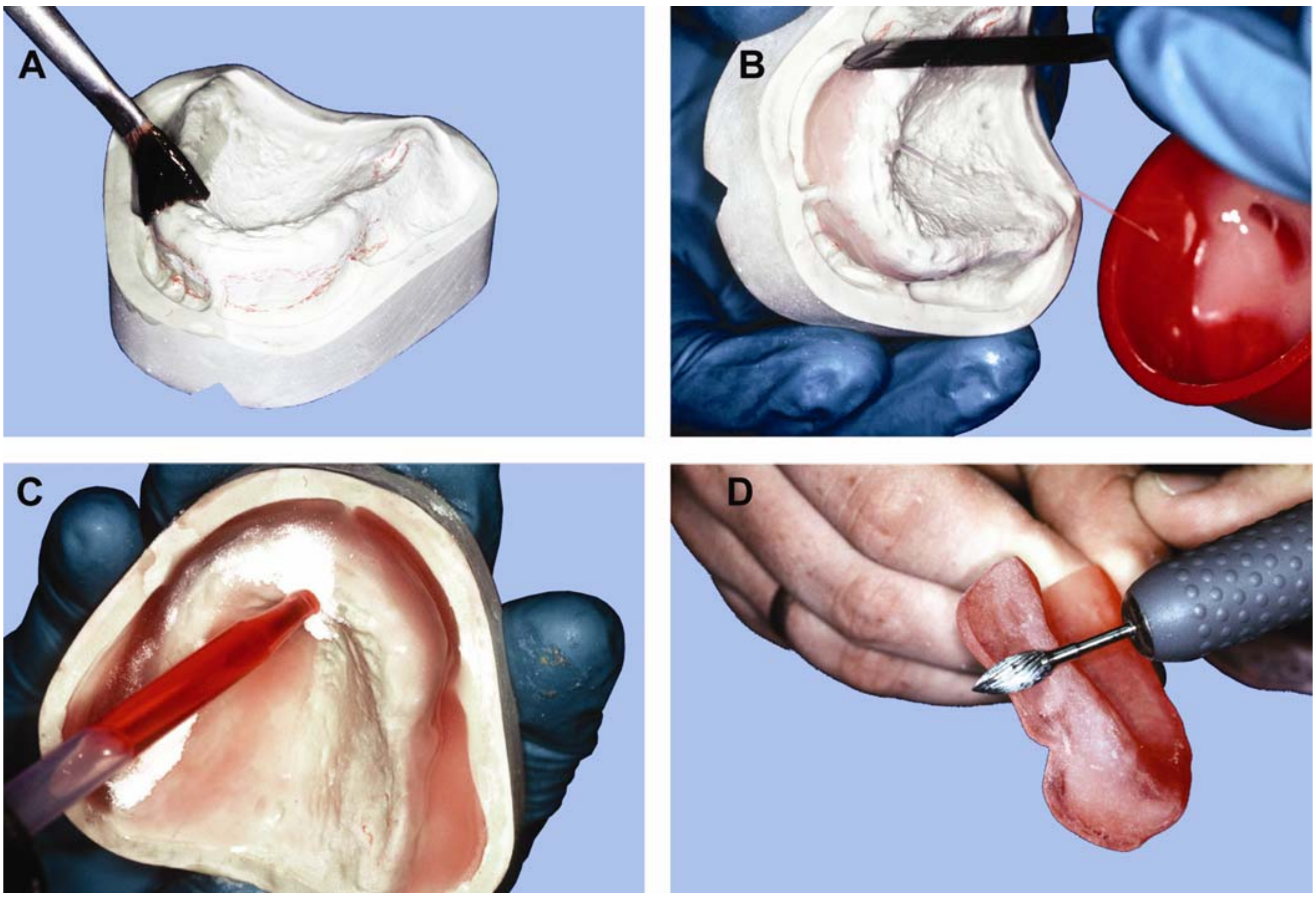
7.42.2.1. Apply tinfoil substitute to the cast and let it dry.

7.42.2.2. Mix resilient autopolymer, such as *Coe-Soft*® (Coe Laboratories, Inc) or *Dura Base*® (Reliance Dental Mfg Co), in a dappen dish. Wait until the mixture reaches a semi-runny state. Apply the mix with a cement spatula and liberally fill cast undercuts.

7.42.2.3. Sprinkle on an autopolymerizing, hard acrylic resin. (This part of the record base should be about 2 mm thick.) Follow the procedure outlined in paragraph 7.40.1.

7.42.2.4. Because resilient autopolymerizing resin remains somewhat tacky after it sets, dust the cast with *talc* to avoid "rolling up" the resilient part. This allows the record base to slide into the undercuts.

Figure 7.24. Stabilizing a Resin Record Base with Resilient Autopolymerizing Resin.



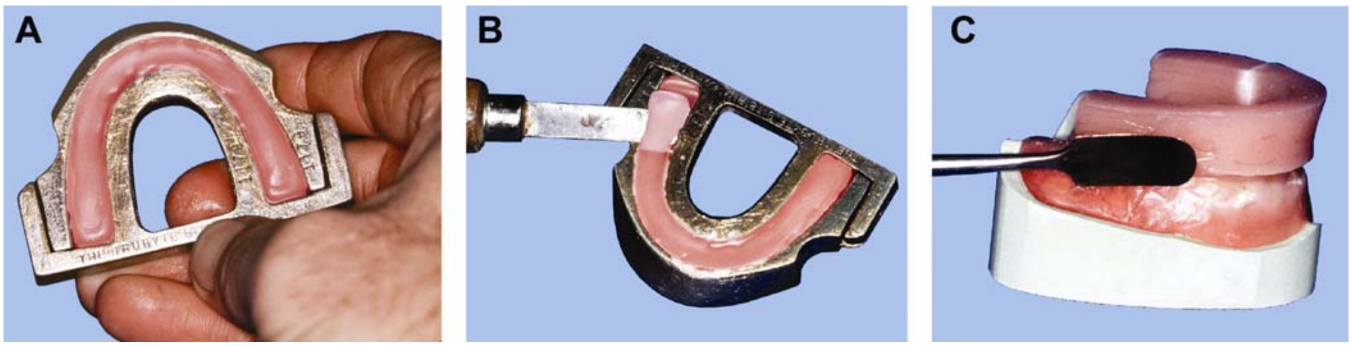
Section 7H—Occlusion Rims

7.43. Commonly Used Materials. Baseplate wax is the most commonly used material for making occlusion rims. The wax rims are supposed to simulate the amount of space formerly occupied by natural teeth and related tissue. The technician builds the occlusion rims to standard, average dimensions and attaches them to the record bases. During the patient's appointment, the dentist modifies the shape, height, and thickness of the occlusion rims in keeping with the person's appearance and functional requirements.

7.44. General Construction Characteristics. Occlusion rims can be made with a device called an *occlusion rim former* or they can be made freehand.

7.44.1. If an occlusion rim former is used (Figure 7.25), apply petrolatum jelly to the halves to prevent wax from sticking. Place the lubricated rim former on a well lubricated glass slab and fill the rim former with molten baseplate wax. The wax can be heated in an electric wax pot or ceramic pickling dish held over an open flame. Slightly overfill the rim former to compensate for solidification shrinkage.

Figure 7.25. Occlusion Rim Former.



7.44.2. Another, less desirable technique is to soften a sheet of baseplate wax, roll it into a cylinder, and place the softened wax cylinder between the two separated parts of the rim former. Then force the halves together, and trim the excess wax flush with the edge of the mold. Remove the wax horseshoe when it hardens.

7.44.3. In the freehand method, baseplate wax is simply rolled lengthwise into a tight cylinder, and then it is shaped to the cast's arch form (Figure 7.26).

7.44.4. Whichever way the mass of the rim is molded, it must be attached to the record base. A wax rim is centered over the crest of the residual ridge and sealed to the record base with molten wax. Melt the wax on a large spatula or use an eyedropper to carry the wax from an electrically heated container. When an eyedropper is used, warm the glass in the Bunsen flame so the temperature of the dropper does not harden the wax before it is used. Contour the facial and lingual surfaces of the rim according to directions in paragraph 7.45. Flatten the rim's occlusal surface with a metal plate.

7.45. Specific Construction Characteristics:

7.45.1. **Maxillary Occlusion Rim Measurements.** The anterior height for the maxillary occlusion rim measures 22 mm from the labial flange (beside the labial notch) to the occlusal plane (Figure 7.27). The labial surface of the rim falls on a line that drops from the sulcus perpendicular to the occlusal plane. The anterior width of the rim is 8 mm. The posterior height of the rim is 18 mm from the deepest point on the buccal flange to the occlusal plane. The posterior width of the rim is 10 mm with the rim centered over the crest of the ridge.

Figure 7.26. Occlusion Rim Fabrication Procedures.

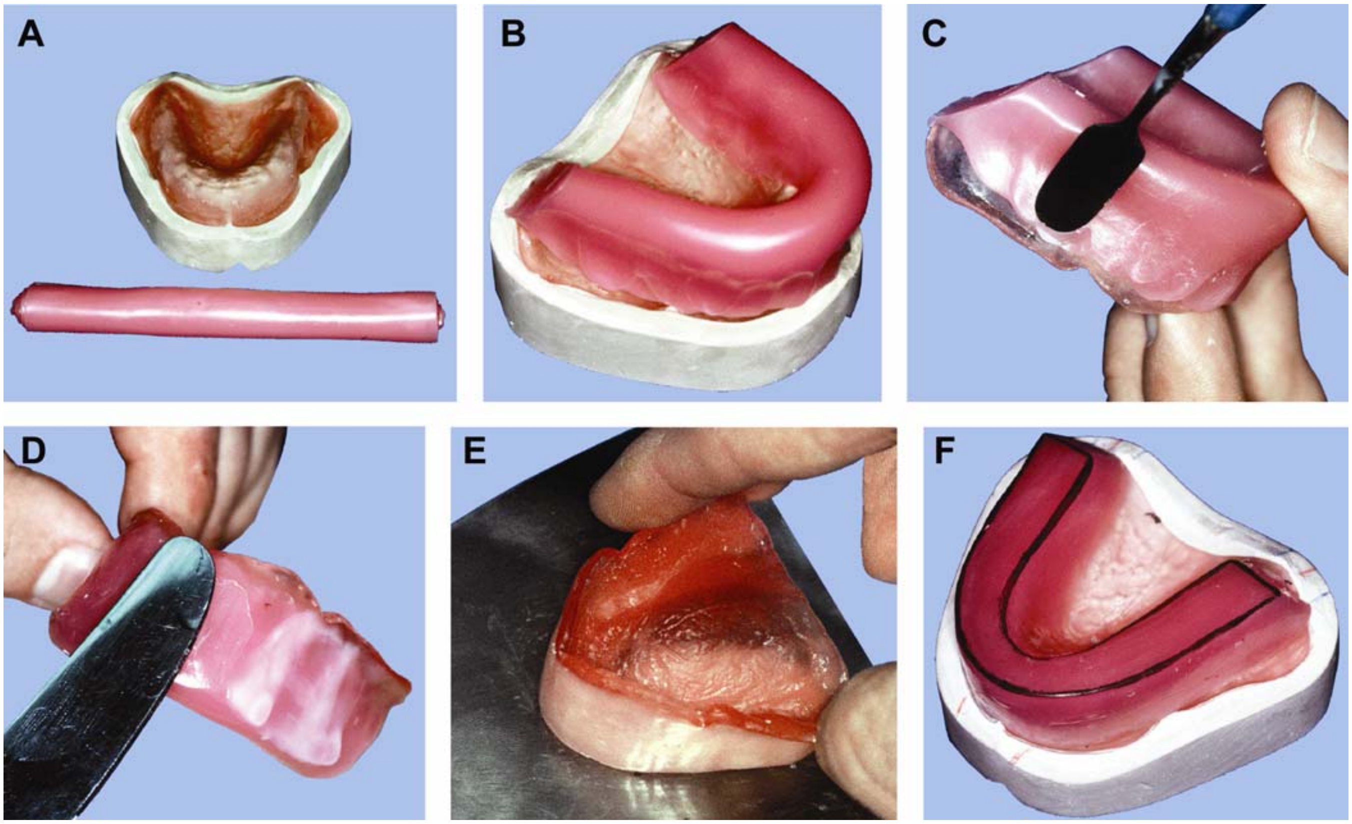
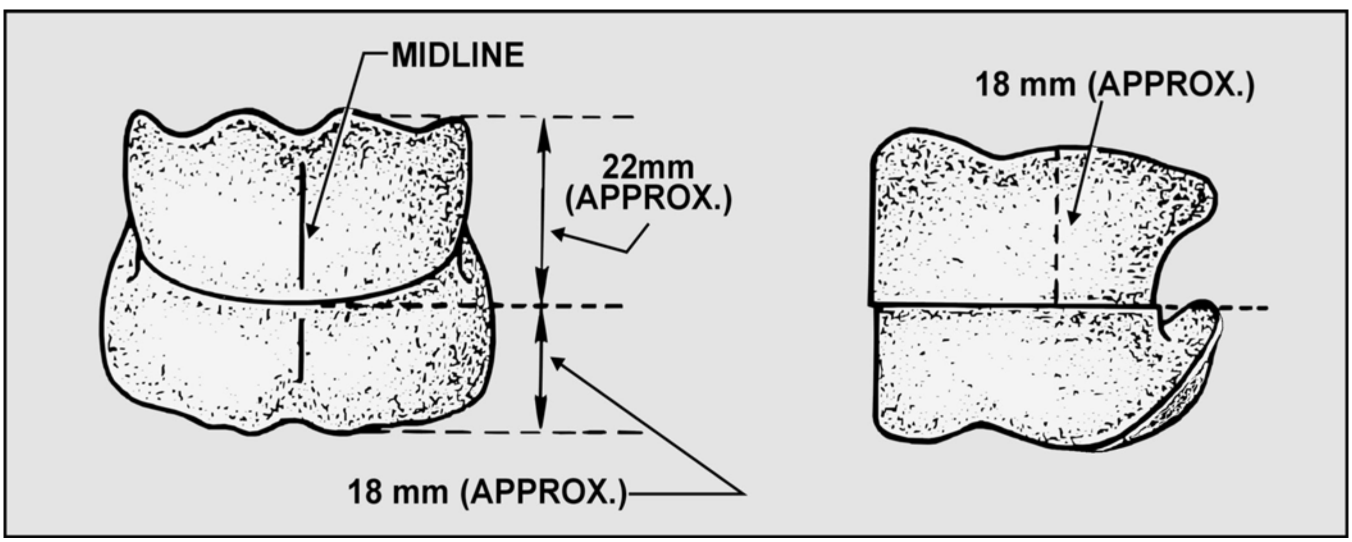


Figure 7.27. Maxillary and Mandibular Occlusion Rim Measurements.



7.45.2. **Mandibular Occlusion Rim Measurements.** The anterior height of the m andibular rim measures 18 m m from the labial flange (beside th e labial notch) to the occlusal plane (Figure 7.27). The labial surface of the rim falls on a line that extends from the depth of the sulcus perpendicular to the occlusal plane. The anterior width of the rim is 8 m m. The posterior height varies with the patients anatom y. The wax rim is flush with lines scored on both heels of the mandibular record base, two-thirds of the way up the retromolar pads. The posterior width of the rim is 10 mm with the rim centered over the crest of the ridge.

Section 7I—Cast Mounting Procedures

7.46. Overview:

7.46.1. Review Chapter 6 for a refresher on the types and uses of articulators. A Hanau® or similar semiadjustable articulator is commonly used for making removable prostheses.

7.46.2. At this point, the dentist has given the technician a centric relation and occlusal vertical dimension jaw relationship record. Included in this record are occlusion rims that have been contoured to guide the positioning of teeth *faciolingually;* a trimmed maxillary occlusion rim that will guide *vertical positioning* of maxillary *anterior teeth*; and canine, high lip, and midline markings on the maxillary occlusion rim act as guides to *denture tooth selection.* The maxillary and mandibular occlusion rims also have been keyed or fused together at the patient's occlusal vertical dimension and in *centric relation.*

7.46.3. The cast mounting procedure is used to orient the maxillary cast to the articulator's condylar elements in the same way that the patient's upper jaw relates to the temporomandibular joints. The procedure is also used to duplicate the patient's occlusal vertical dimension and centric relation.

7.47. Mounting the Maxillary Cast. The position of the cast in the articulator should approximate the position of the patient's maxilla in relation to both temporomandibular joints. Depending on what the dentist thinks the case requires, the mounting may be based on an educated guess or an actual measurement of the patient.

7.47.1. **Arbitrary, Average, or Educated Guess Method:**

7.47.1.1. Because an arbitrary mounting is an estimate of where the maxillary cast should be positioned, this type of mounting has certain limitations. The dentist cannot be confident that lateral excursion tooth contacts developed in the articulator are correct when the patient moves the mandible laterally. When testing a wax trial denture in the patient's mouth, the dentist sometimes discovers that the occlusal vertical dimension estimate was incorrect.

7.47.1.2. In cases where an *arbitrary* mounting of the maxillary cast has been used, incorrect registration of the occlusal vertical dimension requires the dentist to make a new occlusal vertical dimension estimate and a new record of centric relation on the patient. This corrected jaw relationship record is then used to mount the mandibular cast again. Of course, the teeth in the wax trial denture have to be set in new positions.

7.47.1.3. The procedures associated with an arbitrary or average maxillary cast mounting are to:

7.47.1.3.1. Key the casts. This allows the cast to be accurately repositioned on the mounting when the need arises.

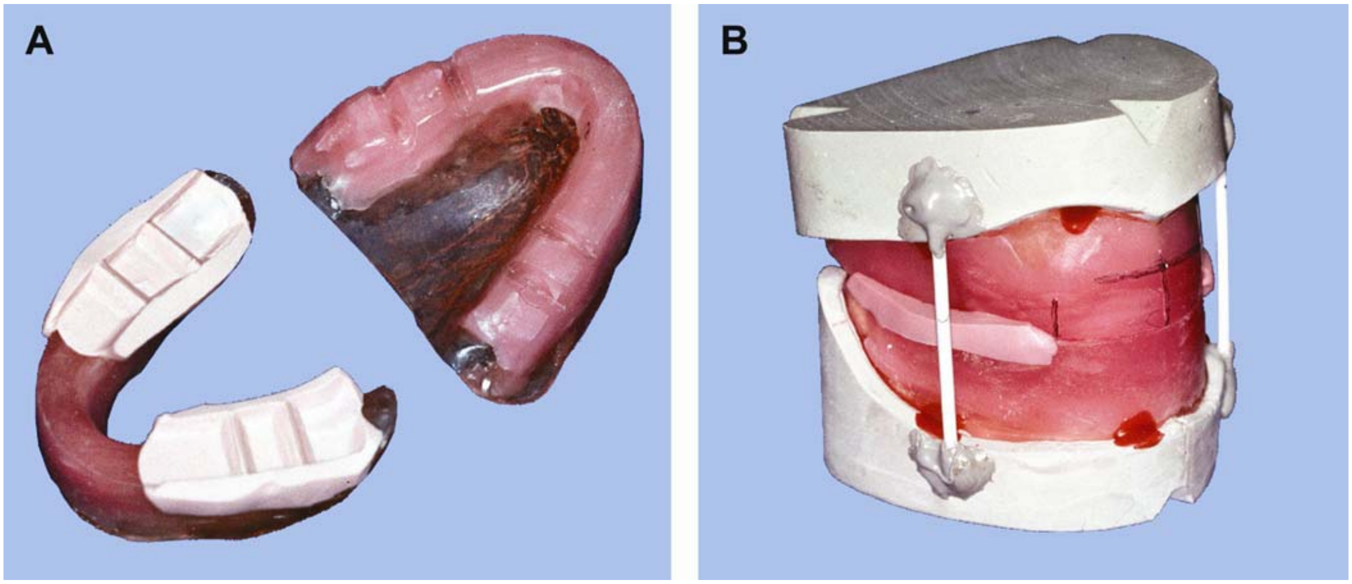
7.47.1.3.2. Attach mounting rings to the articulator. Apply a light coat of petrolatum jelly to the mounting rings to protect them from corrosion and extend their usefulness.

7.47.1.3.3. Use the centric locks to lock the condylar elements against the centric stops.

7.47.1.3.4. Check the articulator settings. Make the incisal guide pin flush with the top of the upper member. Set the horizontal condylar guidance at 30 degrees on the horizontal scale. Rotate the posts to 15 degrees on the lateral condylar indicator scale. Set the incisal guide table and its wings at 0 degrees.

7.47.1.3.5. Prepare the cast and jaw relationship record assembly (Figure 7.28). Seat the maxillary cast in its record base and spot-lute the record base to the cast with wax. Seat the mandibular cast in its record base and do the same. Be sure the occlusion rims are properly oriented, one to the other. Reinforce the assembly with pieces of coat hanger wire. Make sure there is no trace of wobble among any of the components of the assembly. Apply separator to the *keys* of the casts only.

Figure 7.28. Preparing the Cast and Jaw Relationship Record Assembly.



7.47.1.3.6. Position the upper cast by placing a thin rubber band around the incisal guide pin and both posts. Position the band on the pin's lower mark and make the remainder of the band parallel to the horizontal plane of the articulator. Then use clay to position the cast and jaw relationship record assembly between the upper and lower mounting rings.

7.47.1.3.7. Make points A and B of the assembly fall on the plane of the rubber band (Figure 7.29). Point B represents the incisal edge of a maxillary central incisor, and two A points are places measured two-thirds of the way up the retromolar pads on the right and left sides of the mandibular cast.

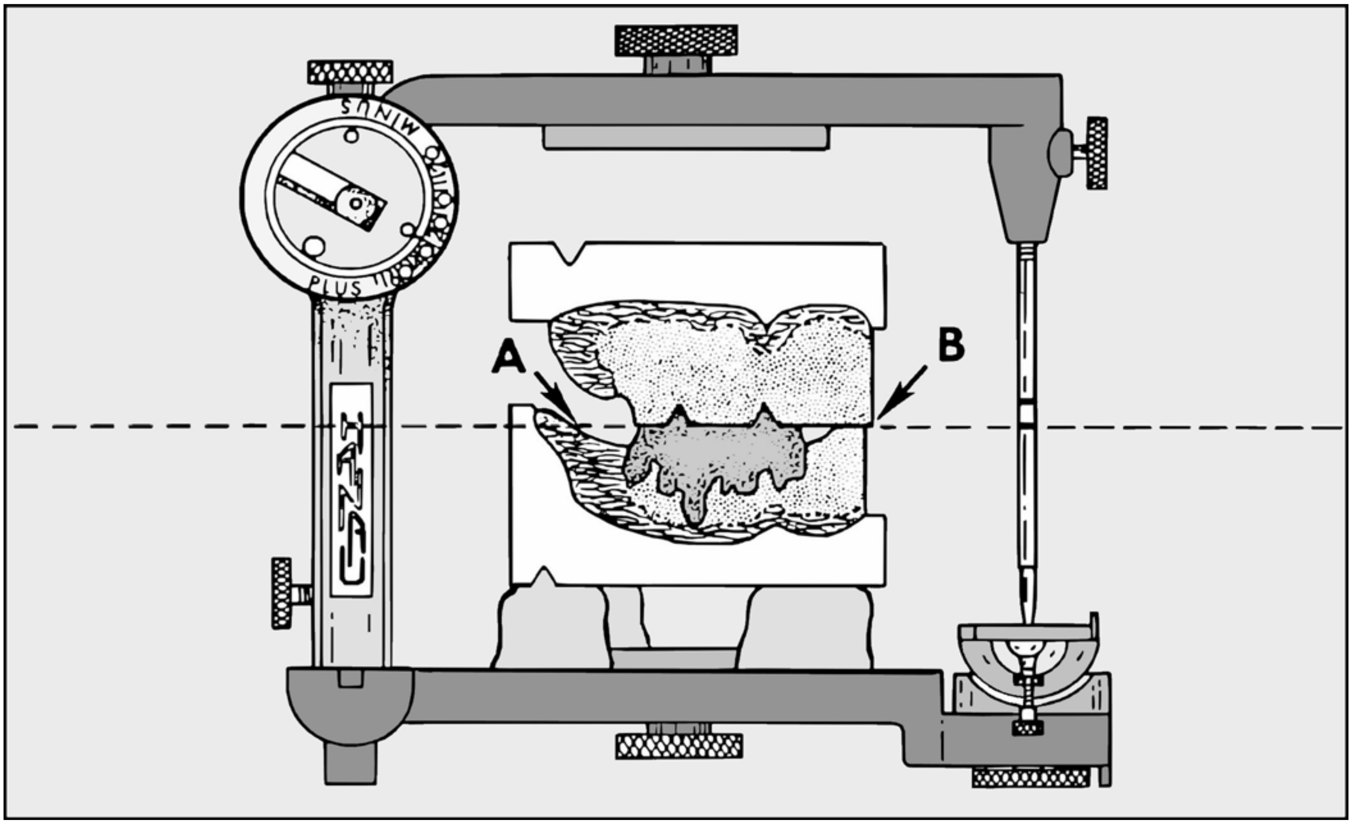
7.47.1.3.8. Center the upper cast under the upper mounting ring. Use the incisal pin as a guide to center the midline mark of the maxillary occlusion rim.

7.47.1.3.9. Moisten the base of the cast with a little SDS. Attach the cast to the upper mounting ring with a slurry accelerated mix of dental stone.

7.47.2. **Facebow Method:**

7.47.2.1. A facebow is a caliper-like device. By using the facebow transfer procedure, a maxillary cast can be positioned on an articulator in three dimensions the same way a patient's upper jaw relates to the temporomandibular joints. Mounting the maxillary cast is no longer dependent on an educated guess. Instead, it is based on an actual measurement of the patient. With a facebow transfer, there is a much better chance the lateral contact relations developed between maxillary and mandibular teeth in the articulator will show up the same as when the patient moves the mandible laterally.

Figure 7.29. Positioning the Upper Cast.



7.47.2.2. If the dentist determines the patient's occlusal vertical dimension was incorrectly registered, a new centric relation occlusal vertical dimension record may not be necessary.

7.47.2.3. When a maxillary cast is mounted with a facebow, it is possible to make slight increases or decreases in the occlusal vertical dimension (± 2 mm) on the articulator without requiring a new jaw relationship record from the dentist. Denture teeth are then reset into positions that correspond with the adjusted occlusal vertical dimension.

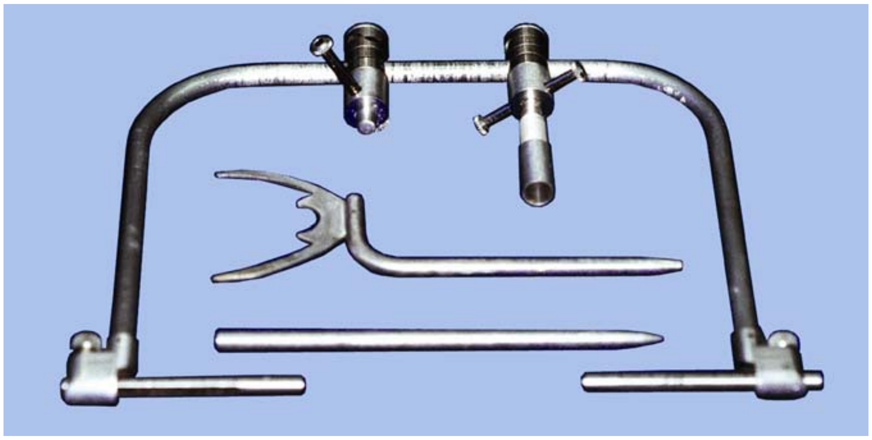
7.47.2.4. Parts of the facebow assembly include the bow, jack clamp, jackscrew, slide bars and locks, facebow fork, and orbital pointer (Figure 7.30).

7.47.2.5. Procedures for a facebow transfer are as follows:

7.47.2.5.1. The dentist heats the facebow fork and fuses it to the maxillary occlusion rim, orienting the plane of the fork parallel to the plane of the wax rim. Any one of a number of methods can be used to locate the patient's condyles, and their positions are marked on the surface of the skin.

7.47.2.5.2. The maxillary occlusion rim with attached facebow fork is inserted into the patient's mouth, and the facebow is placed over the patient's face with the stem on the facebow fork entering the jack clamp. The ends of the slide bars are locked over the skin marks that indicate the location of the condyles. The facebow fork is then locked together with the jack clamp, and the entire assembly is removed from the patient as a unit (Figure 7.31-A).

Figure 7.30. Parts of the Facebow Assembly.



7.47.2.5.3. Before placing the facebow on the articulator, set the articulator to average readings (30 degrees horizontal condylar guidance, 15 degrees lateral condyle guidance, and 0 degrees incisal guidance). Make sure the centric locks are secured. In almost all cases the distance between the facebow's slide bars will not match the length of the articulator's condylar shaft. Also, the readings on the slide bar scales may or may not be the same.

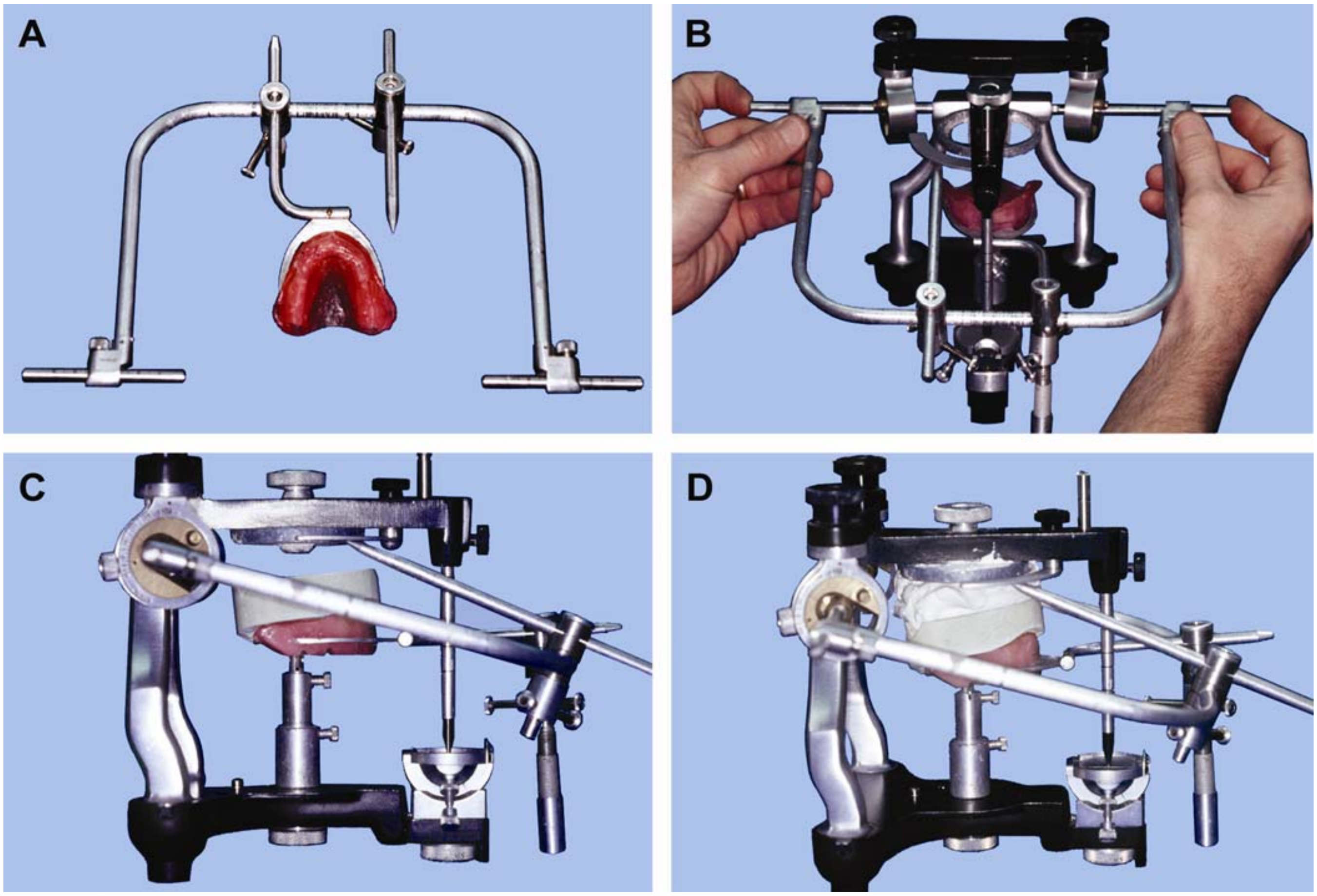
7.47.2.5.4. Before trying to attach the bow assembly to the articulator, make a note of the readings on the slide bar scales. Move the slide bars in or out by the same amount until the facebow springs gently over the ends of the condylar shaft (Figure 7.31-B). Adjust the jackscrew until the plane of the occlusion rim is parallel to the base of the articulator (Figure 7.31-C).

7.47.2.5.5. Index the maxillary cast and apply separator into the keys. Carefully seat the cast in the record base. The weight of the cast and the stone used to mount it must be supported. To counteract this weight, support the occlusion rim with a cast-supporting device or clay.

7.47.2.5.6. Attach the cast to the upper mounting ring with a slurry accelerated mix of dental stone (Figure 7.31-D). Loosen the jack clamp after the stone has reached final set, and remove the facebow from the articulator. Return the maxillary record base and occlusion rim to the dentist who will determine the centric relation and occlusal vertical dimension jaw relationship.

7.47.2.5.7. The value of using a *third point of reference* is most notable during a clinical remount procedure. A dentist uses a facebow transfer with a third point of reference for a first (or original) articulation. Then, interocclusal records or a pantographic tracing is made to set the condylar guidance. If a clinical remount procedure is needed at some later date after the castings or prosthesis is done, the dentist makes another facebow transfer using the same third point.

Figure 7.31. Facebow Mounting of the Maxillary Cast (Hanau H2 Articulator).



7.47.2.5.8. The technician can use the same condylar settings that were used the first time. The dentist does not have to make new interocclusal records or make a new pantographic tracing. The specific point of reference used with the Hanau facebow is the *orbital pointer*, but the Whip-Mix® uses a *nasion relator*. (See Chapter 1, Volume 2, of this pamphlet.). The Hanau H2 also has an attachment called the orbital plane indicator which corresponds to the orbital plane of the patient.

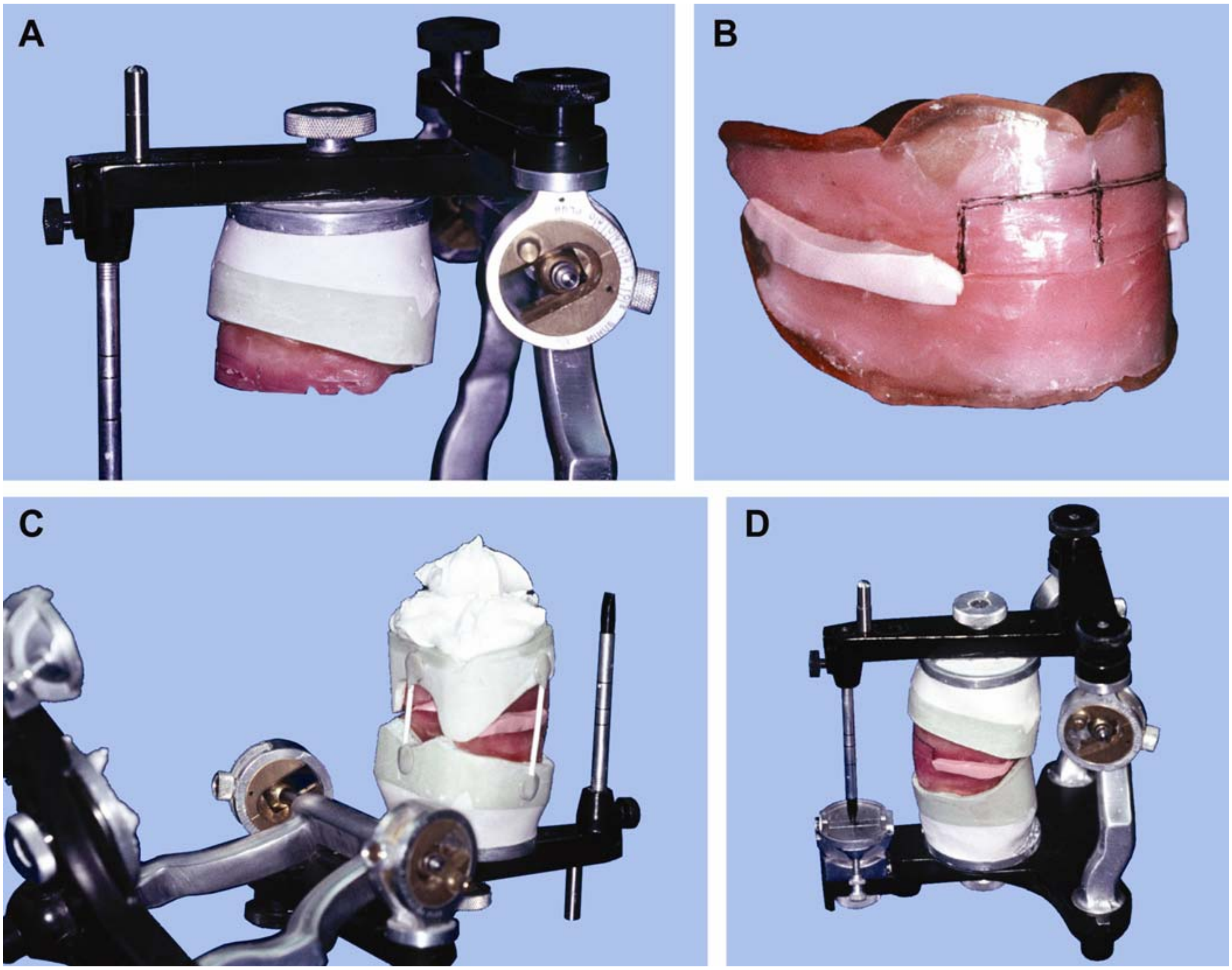
7.47.2.5.9. In addition to procedures in paragraphs 7.47.2.5.1 and 7.47.2.5.2, the dentist positions the tip of the orbital point at the patient's orbitale. After the technician receives the facebow transfer, he or she places the facebow on the articulator and adjusts the jackscrew until the tip of the orbital pointer touches the articulator's orbital plane indicator (Figure 7.31-C).

7.48. Mounting the Mandibular Cast:

7.48.1. If the *arbitrary* (educated-guess) method was used to mount the maxillary cast (paragraph 7.47.1), the mandibular cast is now part of a cast and jaw relationship record assembly stabilized with coat hanger wires.

7.48.2. To mount the mandibular cast, invert the articulator, using a stand if necessary (Figure 7.32). Be certain the condylar elements are locked against the centric stops. Remove the clay from between the base of the mandibular cast and the mounting ring. Moisten the base of the mandibular cast. Attach the mandibular cast to the lower mounting ring with a slurry accelerated mix of dental stone. *The incisal guide pin must be in contact with the incisal guide table* after the mounting is complete. Smooth the mounting with wet/dry sandpaper, and clean up the articulator.

Figure 7.32. Mounting the Mandibular Cast.



7.48.3. If *the facebow transfer* method is used, the maxillary cast should first be attached to the maxillary mounting ring according to directions in paragraphs 7.47.2.5.3 through 7.47.2.5.6. Invert the articulator using a stand if necessary. Be certain the condylar elements are locked against the centric stops. Seat the centric relation and occlusal vertical dimension record on the maxillary cast and spot-lute the record base to the cast. Seat the mandibular cast in the mandibular record base and spot-lute to the record base. Make absolutely sure the occlusion rims are properly oriented one to another. Reinforce the assembly with coat hanger wires. Adjust the top of the incisal guide pin flush with the top surface of the articulator.

7.48.4. Apply separator to the cast index keys, moisten the base slightly, and use dental stone to attach the cast to the mounting ring. *Before the stone reaches its initial set, check to see that the incisal guide pin is contacting the incisal guide table.* Smooth the mounting and make the articulator presentable.

Section 7J—Hanau H2 Articulator Settings in Complete Denture Construction

7.49. Using the Hanau H2 as a Fixed Guide Instrument (Arbitrary, Average, or Educated-Guess Method):

7.49.1. Mount the maxillary cast in an average manner according to paragraph 7.47.1.

7.49.2. Set the horizontal condylar guidances at 30 degrees on the horizontal scale.

7.49.3. Rotate the posts to 15 degrees on the lateral condylar indication scale.

7.49.4. During cast mounting procedures, set the incisal guide table at 0 degrees. The setting of the incisal guide table changes with the kind of complete denture being made; for example, balanced complete dentures versus the monoplane variety. The use of the incisal guide table will be explained as part of the directions for the type of case being done.

7.50. Using the Semiadjustable Capabilities of the Hanau H2:

7.50.1. **Facebow Transfer.** Mount the maxillary cast by the facebow transfer method described in paragraphs 7.47.2.5.3 through 7.47.2.5.6.

7.50.2. **Adjustment of Horizontal Condylar Guidance:**

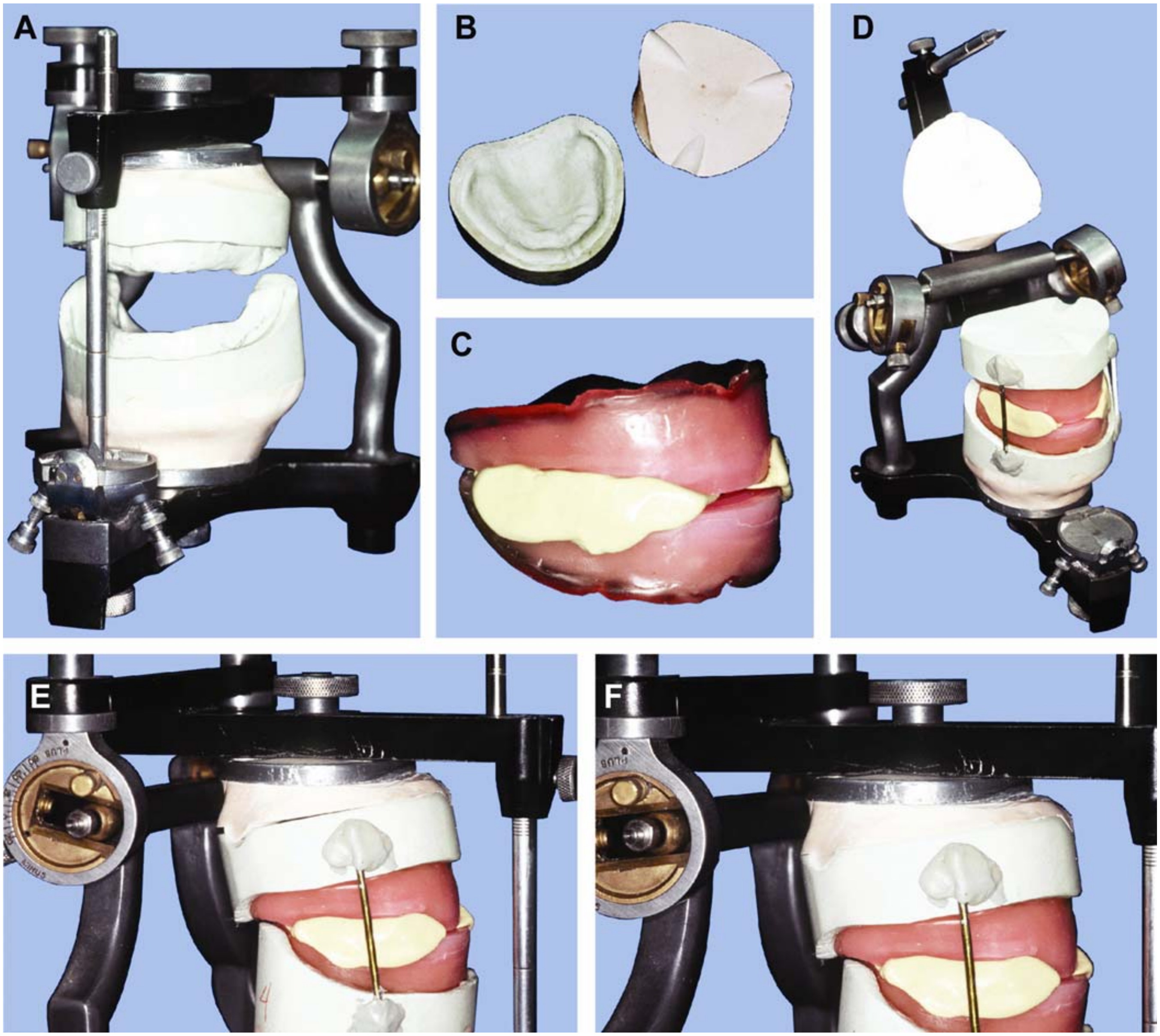
7.50.2.1. After the mandibular cast is mounted using the usual centric relation and occlusal vertical dimension record, set the horizontal condylar guidances with a separate, *protrusive jaw* relationship record or *checkbite* (Figure 7.33). This checkbite is used to transfer the angulation of a person's eminence, as it exists in the skull, to the articulator. A protrusive checkbite gives this relationship with an accuracy of ± 5 degrees.

7.50.2.2. The dentist places the maxillary and mandibular record bases with occlusion rims in the patient's mouth, and makes a record of a protrusive occlusal relationship. The technician then prepares the articulator to receive this record. The technician will raise the incisal pin out of contact with the incisal guide table, loosen the centric locks, loosen the thumb nuts for the horizontal condylar guide inclinations, and set the lateral rotation of the condylar posts at 15 degrees. Unscrew the mounted maxillary cast from the upper member. Separate the cast from the mounting stone in a way that maintains the mounting, the keys, and the cast intact. Separation should not present a problem if *separator* was applied to the cast before mounting.

7.50.2.3. Position the protrusive jaw relationship record on the lower cast and spot-lute the record base in place. Put the upper cast in its record base and do the same. Reinforce the entire assembly with coat hanger wires. Screw the maxillary cast's mounting back onto the upper member. Move the upper member of the articulator to a place where the mounting stone and the base of the maxillary cast seem to fit together best.

7.50.2.4. To adjust the right and left horizontal condylar guidances, rotate the guides back and forth in their housings. Carefully hunt for settings where the stone mounting and the base of the cast fit together *perfectly.* Tighten the condylar guide inclination thumbnuts to preserve the adjustments. Record the settings. Remove the protrusive record. The formal name for the method used to make the horizontal condylar guidance adjustment is the *split cast technique.* ***NOTE:*** Adjustment of the horizontal condylar guidance using a protrusive record is often done after receiving the wax trial denture or during a clinical remount procedure. If this is the case, refer to the procedures in Chapter 1, Volume 2, of this pamphlet for a description of that technique.

Figure 7.33. Split Cast Technique for Adjusting Horizontal Condylar Guidance.



7.50.3. **Adjustment of Lateral Condylar Guidance.** The Hanau articulator provides a formula on the underside of the lower member which is used to set the lateral or side shift setting of the articulator. To determine lateral condylar guidance, divide the horizontal condylar inclination by 8 and add 12. Calculate the proper lateral condylar guidance figure for each condylar post and rotate each post accordingly.

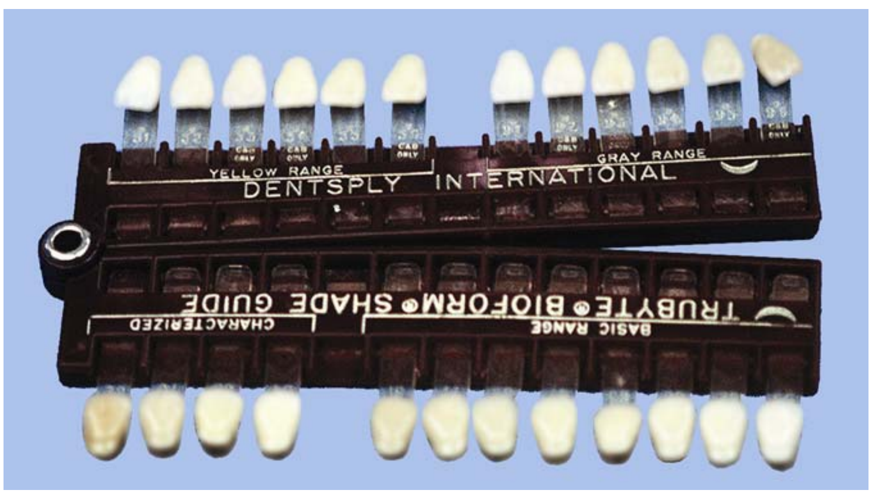
7.50.4. **Adjustment of Incisal Guide Table.** The adjustment of the incisal guide table will be explained with the type of case or situation being described.

Section 7K—Denture Tooth Characteristics and Selection Factors

7.51. Overview. Teeth differ significantly in shape, size, and shade from one person to another (Figures 7.34 and 7.35). To allow for this, manufacturers produce many different kinds of denture teeth. In fact, there are thousands of possible combinations. ***NOTE:*** Denture teeth may be stocked in varieties and quantities appropriate to local usage. A denture tooth stock management system should be established to order and stock the teeth. For information about this system, see Attachment 4.

Figure 7.34. Denture Tooth Shape and Size Variability.

Figure 7.35. Denture Tooth Shade Variability.



7.52. Denture Tooth Sets:

7.52.1. Denture teeth are commercially available in maxillary anterior, mandibular anterior, maxillary posterior, or mandibular posterior matched sets made from porcelain or plastic. Anterior tooth sets consist of six teeth and are known as “1 x 6s.” Posterior tooth sets are called “1 x 8s” (Figures 7.36 and 7.37).

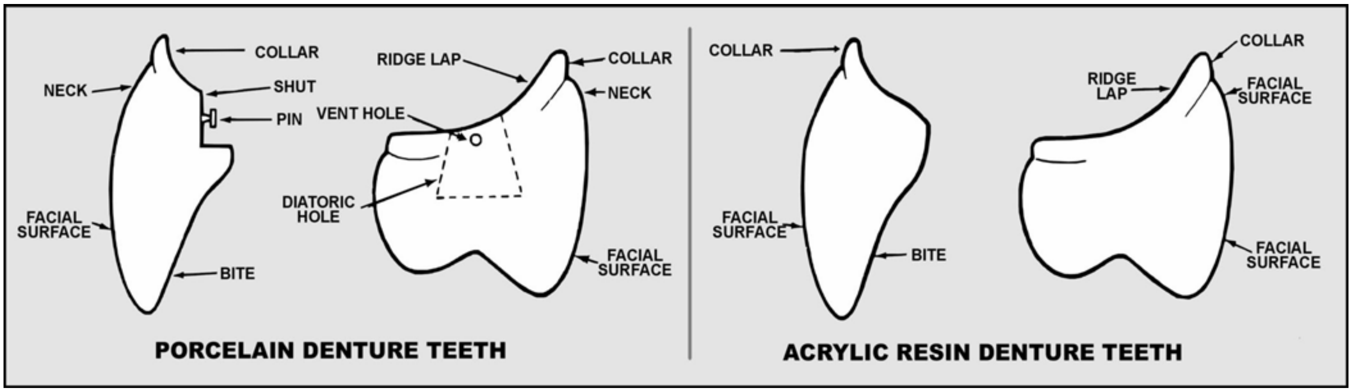
7.52.2. Differences in shape, size, and color (among other characteristics) make the sets distinct from one another. A full complement of denture teeth contains 28 teeth because third molars are not used in the fabrication of complete and RPDs.

Figure 7.36. Anterior Tooth Sets (1 x 6s).

Figure 7.37. Posterior Tooth Sets (1 x 8s).

7.53. Design Features of Porcelain Denture Teeth. Denture bases are made from acrylic resin. Porcelain is an inert material that does not chemically bond to acrylic resin. Therefore, mechanical retention in the form of pins or undercut holes (diatorics) is necessary to retain porcelain teeth in a denture base. If there is very little room between the arches of a complete denture setup, a slightly oversize porcelain tooth might be ground to fit the space. However, care must be taken because a porcelain tooth is ruined the instant the mechanical retention is cut away. The following design features are associated with porcelain teeth (Figure 7.38):

Figure 7.38. Design Features of Artificial Teeth.



7.53.1. **Collar.** The collar is that area on the facial side of a denture tooth, about 1 mm wide, that extends from the gingival edge to the groove across the facial surface. The collar is embedded in the plastic denture base. It helps retain the denture tooth. Sometimes a part of the collar is intentionally left uncovered to simulate the root surface of a tooth.

7.53.2. **Neck.** The neck of a denture tooth is the bulge on the facial side, that is just incisal or occlusal to the collar and its limiting groove.

7.53.3. **Bite.** The bite is the lingual surface of an anterior denture tooth.

7.53.4. **Pins.** Porcelain teeth do not bond to a plastic denture base. Porcelain *anterior* teeth have pins that keep the teeth seated in the base material.

7.53.5. **Shut.** The shut is that portion of the lingual surface of an anterior porcelain denture tooth where the pins are located. There are no shuts or pins on acrylic resin denture teeth.

7.53.6. **Ridgelap.** The ridgelap is that portion of the denture tooth between the shut and the collar that laps over the ridge of the cast.

7.53.7. **Diatoric.** A diatoric is a hole located in the ridgelap of a *posterior* porcelain denture tooth that serves to hold the tooth to the denture base. Additional retention is obtained through vent holes, that extend from the diatoric to the mesial and distal surfaces of the porcelain denture tooth.

7.53.8. **Lingual Finish Line.** The lingual line of union between the tooth and the denture base is the lingual finish line.

7.53.9. **Identification Marks.** Identifying marks are found on the mesial portion of the ridgelap of each posterior tooth. One raised dot identifies a first premolar or a first molar; two dots indicate a second premolar or second molar (Figure 7.39).

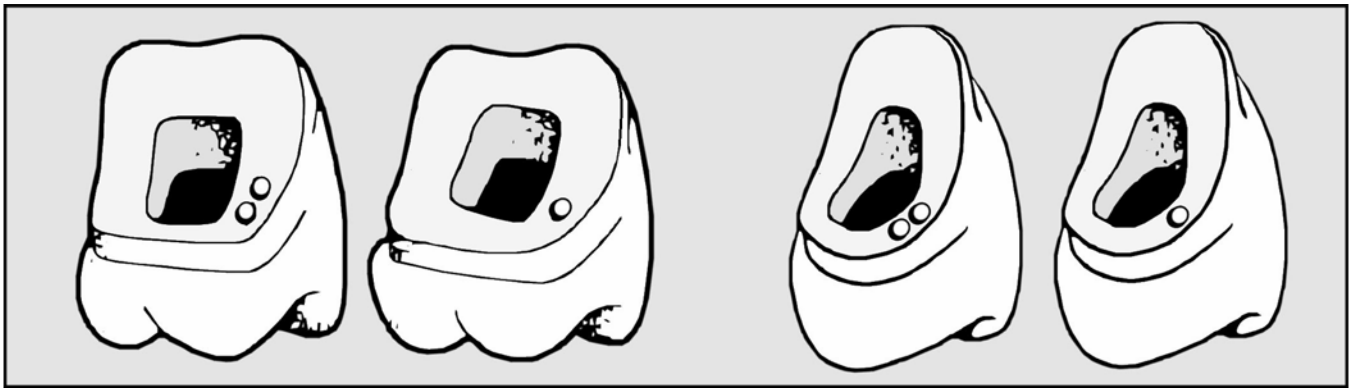
7.54. Design Features of Plastic Denture Teeth. Plastic denture teeth are retained within a denture base because the tooth and the denture base material bond together chemically. Ordinarily, there is no need for mechanical retention, but some of the newer filled resin plastic teeth do not bond well and require chemical treatment or diatorics. The design features of porcelain and plastic teeth are essentially the same except for the following differences:

7.54.1. A plastic anterior tooth does not have a shut or pins.

7.54.2. The extent of the ridgelap on a plastic anterior tooth is not limited by the shut. The ridgelap carries over to the lingual finish line area.

7.54.3. Resin posterior denture teeth do not have diatorics.

Figure 7.39. Denture Tooth Identification Dots.



7.55. Advantages and Disadvantages of Porcelain and Plastic as Denture Tooth Materials:

7.55.1. **Porcelain:**

7.55.1.1. Porcelain teeth are more lifelike in appearance than plastic teeth. They are more stain and wear resistant and are unaffected by solvents.

7.55.1.2. On the other hand, porcelain denture teeth abrades the natural tooth structure. Consequently, porcelain teeth are rarely used to oppose natural teeth. Another problem is that porcelain teeth are prone to fracture on impact. If the occlusal vertical dimension is excessive, opposing porcelain denture teeth may contact and "click" when the patient talks. Also, porcelain teeth cannot be custom ground for a space that is any smaller than leaving the pins or diatoric intact allows.

7.55.2. **Plastic:**

7.55.2.1. Although plastic teeth (when compared to porcelain counterparts) are less lifelike, less stain and wear resistant, and more likely to be damaged by solvents, plastic teeth have highly significant advantages. They can be safely ground to fit small spaces because the shearing strength of plastic in thin sections is much higher than porcelain. Also, some plastic teeth chemically unite with a denture base, and there are no worries about grinding away mechanical retention.

7.55.2.2. Plastic does not abrade enamel and it is the material of choice for denture teeth that oppose natural teeth. Further, when plastic teeth contact each other, they make almost no sound and are much less likely to chip or shatter than porcelain.

7.55.3. **Combination of Porcelain and Plastic Teeth in Complete Denture Setups.** There is no objection to using *plastic anterior* denture teeth and *porcelain posterior* teeth in a maxillary and mandibular complete denture setup, but using *porcelain anterior* teeth and *plastic posterior* teeth is not recommended. Because plastic abrades faster than porcelain, the patient has a tendency to develop premature contacts between upper and lower anterior teeth. This condition is highly destructive to anterior residual ridges.

7.56. Esthetic Factors in Selecting Anterior Denture Teeth:

7.56.1. The primary factor in selecting anterior denture teeth is the esthetic effect of the patient's total image. It is vitally important to match the size, shape, color, and arrangement of denture teeth to a person's anatomical measurements, face form, sexual characteristics, and age.

7.56.2. Pre-extraction records are excellent guides to the patient's original tooth shapes and arrangement. The best kind of record is a plaster cast of the patient's dental arch made before the teeth were extracted. Although very few patients have these types of casts in their possession, most can provide a full-face photograph showing their natural teeth.

7.56.3. In the absence of pre-extraction records, dentists and technicians categorize patients in various ways. Selecting, modifying, and arranging denture teeth are dictated by what usually holds true for the category of person. Selecting denture teeth for esthetic value centers around choosing the set's general size, shape, and color.

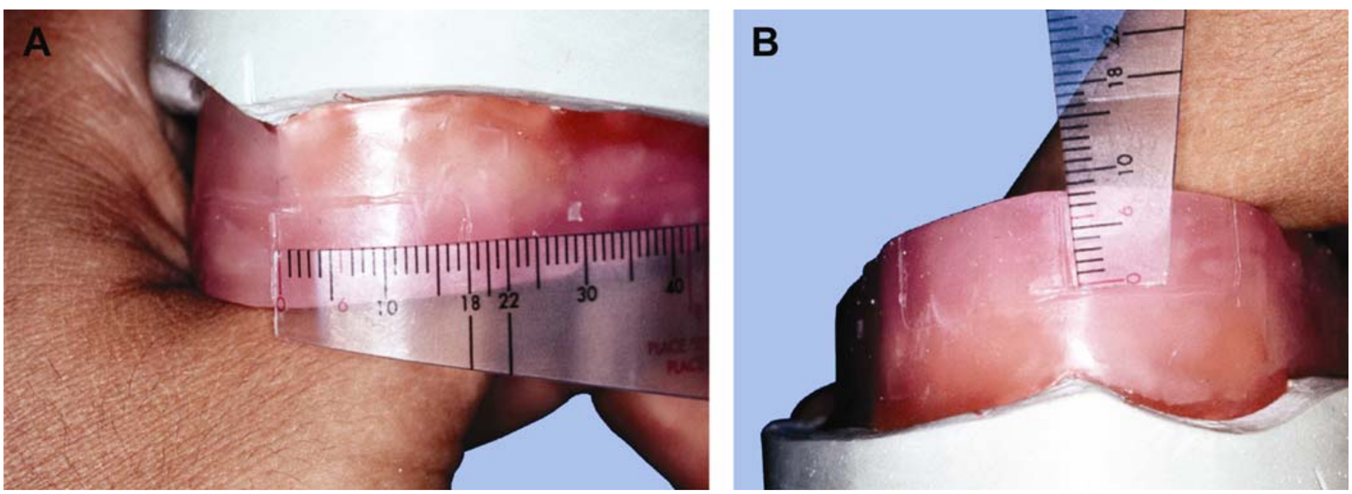
7.56.4. *Modification* means making personalized alterations to the size, shape, and color of the teeth in the set. Denture tooth *arrangement* means positioning teeth in a pleasing, functional manner. Modification and arrangement considerations appear in paragraph 7.73.

7.56.5. See paragraphs 7.57 through 7.59 for an outline of the principles associated with selecting and ordering a set of anterior denture teeth for esthetic value.

7.57. Selecting Maxillary Anterior Denture Teeth:

7.57.1. **Size.** Denture tooth *size* is a combination of facial length and width (Figure 7.40). To estimate the maxillary central incisor length, measure the occlusion rim between the occlusal plane and the high lip line. To find the collective width of the six maxillary anterior teeth, measure the distance between the canine lines and add 8 mm.

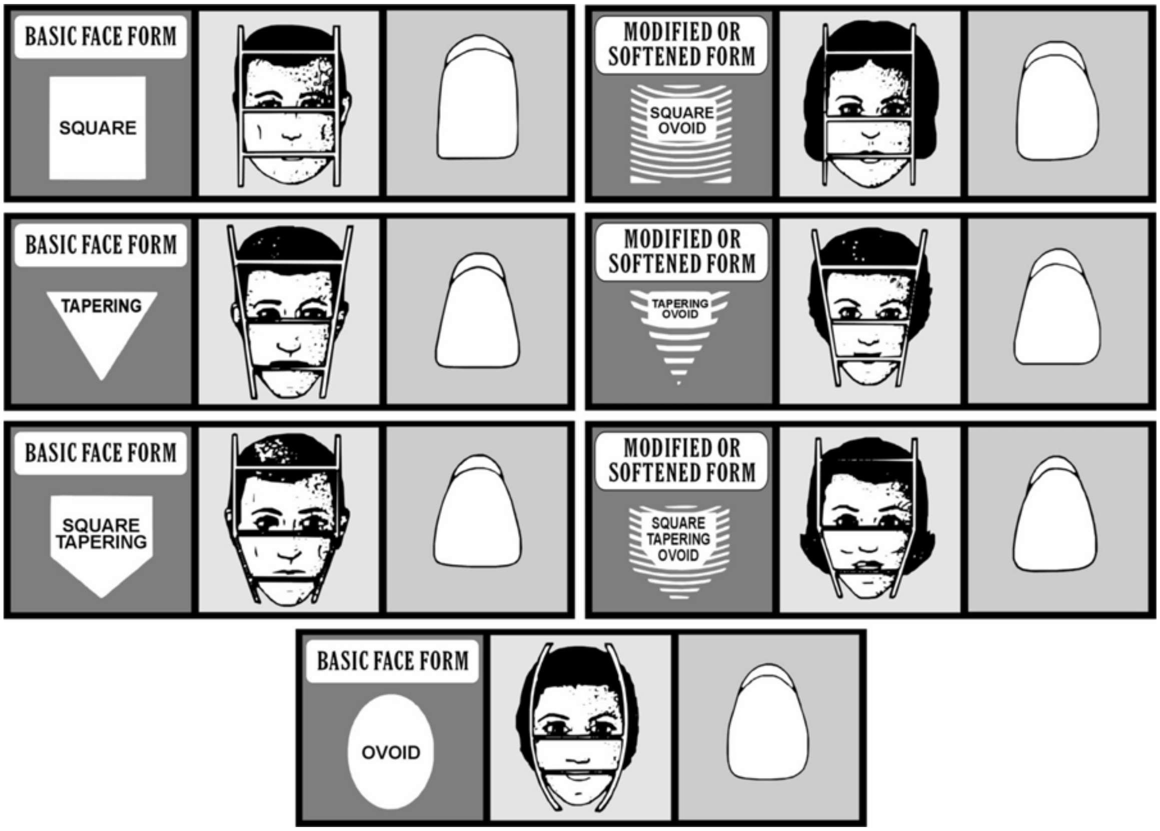
Figure 7.40. Selecting the Size of Maxillary Anterior Teeth.



7.57.2. **Shape (Mold).** Research has shown that an inverted maxillary incisor tooth has roughly the same shape as the person's face, both in the profile and frontal view. A tooth that approximates the shape of a patient's face looks good in that person's mouth. In profile, individuals have either flat or convex surfaces. Viewing people's faces frontally, *four basic face forms* and *three subgroups* have been defined in Figure 7.41 and the following subparagraphs: (***NOTE:*** This figure was adapted from material presented in *A Portfolio on Prosthetics,* Dentsply International Inc, York PA.)

7.57.2.1. **Square.** In this basic form, the sides of the cranium, the condylar areas, and the angles of the mandible fall on more or less straight, roughly parallel lines.

Figure 7.41. Typical Face Forms.



7.57.2.2. **Square Ovoid.** In this subgroup of the square form, the character of the square tooth is softened (rounder incisal corners and line angles) which makes it a more feminine tooth form.

7.57.2.3. **Tapering.** In this basic form, the tapering face is widest at the height of the sides of the cranium. The sides of the cranium, the condylar areas, and the angles of the mandible fall on more or less straight, converging lines.

7.57.2.4. **Tapering Ovoid.** In this subgroup of the tapering form, the tapering tooth is softened by a more rounded appearance, which makes it a more feminine tooth form.

7.57.2.5. **Square Tapering.** In this basic form, the sides of the head are parallel from the condylar areas upward. The facial outline tapers toward the angles of the mandible from the condyles downward.

7.57.2.6. **Square Tapering Ovoid.** In this subgroup of the square tapering form, the square tapering tooth is softened by a more rounded appearance, which makes it a more feminine tooth form.

7.57.2.7. **Ovoid.** In this basic form, the ovoid face is widest through the level of the condyles. The facial outlines curve inward above and below to form an oval. There is no subgroup for the basic, ovoid form.

7.57.2.8. **Different Forms for Men and Women.** The square, tapering, and square tapering face forms are highly angular and are usually associated with males. Subgroups are softer, less angular versions of their basic groups and are more feminine in nature. On the other hand, the basic, ovoid form may be characteristic of either a man or a woman. Each basic group and subgroup has a specific denture tooth mold associated with it. A dentist who believes in these theories makes a face form analysis and picks tooth shapes with *basic* forms for men and tooth shapes with *subgroup* or ovoid forms for women.

7.57.3. **Color (Shade).** Teeth are blends of grays and yellows, but traces of other colors will most likely be present. Color choice is mainly a function of the patient's age. Natural teeth absorb food and tobacco stains as people get older. Teeth tend to get darker with advancing years. One sure way to create a false-looking denture is to use very light teeth for an older person. An argument can be made for selecting light colored teeth for fair skinned, blond people because dark teeth would probably look unsightly. However, there is no justification for routinely choosing dark teeth for people with black hair and dark skins. A man's teeth might be a shade darker than a woman's teeth of the same age, but this is only a guide and is not universally true.

7.58. Ordering Anterior Maxillary Denture Teeth. Each manufacturer publishes a tooth mold chart that presents pictures of available shapes along with a statement of their sizes. The face form analysis of the patient helps develop a firm idea of the needs of the patient in terms of anterior tooth size, shape, and color. To order denture teeth, obtain the manufacturer's code for the set of maxillary anterior denture teeth that best fits the size and shape specifications. Then identify the tooth color appropriate for the patient on the manufacturer's shade guide.

7.59. Selecting Mandibular Anterior Denture Teeth. The mold chart indicates the mandibular anterior tooth size and shape that goes well with the chosen maxillary anterior tooth mold. However, a mold chart is only a guide. For example, a Class II or Class III case could dictate a step up or down in size, while shape and color remain constant.

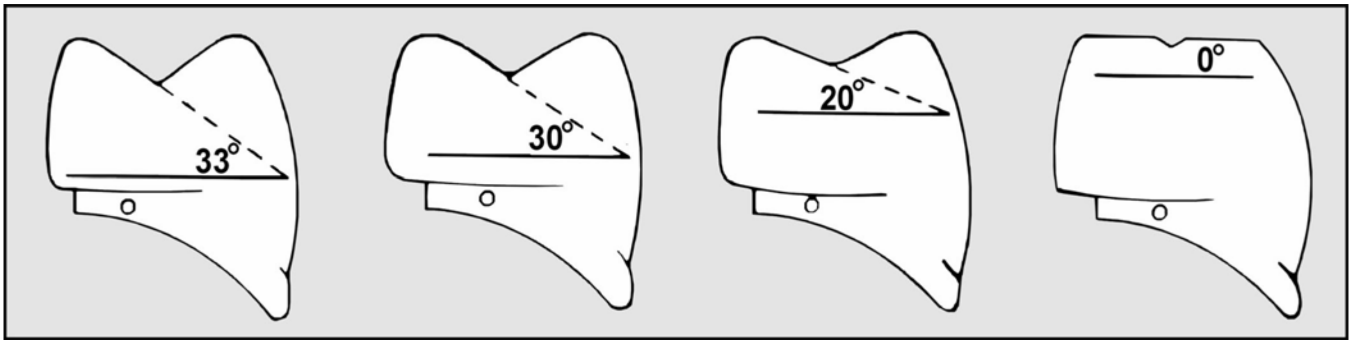
7.60. Functional and Esthetic Factors in Selecting Posterior Denture Teeth. The emphasis in selecting posterior denture teeth shifts from esthetics to function. *Esthetics* is still important, but *function* is more important when selecting posterior denture teeth. The choice between porcelain and plastic posterior teeth as well as tooth shape (mold) is the dentist's decision. *Size* can be the technician's choice.

7.60.1. **Posterior Denture Tooth Size.** Size factors considered are crown height and mesiodistal length. For practical purposes, the distance between the record base and the occlusal plane is measured to get an estimate of proper posterior tooth height. The combined mesiodistal length of the first premolar through the second molar is determined by measuring the millimeter distance from the distal of the maxillary canine denture tooth to the front of the maxillary tuberosity on both sides. The *lower* number is used.

7.60.2. **Posterior Denture Tooth Shape (Mold).** Posterior denture tooth *shape* refers to the presence or absence of cusps (Figure 7.42). The common denture tooth cusp angles are 33, 30, 20, and 0 degrees as follows:

7.60.2.1. **The 33- and 30-Degree Denture Teeth (Anatomic).** These posterior denture teeth look more natural in a patient's mouth and seem to have more chewing efficiency than teeth with smaller cusp angles. Complete dentures with anatomic denture teeth are more commonly made for patients with good residual ridges because these dentures have a tendency to be displaced when the mandible moves into lateral excursions. Residual ridges must have at least moderate vertical height to oppose this tendency.

Figure 7.42. Denture Tooth Cusp Angles.



7.60.2.2. **The 20-Degree Posterior Denture Teeth (Semianatomic).** The 20-degree posterior denture teeth enjoy a great deal of popularity. They cause less lateral, denture displacing force than 30-degree teeth and have better esthetics than 0-degree teeth.

7.60.2.3. **The 0-Degrees Denture Teeth (Nonanatomic).** These denture teeth have no cusp inclines; and they are supplied in porcelain, plastic, or plastic with metal inserts. They are rarely used in cases that require articulation with natural teeth. The 0-degree teeth are favored in cases where the patients have poor muscle coordination or poor ridges or when the ridges are in crossbite.

7.60.3. **Posterior Denture Tooth Color (Shade).** Because natural posterior teeth are darker than the anterior teeth in the mouths of most people, the dentist tends to choose a posterior denture tooth color that is one shade darker than the anterior shade selected.

7.61. Manufacturer's Coding of Posterior Teeth (1 x 8 Sets):

7.61.1. After the dentist selects a shade, the shape and size of the posterior teeth are chosen from a manufacturer's mold guide. A set of 1 x 8s has shade and mold codes printed on the mounting card. Most manufacturers use their own unique codes.

7.61.2. One manufacturer uses a number and a letter to code posterior tooth molds. The number refers to the tooth mesiodistal length in millimeters of the four maxillary posterior teeth of one side. The letter refers to their relative occlusogingival height ("S" for short, "M" for medium, and "L" for long). Short teeth measure about 7 to 8.5 mm.

7.61.3. As an example, a mold labeled "30L" would be a maxillary posterior set whose overall mesiodistal width of the four teeth on one side is 30 mm and whose individual teeth are more than 10 mm in length. Mandibular posterior denture teeth interdigitate only with maxillary posterior denture teeth of the same mold number; but they can be set against denture teeth of a different length. Thus, 30L maxillary posterior denture teeth occlude perfectly with 30S or 30M mandibular posterior denture teeth, but they do not occlude with 32L or 34L mold teeth. ***NOTE:*** Although number and letter codes have not been standardized, conversion charts are available.

Section 7L—Denture Tooth Arrangement (General)

7.62. Responsibilities and Objectives. It is the dentist's responsibility to get the proper jaw relationship records and accurate measurements in the patient's mouth. The technician makes sure the arrangement (positioning) of the denture teeth harmonizes with these limiting factors. There are at least three objectives in setting or arranging denture teeth. The first is to achieve the maximum chewing function and stability, the second is to avoid any interference with the patient's speech, and the third is to restore the natural appearance.

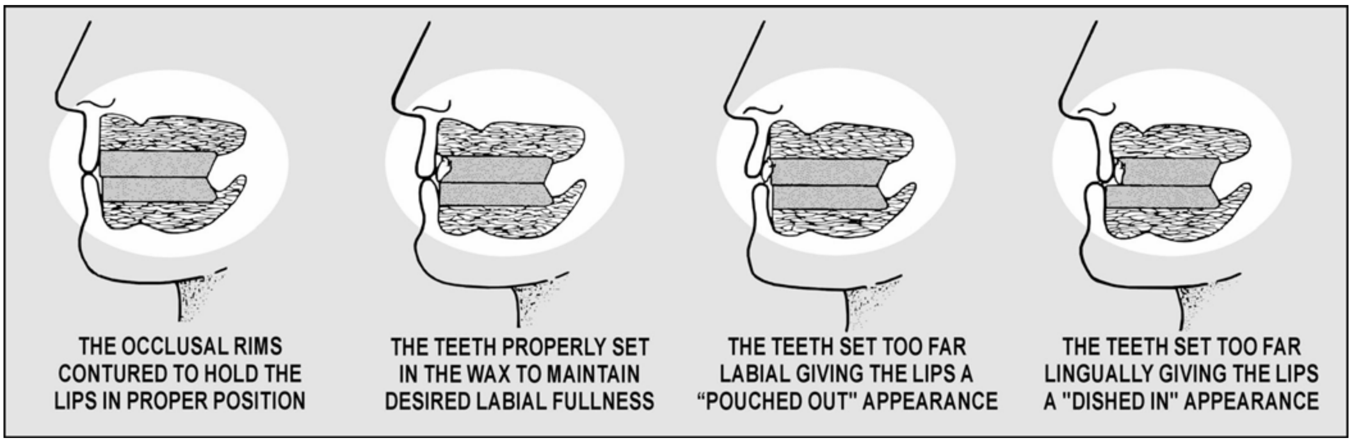
7.63. Gross Alignment of Anterior Denture Teeth:

7.63.1. The technician establishes a permanent midline reference by extending the midline mark on the maxillary occlusion rim onto the base of the maxillary cast. The maxillary central incisors are set on each side of this midline mark which corresponds to the middle of the patient's face.

7.63.2. The dentist has previously shaped the labial contour of the occlusion rim to give adequate support to the patient's lips. The dentist adjusted the anterior portion of the occlusal plane (also called the incisal plane) to expose about 1 mm of occlusion rim wax when the patient's lips were in a relaxed state. This is because the edges of the central incisors are normally visible when facial muscles are at rest. Due to progressive wear of natural dentition, more edge shows in the very young patient and less or no edge is visible in older patients. Finally, the dentist oriented the incisal plane parallel to an imaginary line drawn between the pupils of the patient's eyes.

7.63.3. After the dentist's efforts, the technician positions the labial surfaces of the maxillary anterior denture teeth on the occlusion rim's labial surface. The edges of most of the upper anterior teeth are set to touch the occlusal plane as developed by the dentist (Figure 7.43). The technician positions the mandibular central incisors on each side of the midline, and the mandibular anterior teeth should follow the labial shape of the mandibular occlusion rim.

Figure 7.43. Set Anterior Denture Teeth To Match Occlusion Rim Contours.



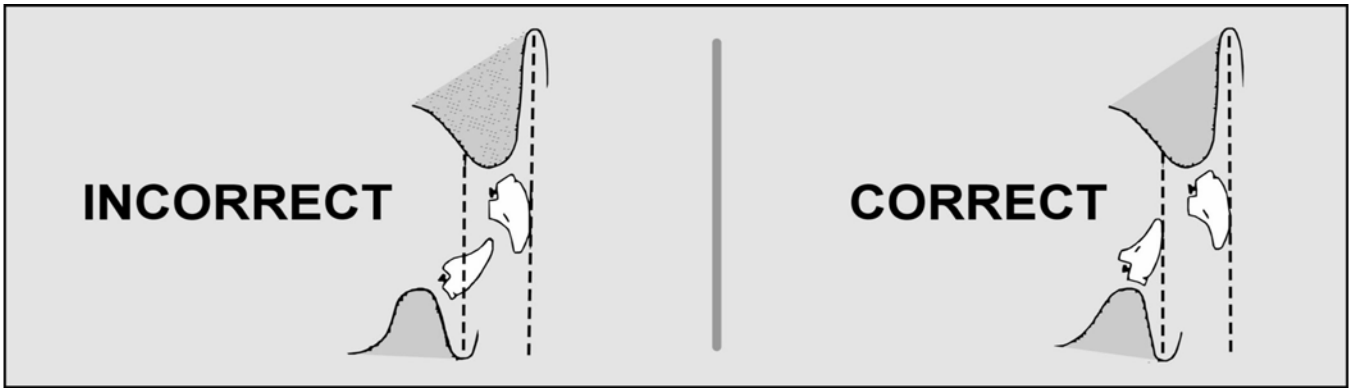
7.63.4. The esthetic and functional requirements of the denture occlusion being organized dictate the horizontal and vertical overlaps. For example, vertical overlap usually improves the appearance of a denture, but anterior teeth in some monoplane dentures that use 0-degree posteriors do not overlap vertically. Vertical overlap in a monoplane denture tends to reduce the denture's stability in lateral and protrusive occlusion.

7.63.5. The labial surfaces of mandibular anterior denture teeth conform to the labial contour of the occlusion rim. (***EXCEPTION:*** The facial surfaces of lower anterior teeth must not be positioned further labially than a line extending from the depth of the mandibular labial sulcus, which is also perpendicular to the occlusal plane [Figure 7.44].) Lower anterior teeth that are set forward of this line could be responsible for gross denture instability.

7.63.6. This guideline is most frequently violated when dentures are made for a patient with a Class II (retrognathic) jaw relationship. The dentist or technician mistakenly tries to produce dentures with a horizontal overlap that is characteristic of a Class I (normal) case. In Class II cases, enough horizontal overlap must be used to properly relate the lower incisors to the mandibular labial sulcus.

7.63.7. If contoured occlusion rims are not available to assist placement of anterior teeth, follow purely anatomical guidelines as a last resort. However, there is no assurance that complete reliance on these guidelines will yield an acceptable esthetic result.

Figure 7.44. Maximum Labial Placement of Lower Anterior Teeth.



7.63.8. If using anatomic guides, the incisive papilla is an excellent guide to the midline of the face. However, the maxillary labial frenum should not be used for such an estimate because it is unreliable.

7.63.9. Next, determine the position of the occlusal plane. The posterior edge of the plane should be located two-thirds of the way up the retromolar pad on both sides of the arch. Anteriorly, the plane is oriented equidistant between the upper and lower ridges, and the measurement is made in the midline. The edges of the maxillary central incisors and canines are set to contact this plane. The labial faces of the maxillary anterior teeth are made to fall on a line dropped vertically from the depth of the labial sulcus, and perpendicular to the occlusal plane. In similar fashion, the mandibular labial sulcus is used as a guide to position the mandibular anterior teeth.

7.64. Gross Alignment of Posterior Denture Teeth. In the anterior area, occlusion rim features almost always take precedence over anatomical landmarks as guides for setting teeth. When setting posterior teeth, the relative importance of intraoral anatomical guides increases because these guides have a very high level of reliability. If the posterior areas of occlusion rims are not fully contoured, posterior denture teeth can be confidently positioned by using key anatomical features as references. Be very suspicious of occlusion rim contours in posterior areas that deviate from intraoral anatomical guides. When questions arise, confer with the dentist.

7.64.1. **Identifying Anatomical Guidelines on the Cast.** On both sides, mark the projection of the following anatomical landmarks on the land area of the cast where they can be seen:

7.64.1.1. On the maxillary cast, the anterior borders of the maxillary tuberosities (Figure 7.45).

7.64.1.2. On the mandibular cast, point "A" depicting the anterior border of the retromolar pad and point "B" depicting the lingual border of the retromolar pad (Figure 7.46). Also on the mandibular cast, point "C" depicting a point two-thirds of the way up the length of the retromolar pad which is measured from its anterior border.

Figure 7.45. Maxillary Tuberosity Projection.

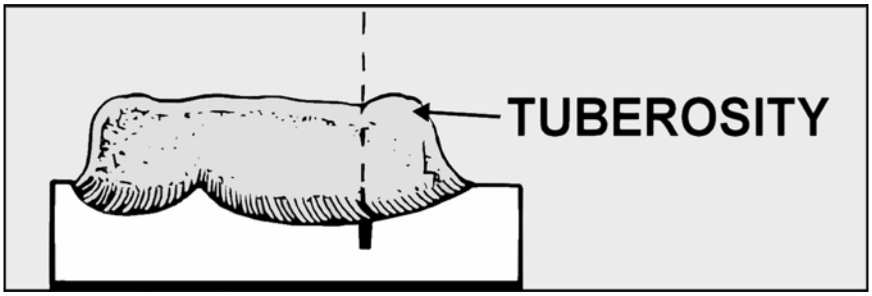
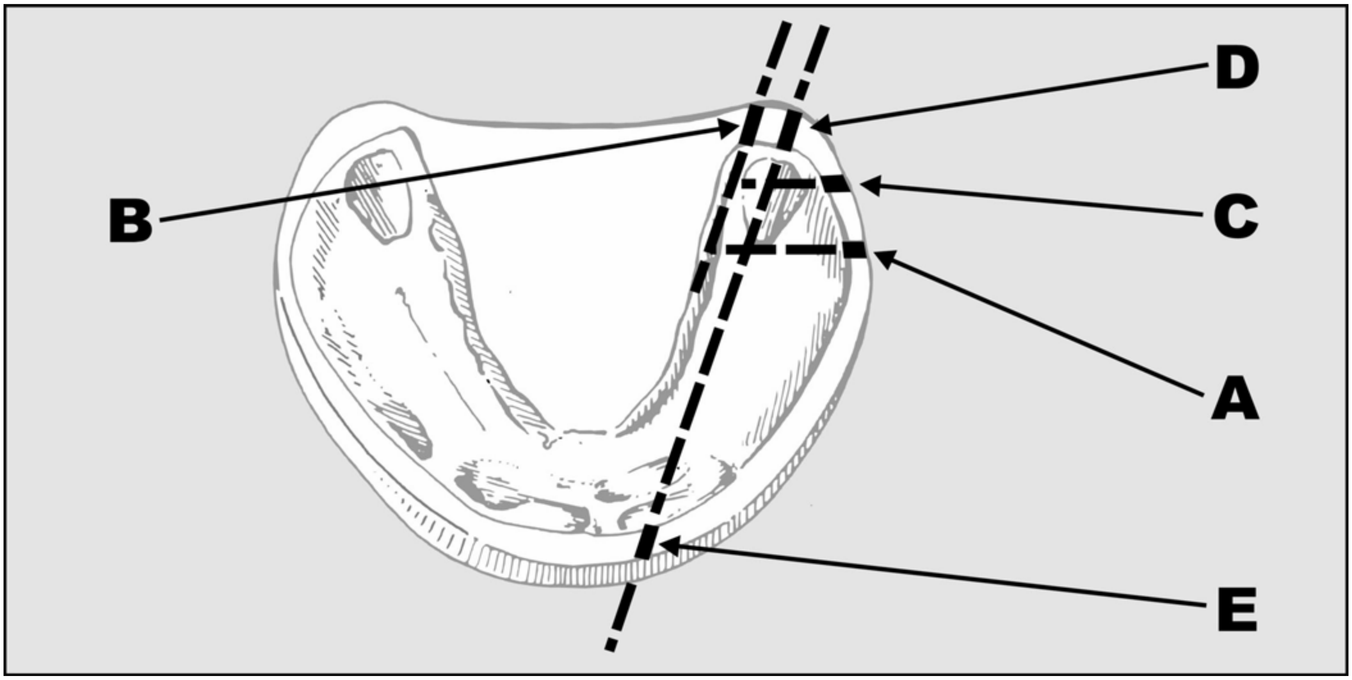


Figure 7.46. Mandibular Cast Landmarks.



7.64.1.3. Mark the anterior and the posterior points that define a line over the crest of the mandibular residual ridge (Figure 7.46, points "D" and "E"). This line passes through the canine region anteriorly, and the retromolar pad, posteriorly. Using points "D" and "E" as references, transfer this line to the occlusal surface of the mandibular wax rim (Figure 7.47).

7.64.2. **Crests of the Residual Ridges.** The crests of residual ridges are reliable for buccolingual positioning of posterior denture teeth as long as resorption is slight to moderate. Reliability decreases as the amount of resorption increases (Figure 7.48):

7.64.2.1. **Mandibular Residual Ridges:**

7.64.2.1.1. There is less support for a denture in the mandibular arch than for a denture located on the maxillary arch. The maxillary denture can take advantage of the support provided by the palate, which bears some of the chewing load. Mandibular ridges that support complete dentures can be expected to resorb faster than maxillary ridges.

7.64.2.1.2. One method used to keep resorption to a minimum is positioning mandibular posterior denture teeth as ideally as possible. Therefore, as a guideline for setting posterior denture teeth, the crest of the ridge in the mandibular arch takes precedence over the crest of the ridge in the maxillary arch. When resorption is slight to moderate, position the buccal cusps of mandibular posterior denture teeth over the crest of the mandibular ridge.

7.64.2.1.3. In many cases, maxillary posterior teeth are set before the mandibular posterior teeth. The central grooves of the maxillary teeth must be centered over the crest of the mandibular ridge (occlusion rim line) so the buccal cusps of the mandibular teeth fall over the crest of the mandibular ridge when the denture teeth contact in centric occlusion; that is, buccal cusps of the mandibular teeth in the fossae and embrasures of the maxillary teeth (Figure 7.49).

Figure 7.47. Crest of the Mandibular Ridge Marked on the Occlusion Rim.

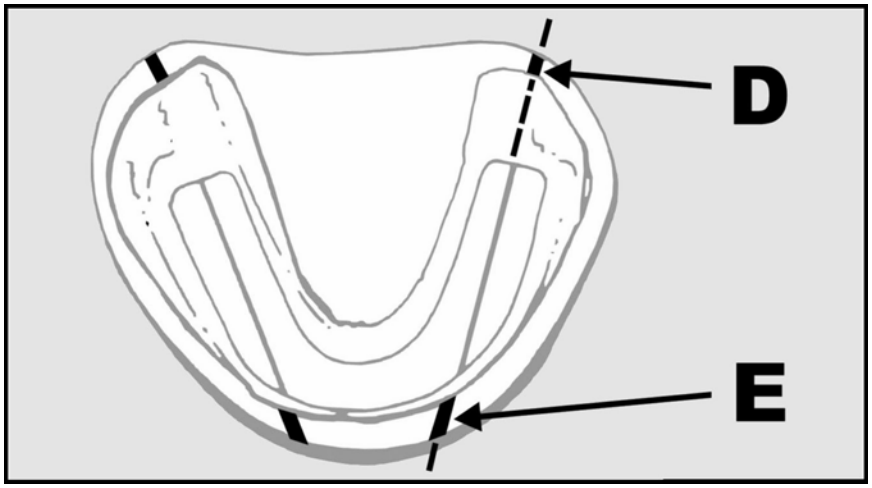
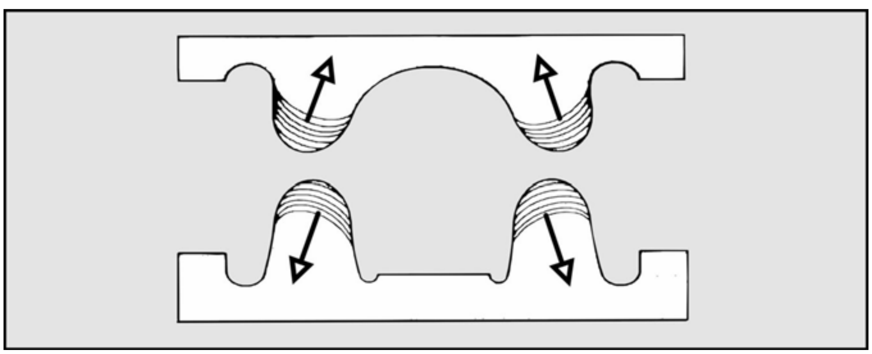


Figure 7.48. Edentulous Ridge Resorption Patterns.



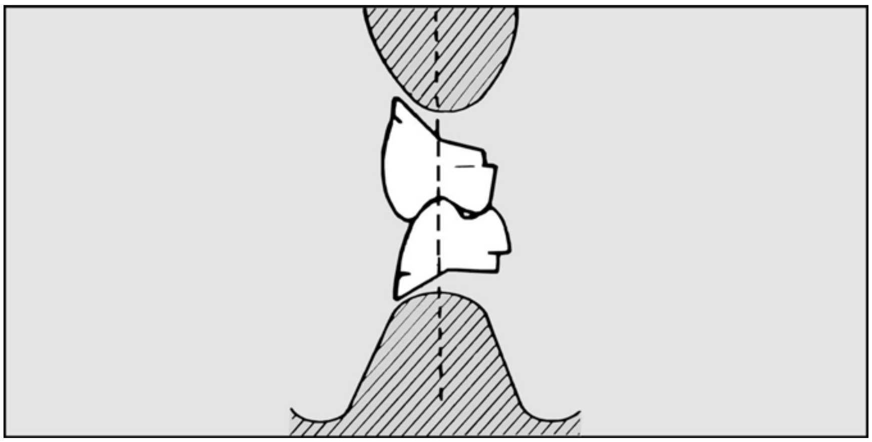
7.64.3. **Maxillary Residual Ridges:**

7.64.3.1. The buccolingual positioning of posterior denture teeth in the maxillary arch is largely dictated by the most favorable position for posterior denture teeth in the mandibular arch. When following this rule, the maxillary posterior denture teeth will be more or less centered over the crests of the maxillary ridges. Because mandibular ridges resorb downward and outward (Figure 7.48), maxillary posterior denture teeth are rarely placed too far *lingually* when a technician sets them; the tendency is to place them too far *buccally*.

7.64.3.2. The buccal surfaces of maxillary posterior denture teeth must not be placed any more buccally than a line perpendicular to the occlusal plane drawn into the depth of the buccal sulcus. If ideal positioning of mandibular posterior denture teeth forces placement of the maxillary posterior teeth more to the buccal than the rule allows, then it is not a normally related case. Under these circumstances, set denture teeth in crossbite (Section 7P). A good indicator of a possible crossbite situation is when the arch of the mandibular residual ridge is much larger than its maxillary counterpart.

7.64.3.3. Although the tuberosities are the most distal features of the maxillary edentulous ridge and are technically a part of it, denture teeth are not set on tuberosities. If maxillary posterior denture teeth extend on to the tuberosities, select a smaller size tooth or drop a posterior tooth from the setup. First premolars are the teeth usually omitted.

Figure 7.49. Mandibular Residual Ridge as a Landmark for Setting Teeth.



7.64.4. **Retromolar Pad.** The retromolar pad:

7.64.4.1. Is a guide to the combined anteroposterior length of the mandibular posteriors on one side. Denture teeth must never be set on a retromolar pad. If the combined anteroposterior length of a posterior mold is too great, either choose another size or drop a posterior tooth from the setup.

7.64.4.2. Can become a guide to the buccolingual position of the mandibular posteriors. If the mandibular residual ridge is virtually gone and it becomes unreliable as a guide for setting mandibular posterior teeth, the lingual cusps of the mandibular posterior teeth should lie within a triangle formed by the buccal and lingual boundaries of the retromolar pad and the mesial surface of the mandibular canine (Figure 7.50).

7.64.4.3. Is a guide to the superior-inferior positioning of the occlusal plane within the interarch space. The occlusal plane of a natural dentition projected from the anterior hits the retromolar pads posteriorly about two-thirds of the way up their length (Figure 7.51). Try to imitate this condition in complete denture construction. The occlusal plane is established by the first arch set. To establish the occlusal plane, position the anterior teeth to match the occlusion rim and use a flat metal plate to help position the posteriors (Figures 7.52, 7.53, and 7.54).

Figure 7.50. Retromolar Pad as a Landmark for Buccolingual Positioning of Mandibular Posterior Denture Teeth.

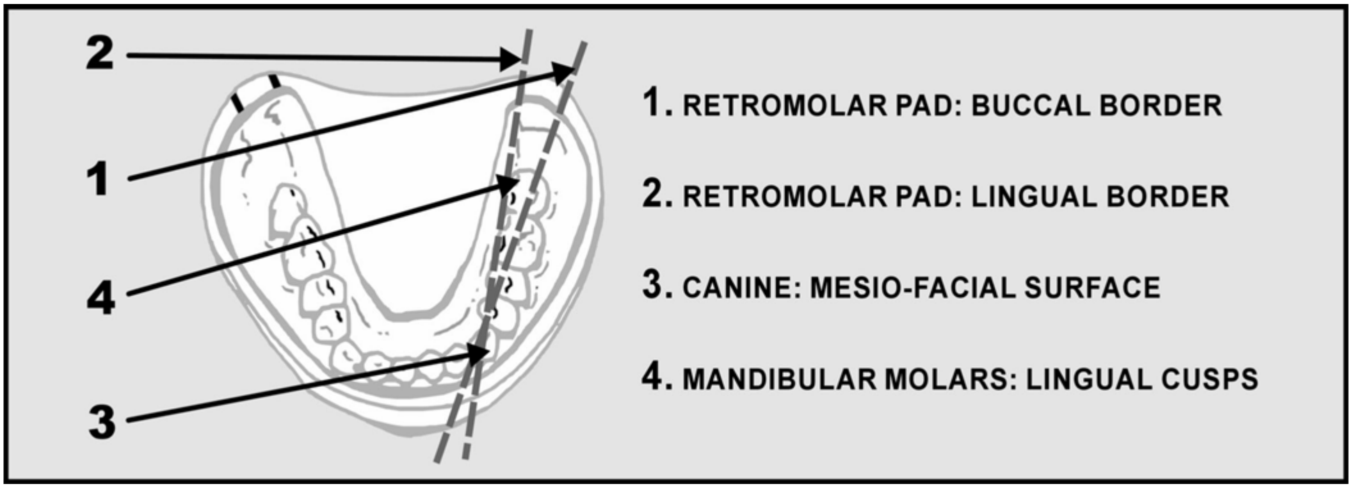
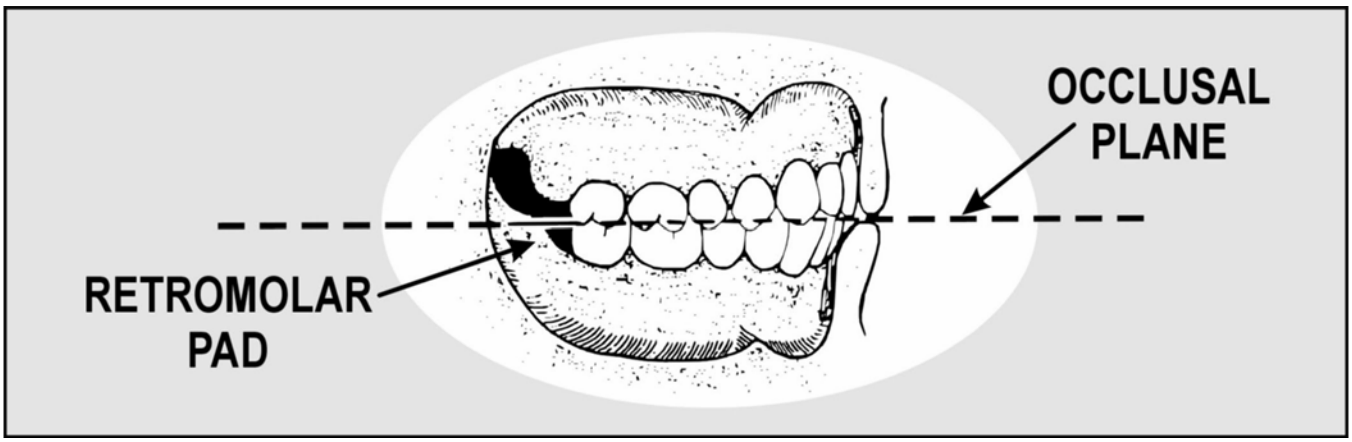


Figure 7.51. Relationship of the Retromolar Pad to the Natural Dentition.



7.65. Sequence of Arranging Denture Teeth. When individually arranging denture teeth in a systematic, regular sequence, the results are consistently better. One of the following sequences should be used:

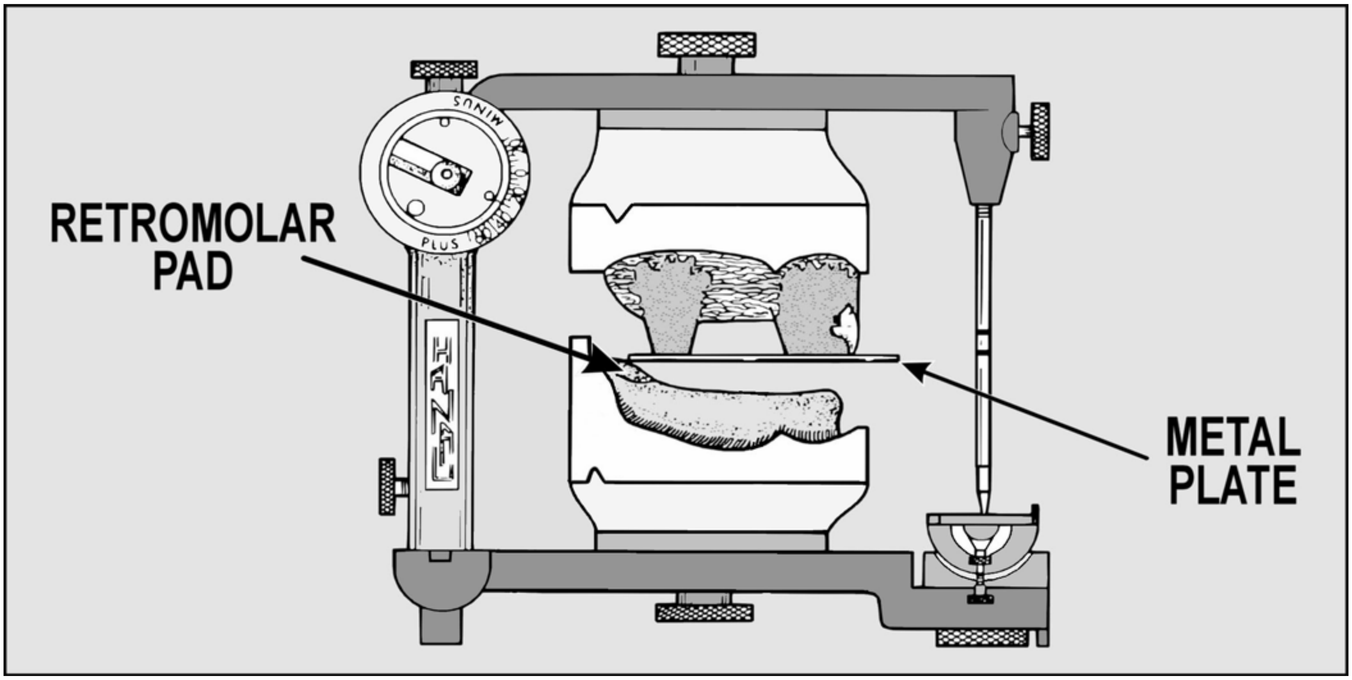
7.65.1. **Sequence #1 (Most Popular).** One of the most popular, this sequence uses maxillary anterior teeth first and then the maxillary posterior, mandibular posteriors, and mandibular anterior teeth as follows:

7.65.1.1. Set the two maxillary central incisors first and then the lateral incisor and canine on one side. The lateral incisor and canine on the opposite side complete maxillary anterior setup.

7.65.1.2. Place the maxillary first premolar, second premolar, first molar, and second molar on one side. Repeat the same sequence for the opposite side. Set maxillary posteriors against the top of a metal template (Figure 7.52).

7.65.1.3. Place the mandibular posterior denture teeth (except the premolars) in the following order: first, set the two first molars, bilaterally, next, position the second molar and second premolar on one side, and then position the second molar and second premolar on the other side.

Figure 7.52. Use of a Flat Template (Sequence #1).



7.65.1.4. Place the mandibular anterior denture teeth in the same order as the maxillary anterior denture teeth.

7.65.1.5. Position the mandibular first premolar denture teeth last.

7.65.2. **Sequence #2 (Used For 0-Degree Monoplane and 20-Degree Balanced Occlusion).** This sequence is commonly used for setting 0-degree posterior in monoplane occlusions and occasionally used for setting 20-degree posteriors in balanced occlusions. In this sequence, set the maxillary anterior teeth first and then mandibular anterior teeth. A flat metal plate establishes the occlusal plane in monoplane occlusions (Figure 7.53) and a curved 20-degree plate forms a compensating curve for balanced occlusions (Figure 7.54). Set mandibular denture teeth against the undersurface of the approximate metal template. Set the maxillary posteriors last.

7.65.3. **Sequence #3 (Alternate Method).** This sequence is maxillary anterior teeth, mandibular anterior teeth, maxillary posteriors, and mandibular posteriors.

7.65.4. **Additional Guidance for Sequences.** Some dentists set maxillary anterior denture teeth on the occlusion rim in the patient's mouth as a first step toward composing a complete setup. For all practical purposes, the rest of the arrangement is done on an articulator. In such situations, it is reasonable to follow arrangement sequence #1. A few dentists set the maxillary and mandibular anterior teeth while the patient is present. Depending on the dentist's wishes, either sequence #2 or #3 will apply.

7.66. Compensation for a Lack of Interarch Space. It is common for interarch space to be at a premium in complete denture construction. One solution is to use plastic denture teeth. If that does not help enough, cut out the interfering part of the record base, adapt a piece of tin foil to the cast slightly larger than the cut out area, and set the record base on the cast over the foil. Try to make as conservative a hole in the record base as possible.

Figure 7.53. Use of a Flat Plate for Monoplane Occlusions (Sequence #2).

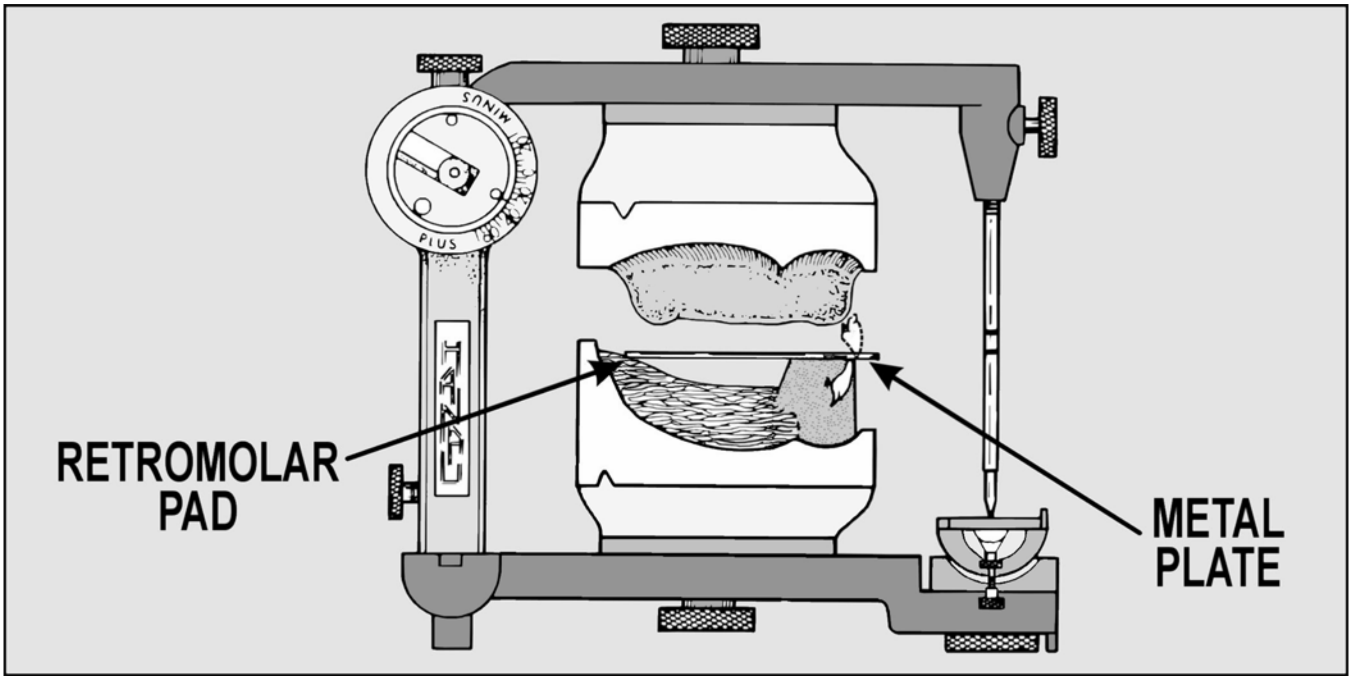
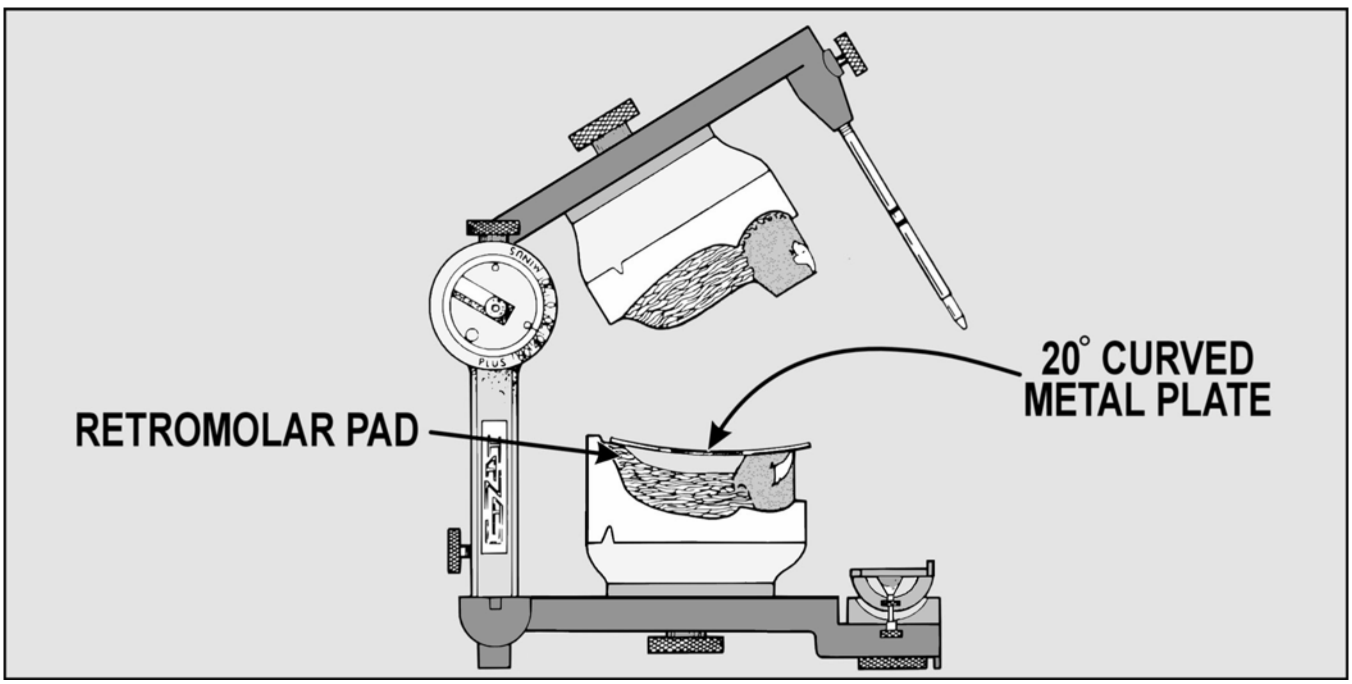


Figure 7.54. Use of a Curved Plate for Balanced Occlusions (Sequence #2).



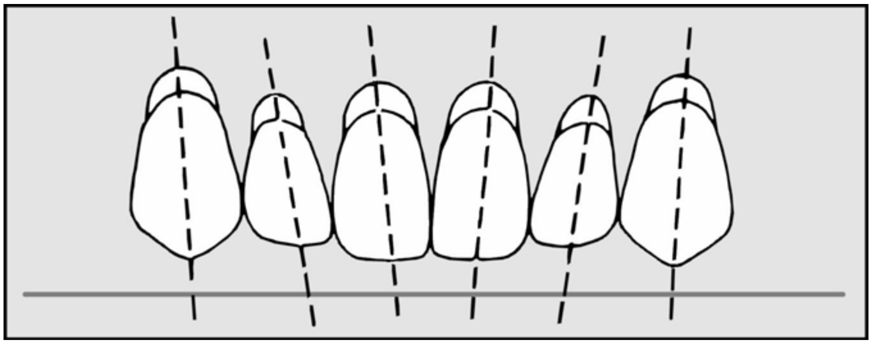
Section 7M—Arrangement of Anterior Denture Teeth

7.67. "Basic" Arrangement (Maxillary):

7.67.1. Other names for this type of maxillary anterior denture tooth alignment are symmetrical arrangement and silver-dollar setup. The term "silver-dollar" setup originated when technicians who prided themselves on their speed rapidly aligned the incisal edges of upper anterior teeth to match the rim of a silver dollar.

7.67.2. Another characteristic of the basic arrangement is that the axial inclinations of the maxillary anterior teeth are mirror images of each other from right to left side (Figure 7.55). This arrangement could represent an 18-year-old person who has perfectly formed teeth in ideal alignment. The arrangement is certainly possible, but it is almost too good to be true. When it is placed in the mouth of an average complete-denture patient who is 35 years or older, the silver-dollar setup stands out as false.

Figure 7.55. Axial Inclination of Maxillary Anterior Teeth in the "Basic" Arrangement.



7.67.3. The primary reason why the silver-dollar setup is put together at all is as a point of departure. The dentist or technician starts with this arrangement and then moves teeth into positions that give the setup more credibility.

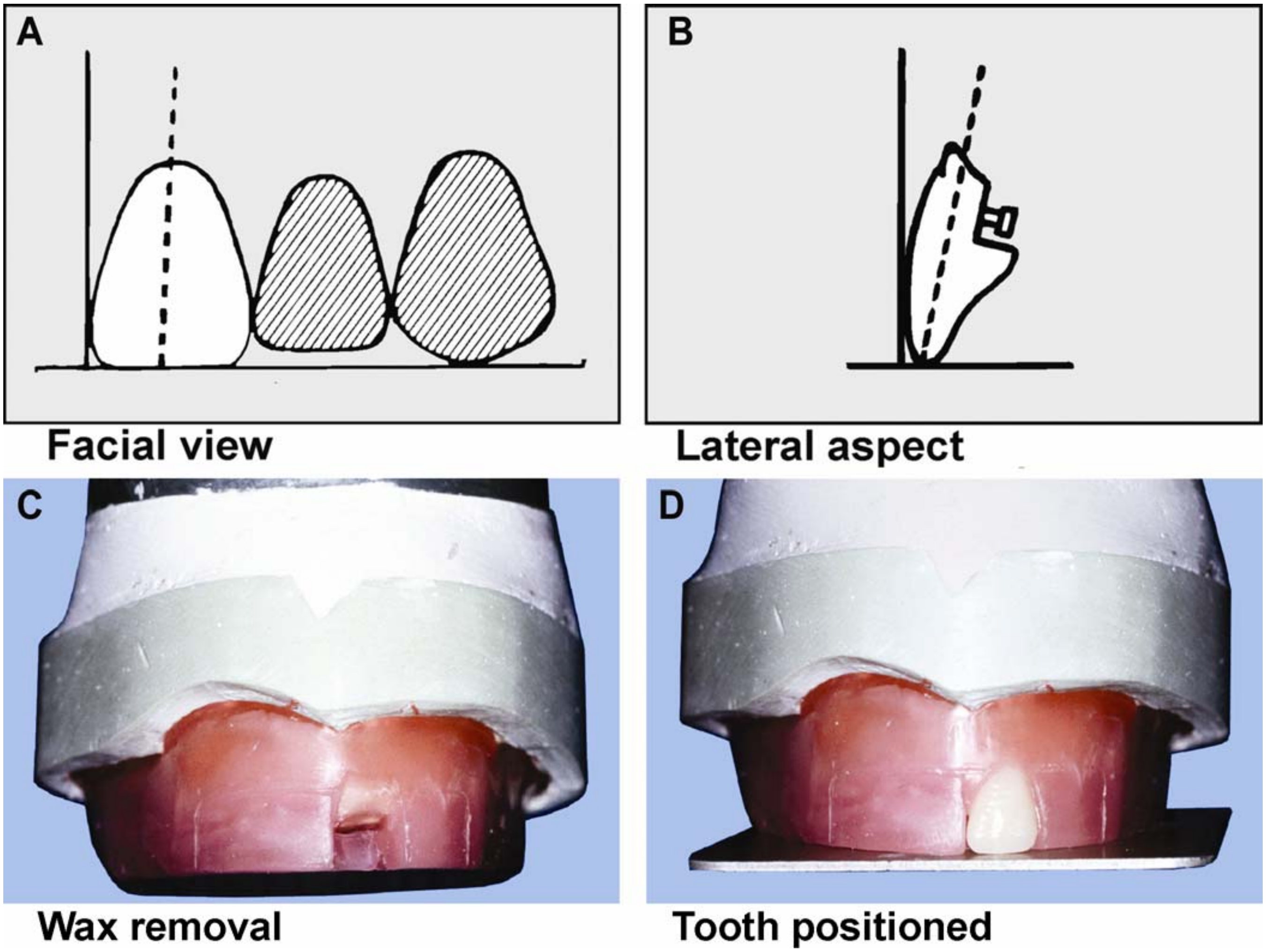
7.68. Guides and Procedures. The guides and procedures for aligning the maxillary anterior teeth are as follows:

7.68.1. **Central Incisor.** Cut out a block of wax large enough to accommodate the central incisor and seat the tooth in soft wax (Figure 7.56). Position the mesial surface on the midline. Position the tooth so the full mesiodistal width of the incisal edge contacts the incisal plane. This automatically tilts the long axis to the distal slightly, the neck of the tooth is somewhat depressed, and the incisal and middle thirds of the labial face are flush with the labial contour of the wax rim. Secure the tooth in place by flowing a small amount of molten wax around it. Position the other incisor in the same way.

7.68.2. **Lateral Incisor.** Prepare a cutout for the lateral incisor and place it in a bed of soft wax (Figure 7.57). Set the long axis of the lateral at an angle that is more distal to the perpendicular than the central. The incisal edge should be about 1 mm above the incisal plane. The neck should be more depressed than the neck of the central incisor. The incisal third should be flush with the labial contour of the wax rim. Seal the tooth in place.

7.68.3. **Canine.** The incisal tip of the canine rests on the occlusal plane (Figure 7.58). The long axis is cocked more distal to the perpendicular than the central incisor, but not as much as the lateral incisor. From a labiolingual point of view, the long axis is vertically oriented and the middle third of the labial surface is flush with the wax rim. The canine tooth is located at a corner of the dental arch. In keeping with its position, the canine has two definite planes on its labial face, a mesial plane and a distal plane. Align the mesial plane to follow the curve of the anterior teeth. Align the distal plane with the posterior teeth. Position the lateral incisor and canine on the opposite side and be sure to follow the contour of the occlusion rim (Figure 7.59).

Figure 7.56. Maxillary Central Incisor.



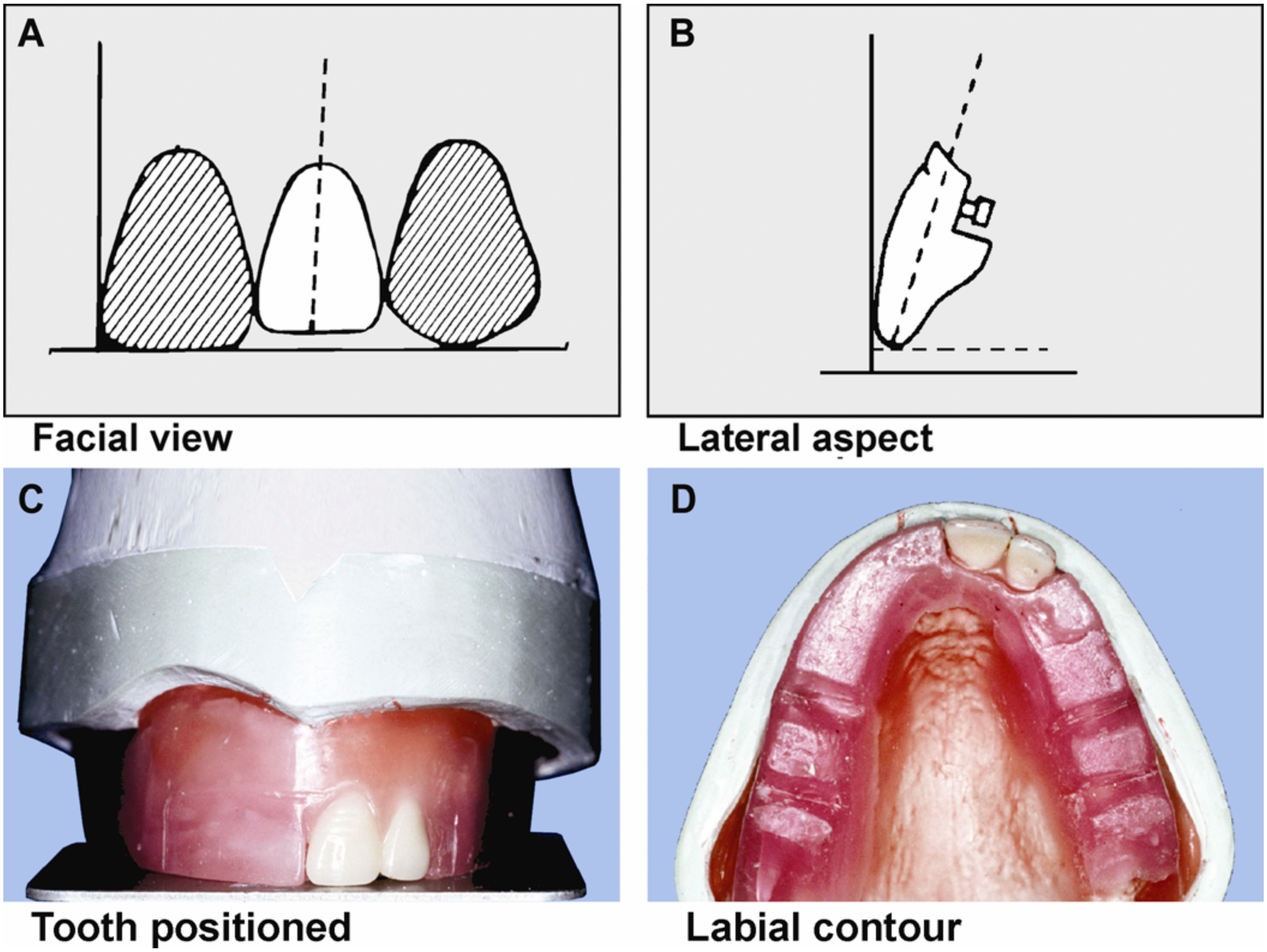
7.69. "Basic" Arrangement (Mandibular):

7.69.1. When a standardized mandibular tooth arrangement is used, the teeth are positioned on or are slightly facial to the mandibular ridge. If they are lingual to the ridge, they encroach on the space the tongue normally occupies. If they are too far facial to the ridge, the lower lip presses against them, and adverse leverages will tend to dislodge the denture.

7.69.2. The distance the maxillary anterior teeth extend over the mandibular anterior teeth in a vertical direction is the vertical overlap. The distance the maxillary anterior teeth project beyond the mandibular anterior teeth in a horizontal direction is the horizontal overlap (Figure 7.60). When teeth are in centric occlusion, the angle formed with the occlusal plane by a line drawn between the incisal edges of the upper and lower central incisors is the incisal guide angle.

7.69.3. Horizontal and vertical overlap varies with the kind of occlusion being organized (balanced versus monoplane), the posterior tooth mold used (20 degrees versus 30 degrees), and the tooth arrangement sequence employed. This pamphlet explains the details of a number of different complete denture occlusions. A suggested tooth sequence and specific directions for setting overlaps are given with the complete denture occlusion being described.

Figure 7.57. Maxillary Lateral Incisor.



7.70. Guides and Procedures. The guides and procedures for aligning the mandibular anterior teeth are described much like the maxillary anterior teeth.

7.71. Arch Form and Axial Inclination. The basic, uncharacterized arch form and axial inclination of mandibular anterior denture teeth are shown in Figure 7.61 and as follows:

7.71.1. **Central Incisor:**

7.71.1.1. The labiolingual inclination is slightly depressed at the neck.

7.71.1.2. The mesiodistal inclination is perpendicular to the occlusal plane.

7.71.1.3. The arch alignment is on the curve of the arch (occlusion rim).

7.71.2. **Lateral Incisor:**

7.71.2.1. The labiolingual inclination is perpendicular to the occlusal plane.

7.71.2.2. The mesiodistal inclination is a slight disal inclination.

7.71.2.3. The arch alignment is on the curve of the arch (occlusion rim).

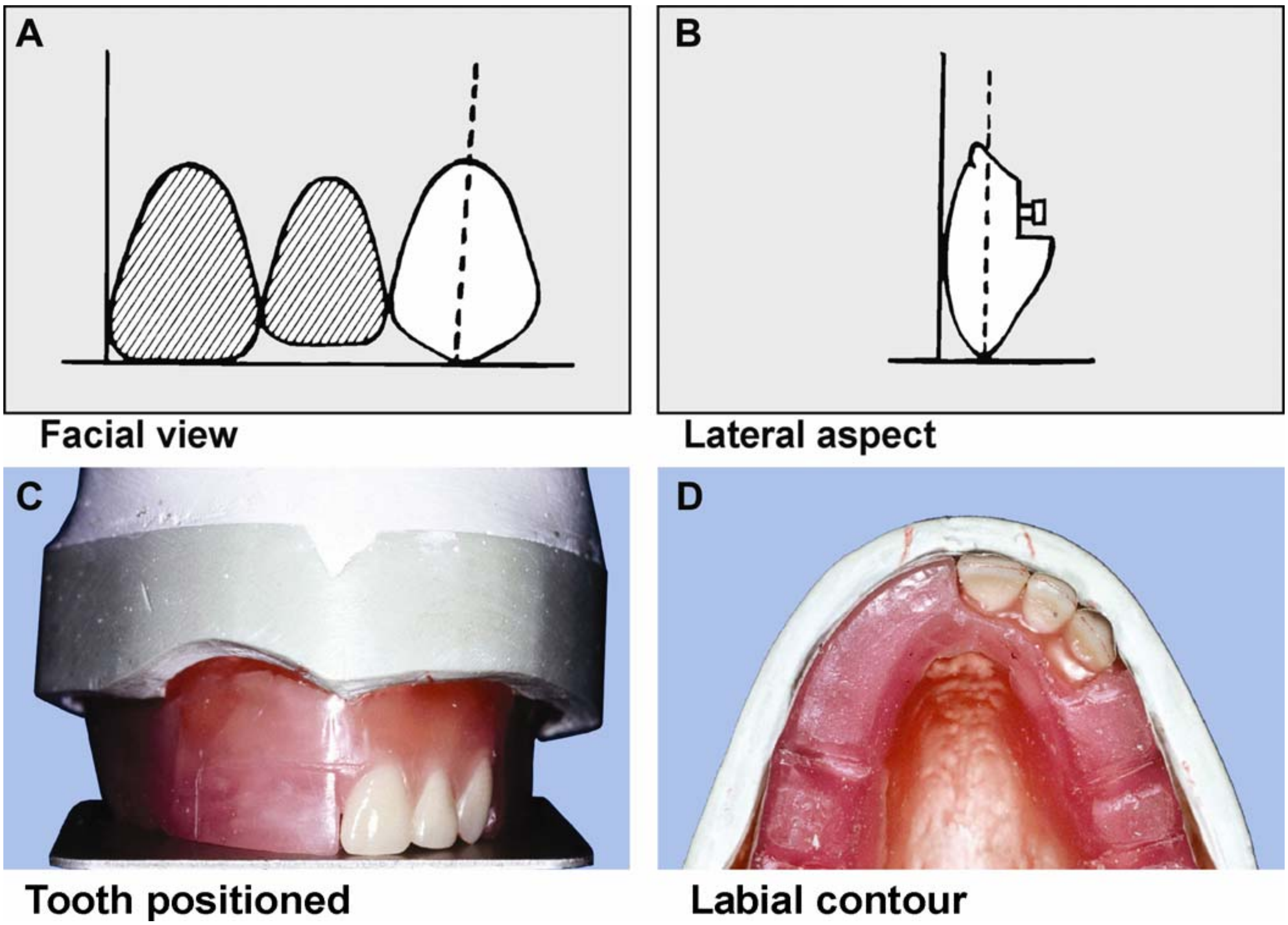
7.71.3. **Canine:**

7.71.3.1. The labiolingual inclination is inclined.

7.71.3.2. The mesiodistal inclination is more distally inclined than the lateral incisor.

7.71.3.3. In the arch alignment, the mesial half of the labial face conforms to the curve of the arch initiated by the incisors. The distal half of the labial surface is angled to match the posterior buccal alignment. ***NOTE:*** The two central incisors are usually set first, the lateral incisor and canine on a side are set next, and the lateral incisor and canine on the opposite side complete the setup.

Figure 7.58. Maxillary Canine.



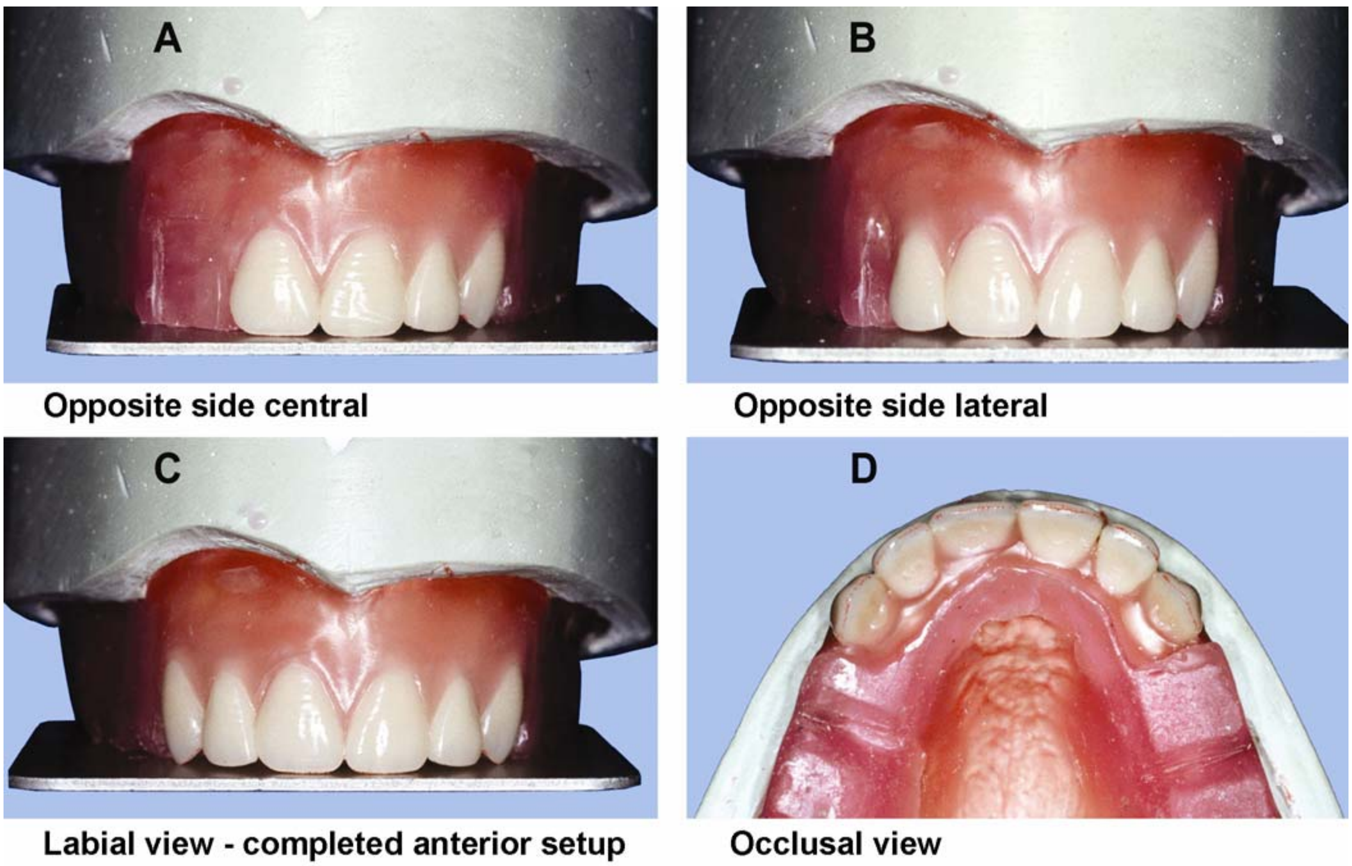
7.72. Characterizing Anterior Denture Teeth. Characterization is an attempt to coordinate the appearance of the prosthesis with the patient's anatomical measurements, face form, sex, and age. Race is also a consideration when choosing the color of a denture base material.

7.73. Modifying a Tooth's Basic Shape (Mold). The teeth in a set can be ground to produce special effects used for customizing denture tooth arrangements. The objective of characterized arrangement is to harmonize the appearance of the denture teeth with the unique features of the patient and existing dentition, as follows:

7.73.1. **Sex.** The mesial and distal corners of the maxillary incisors can be rounded to produce a more feminine appearance.

7.73.2. **Age.** Natural teeth wear down at varying rates as people grow older. One characteristic of age is that the incisal edge of the maxillary lateral incisor touches the occlusal plane. Besides setting the maxillary lateral incisor in this manner, grind the edges of the anterior teeth to simulate wear that is appropriate for the person's age. Men usually show more wear than women of the same age. When grinding the teeth, it is not necessary to grind all of them and no two teeth should be ground in exactly the same way.

Figure 7.59. Completed Maxillary Anterior Setup.



7.74. Organizing a Unique Set of Anterior Teeth Using Size, Shape, and Color Combinations from Different Sets:

7.74.1. **Size.** Wide maxillary lateral incisors are generally thought to be a masculine characteristic. Small, narrow lateral incisors are associated with femininity.

7.74.2. **Shape.** Square, angular molds are associated with masculinity. The ovoid forms are suppose to suggest femininity.

7.74.3. **Color (Shade).** Marked differences in color among anterior teeth are common in older people.

7.75. Composing a Suitable Arrangement. Arrangement is the manner in which the teeth of a denture relate to the residual ridge and to other teeth within the denture base. Some types of arrangements are as follows:

7.75.1. **Basic Arrangement.** This is the classical silver-dollar setup which has already been discussed in detail (paragraph 7.67). It is composed of teeth in perfect, symmetrical alignment. If an elderly patient is determined to have this kind of arrangement, grinding individual teeth within the arrangement for sex characteristics and wear patterns makes the setup more believable.

Figure 7.60. Horizontal and Vertical Overlap.

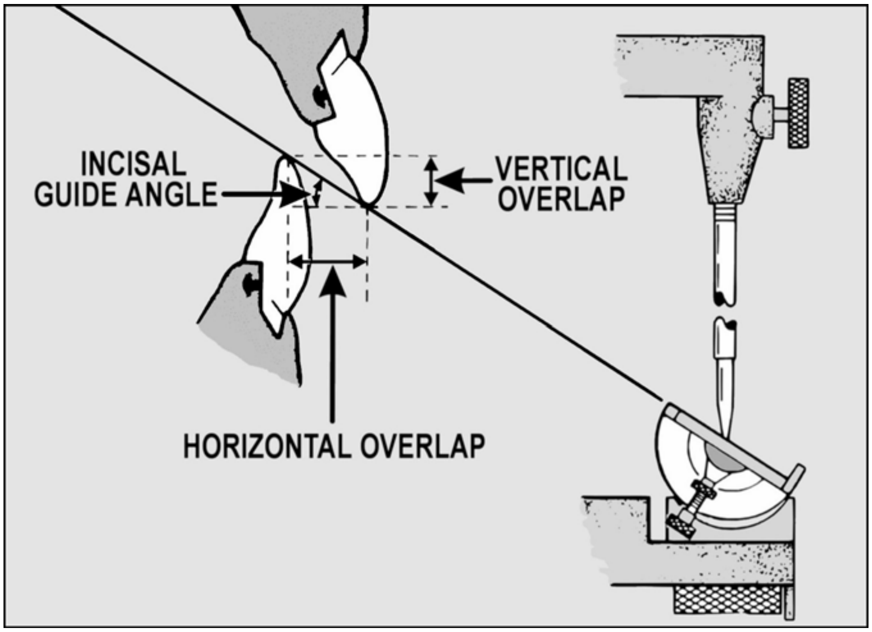
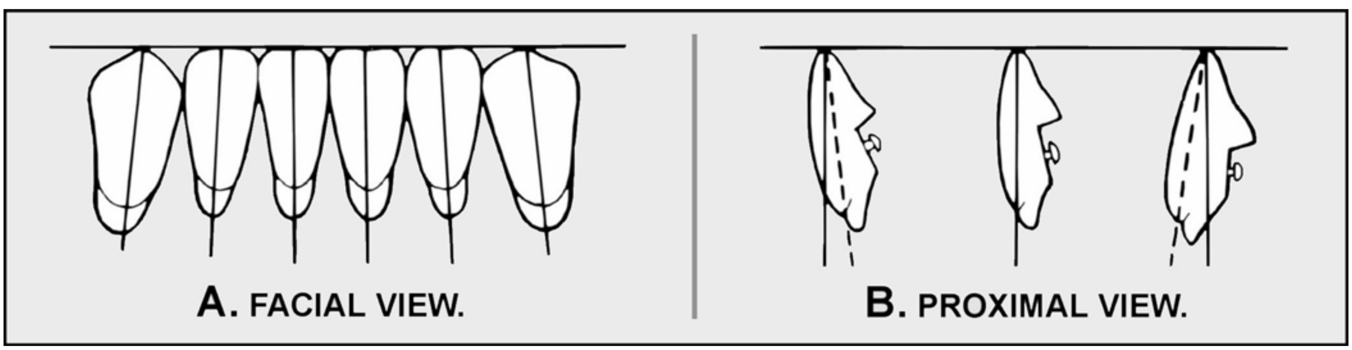


Figure 7.61. Axial Alignment of Mandibular Anterior Denture Teeth.



7.75.2. **Vigorous Arrangement.** A vigorous arrangement introduces a masculine element if rounded, feminine teeth are used, or it intensifies the masculine image when angular, masculine teeth are used. Some features of a vigorous arrangement are as follows:

7.75.2.1. To show more or less of a tooth's labial surface can make it look masculine or feminine. The order of increasing masculinity is as follows: The labial face is parallel to the curve of the arch, the distal surface of a tooth is rotated outward, the mesial surface is turned inward, and the mesial surface is lapped by the tooth mesial to it (most masculine).

7.75.2.2. The incisal edge of the maxillary lateral incisor is on the same plane as the maxillary central incisor. ***NOTE:*** This is characteristic of masculinity and old age.

7.75.2.3. When the long axis of a maxillary canine is set vertically from a labiolingual view, the orientation is considered neutral. When the inclination is more facial (protruded at the neck), the effect is more masculine.

7.75.2.4. The use of one or two small diastemas (spaces) can lend vigor to a setup. However, some patients have a fixation for ideal denture setups with chalk-white teeth. This kind of person would strenuously object to spacings between the teeth even though spaces were present before their natural teeth were extracted. Spacing effects should be used only at the direction of the dentist.

7.75.3. **Softened Arrangement.** Softened arrangements either introduces a feminine element when angular masculine teeth are used or intensifies femininity if rounded feminine teeth are used. For the most part, the features of this arrangement are opposite the vigorous type, as follows:

7.75.3.1. The labial face exposure of a tooth, in order of increasing femininity, is as follows: the distal surface is rotated inward to increase mesial surface exposure and the mesial surface laps over the distal aspect of the tooth mesial to it (more feminine).

7.75.3.2. The incisal edge of the lateral incisor is raised above the plane of the central incisor. (This is also a youthful characteristic.)

7.75.3.3. The long axis of a maxillary canine set vertically from a labiolingual view is considered neutral. Using this orientation as the baseline, the set of the canine is made feminine by depressing the neck.

7.75.4. **Asymmetrical Arrangements.** All tooth arrangements should be somewhat asymmetrical when the right and left sides of the setup are compared. However, the variety called asymmetrical is very obviously so. Facial asymmetry is more noticeable in some people than in others. One side of the face may be more angular or maybe even larger than the other side. It is common to assign male characteristics to the shape and arrangement of teeth on the hard side and female characteristics to the tooth shapes and arrangement on the soft side. A technician might make a personal decision for a vigorous or a soft arrangement, but the dentist usually makes a specific request for the asymmetrical variety.

7.75.5. **Crowded Arrangement.** Crowding is usually a result of natural teeth that are too large for the size of the arch. Also, a patient's natural mandibular anterior teeth become increasingly crowded as the patient becomes older. This arrangement shows generalized, moderate, and proximal overlapping of many of the anterior teeth.

7.75.6. **Spaced Arrangement:**

7.75.6.1. In the natural state, crowding is probably the result of large teeth in a small arch. Looking at the opposite situation, small teeth situated in a large arch often show considerable spacing among them.

7.75.6.2. Even though either condition could be there naturally, it is difficult to get patients to accept such arrangements in dentures because they tend to think crowding or spacing is ugly and usually want these features eliminated in artificial setups. Do not take the liberty of putting such arrangements together without very specific directions from the dentist. ***NOTE:*** Trying to create a totally masculine or totally feminine effect is usually a mistake. Few men present an absolutely perfect masculine image and the same is true of women and femininity. Most teeth show a majority of characteristics associated with their respected sex and a few traits of the opposite sex.

Section 7N—Balanced Complete Denture Occlusions

7.76. Goal of Complete Balanced Denture Occlusion:

7.76.1. The goal in completely balanced denture occlusions is to produce multiple contacts between maxillary and mandibular teeth in anterior and posterior areas, on the right and on the left, in lateral and protrusive excursions. Cusped teeth (33, 30, or 20 degrees) are usually used in balanced occlusions although 0-degree teeth can be used for this purpose.

7.76.2. In order for denture teeth to achieve maximum contact in all mandibular positions, a compensating curve must be incorporated into the posterior segments of the denture occlusion. When the molars are set with the compensating curve fully formed, the distobuccal cusp of the maxillary second molar must be no higher than the highest part of the retromolar pad.

7.76.3. Initial development of the occlusal plane begins with the incisors and premolars. After the second premolars are set, the posterior projection of the occlusal plane should hit two-thirds of the way up the retromolar pads. If the plane is not properly begun with the incisors and premolars, there is a chance of coming out too low or too high in relation to the pads after the compensating curve is formed.

7.76.4. Set the maxillary anterior teeth first (paragraph 7.67), followed by the maxillary posteriors. Center the fossae and central groove of the maxillary posteriors over the crest of the mandibular ridge, buccolingually. The buccal aspect of the maxillary posteriors must not be set lateral to a line dropped perpendicular into the depth of the maxillary buccal sulcus. Do not set teeth on the tuberosities.

7.76.5. Next, set the mandibular posteriors. Situate the buccal cusps over the crest of the ridge. Do not set teeth on the retromolar pads. When setting the lower teeth to develop lateral excursion balance, be sure to incorporate sideshift into the lateral test movements. To get full sideshift value, follow the directions in paragraph 6.21. Complete the setup by positioning the mandibular anterior teeth.

7.77. Arrangement of Cusped Maxillary Posterior Teeth. Remove the occlusion rim from the mandibular cast. Find the longest straight segment of the residual ridge on the right and left sides. Place reference marks on the anterior and posterior land areas of the cast. Return the mandibular occlusion rim to the cast. Using the reference marks as guides, register the right and left crests of the residual ridge on the top surface of the mandibular occlusion rim. Position each maxillary posterior denture tooth on one side, one at a time, relative to the crest of the mandibular ridge and in relation to a flat metal plate which represents the occlusal plane (Figures 7.47 and 7.52), as follows:

7.77.1. **Recommend Space Inclusion.** Create a 0.5 mm space between the distal surface of the maxillary canine and the mesial of the first premolar. The space makes the final positioning of the mandibular first premolar tooth easier. Set all upper posteriors in proximal contact.

7.77.2. **Forming the Compensating Curve Pattern for All Cusped Maxillary Posteriors (Except Pilkington-Turner 30-Degree Teeth):** (***NOTE:*** See Figures 7.62 through 7.64.)

7.77.2.1. **Maxillary First and Second Premolars.** Place the maxillary first premolar with its long axis at right angles to the occlusal plane. Place the buccal and lingual cusps on the plane. Position the maxillary second premolar in a similar manner.

7.77.2.2. **Maxillary Molars.** Arrange the buccal cusps of the molars to form an angle of about 6 degrees with the occlusal plane, beginning at the buccal cusp of the second premolar. Place the mesiolingual cusp of the first molar on the plane. Starting with this cusp, the remaining lingual cusps should form an angle of 6 degrees with the plane and be more or less parallel with the line of the buccal cusps. The mesiolingual cusp of the first molar touches the plane, and the mesiobuccal cusp is raised 0.5 mm out of contact. The distolingual cusp is raised 0.5 mm and the distobuccal cusp is 1 mm off the plane. The mesiolingual cusp of the second molar is 0.75

mm off the plane, and the mesiobuccal cusp is 1.25 mm raised out of contact. The distolingual cusp is raised 1.5 mm.

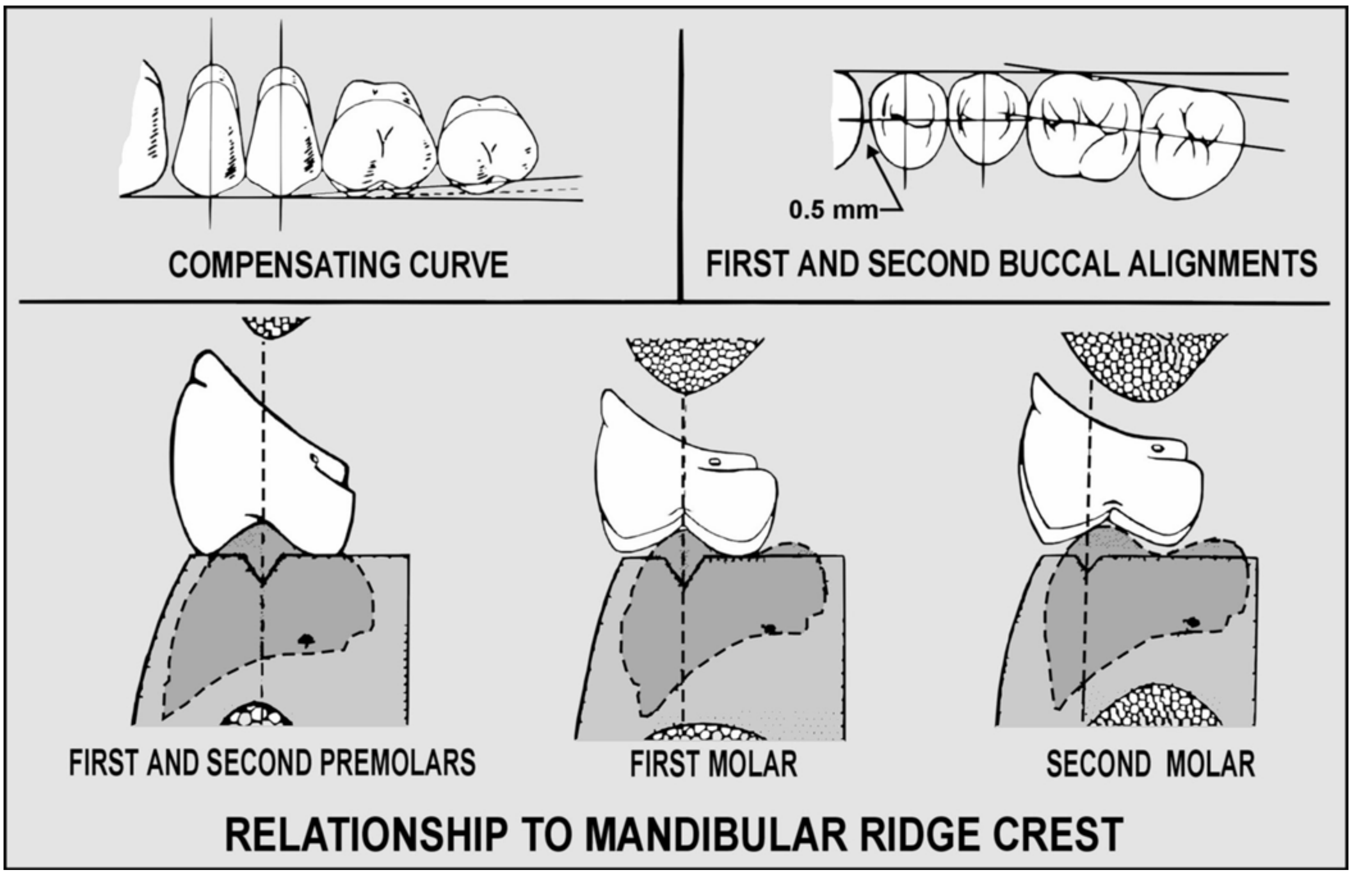
7.77.3. **Pilkington-Turner 30-Degree Maxillary Posteriors.** The compensating curve characteristics of Pilkington-Turner teeth differ slightly from other cusped forms (Figure 7.65), as follows:

7.77.3.1. **Maxillary First and Second Premolars.** From a facial view, the long axes of the premolars are perpendicular to the plane. The lingual cusps of the first and second premolars touch the plane, and the buccal cusps are raised 0.5 mm.

7.77.3.2. **Maxillary First Molar.** The mesiolingual cusp touches the plane, and the mesiobuccal cusp is raised 0.5 mm out of contact. The distolingual cusp is raised 0.5 mm, and the distobuccal cusp is 1 mm off the plane.

7.77.3.3. **Maxillary Second Molar.** The mesiolingual cusp is 0.75 mm off the plane, and the mesiobuccal cusp is 1.25 mm raised out of contact. The distolingual cusp is 1 mm off, and the distobuccal cusp is raised 1.5 mm.

Figure 7.62. Maxillary Arch Arrangement of Cusped Posterior Teeth (Except Pilkington-Turner Posteriors).



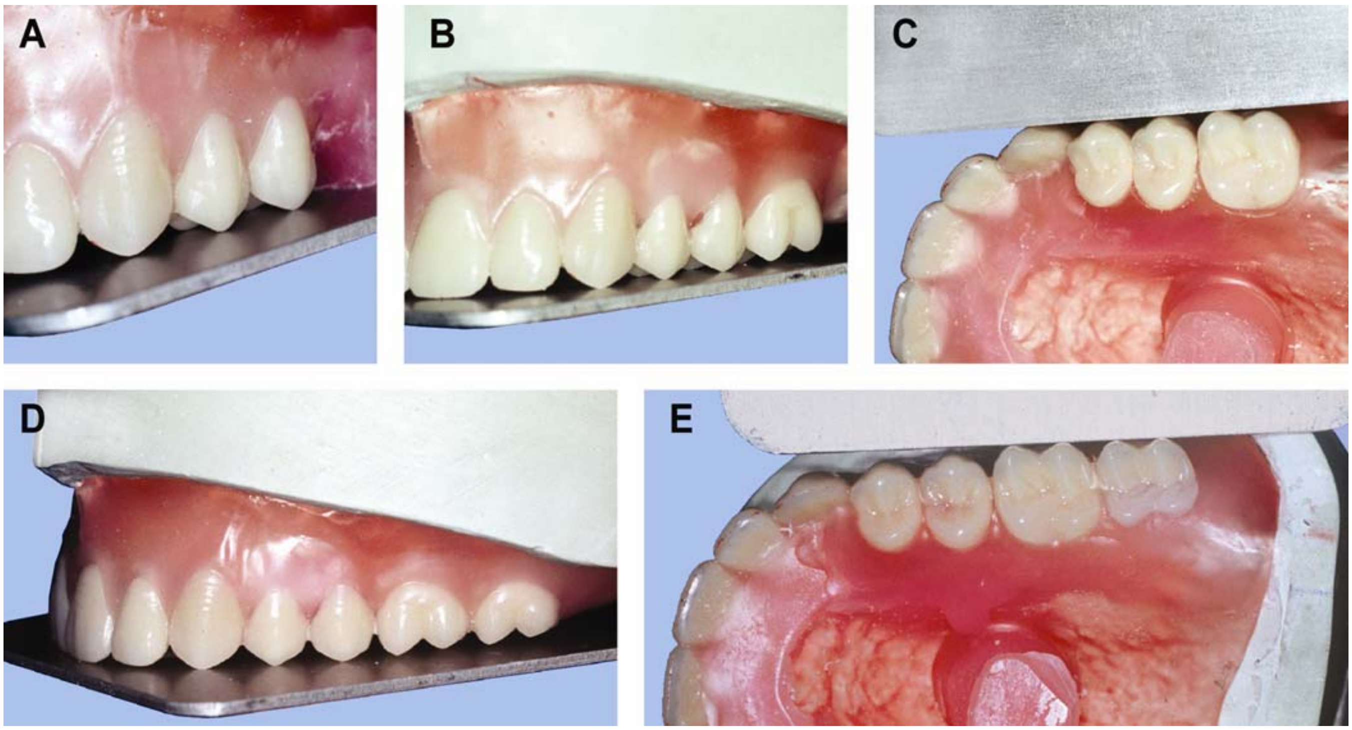
7.77.4. **First and Second Buccal Alignments.** The buccal alignment of maxillary posterior denture teeth is the same for all cusped forms, as follows:

7.77.4.1. **First Buccal Alignment.** Align the labial ridge of the canine, the buccal ridges of the first and second premolars, and the mesial buccal ridge of the first molar (Figure 7.63-C).

7.77.4.2. **Second Buccal Alignment.** Align all four buccal ridges of the molars so they are on a separate straight line from the first alignment (Figure 7.63-E).

7.77.5. **Stabilizing the Alignment.** After setting both sides of the maxillary arch, flow wax around the collars of the teeth to fix them in place securely. Few (if any) changes should be necessary in the maxillary arch from this point on.

Figure 7.63. Setting Maxillary Left Posterior Teeth Using a Flat Template.



7.78. Setting Cusped Mandibular Posterior Teeth for Balance. The procedures for developing balance are the same for all cusped teeth. To get an idea of what is expected, paragraphs 7.78.1.1 through 7.78.1.4 depict typical centric, working, balancing, and protrusive excursion contacts (occlusions), respectively. Carefully and closely follow these directions for setting each kind of tooth.

7.78.1. **Mandibular Left First Molar:**

7.78.1.1. **Centric Occlusion (Figure 7.66).** Attach a cone of soft wax to the left mandibular first molar. Place the tooth on the mandibular record base in the approximate position it will assume in centric occlusion. Close the articulator. From the buccal view, while the wax is still soft, position the tooth so the mesiolingual cusp of the maxillary first molar seats in the central fossa of the mandibular first molar. The triangular ridge of the mesiobuccal cusp of the upper first molar rests in the buccal development groove of the lower first molar. From the lingual view, the mesiolingual cusp of the upper first molar is seated in the central fossa of the lower and the mesiolingual cusp of the lower first molar fills the lingual embrasure between the upper second premolar and the first molar.

Figure 7.64. Completed Maxillary Arch Setup.

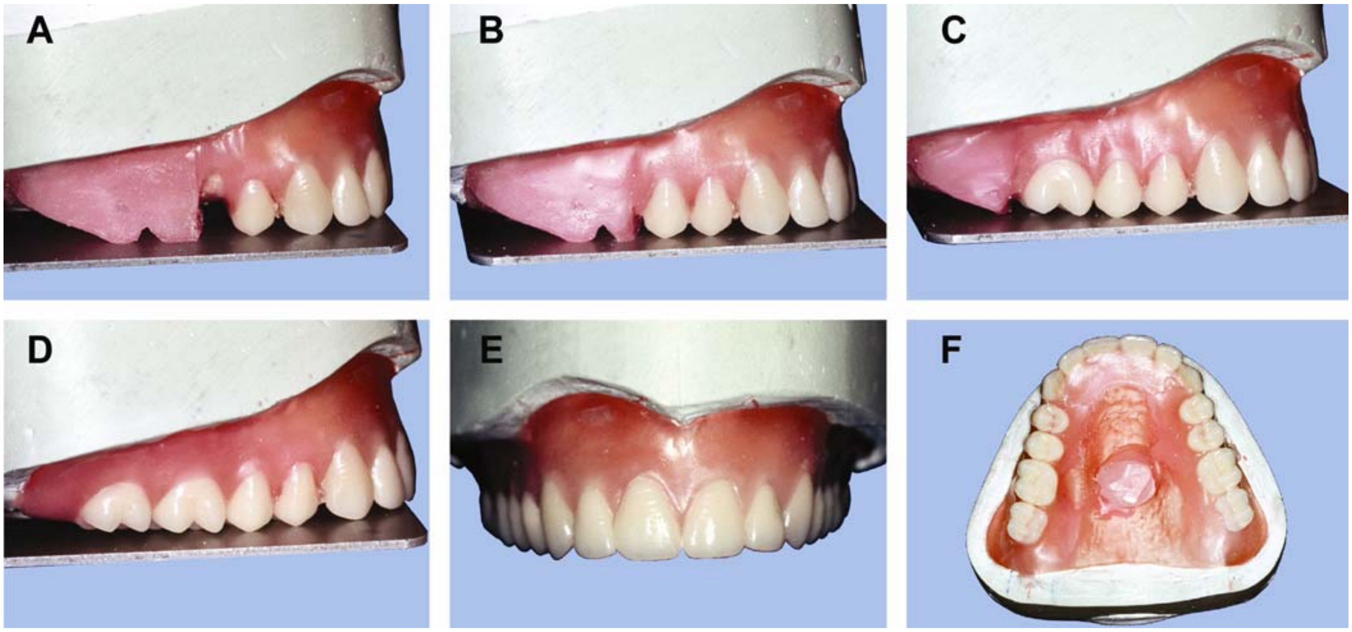
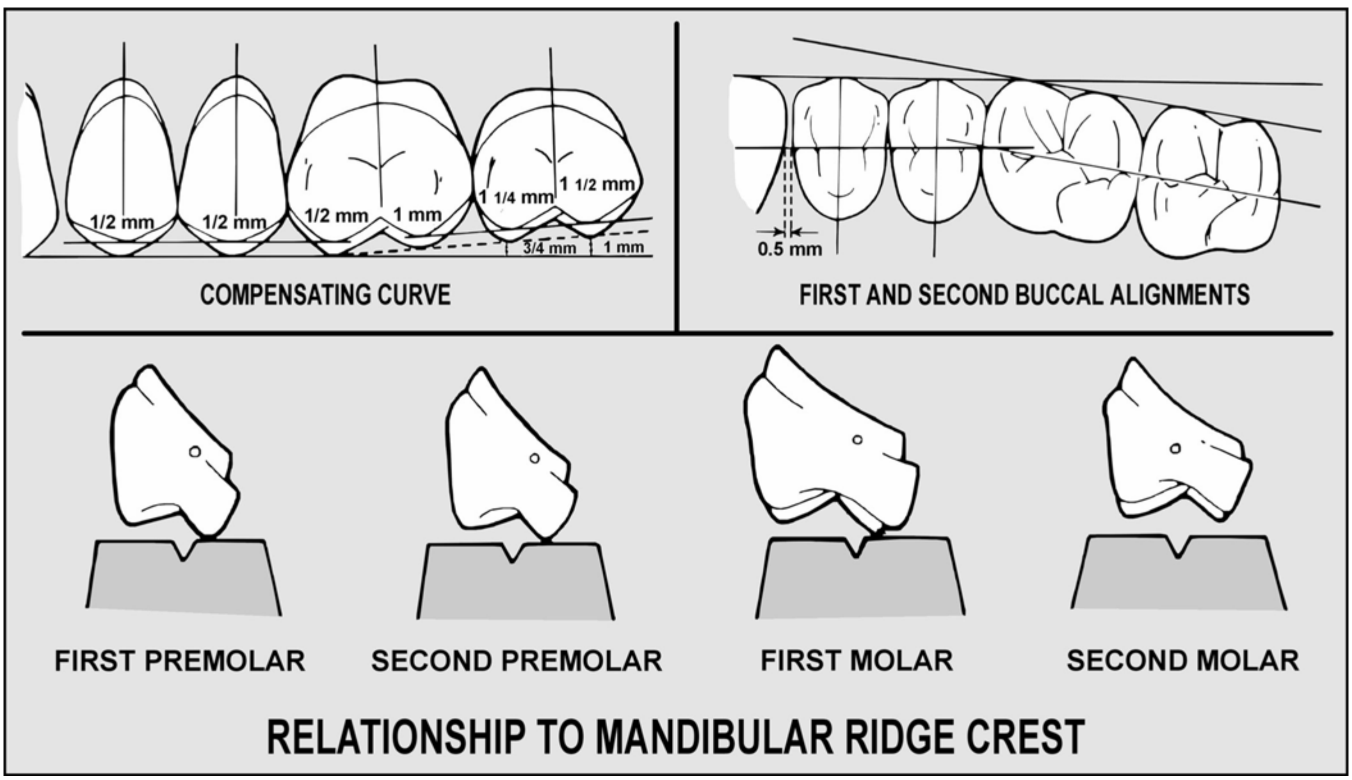
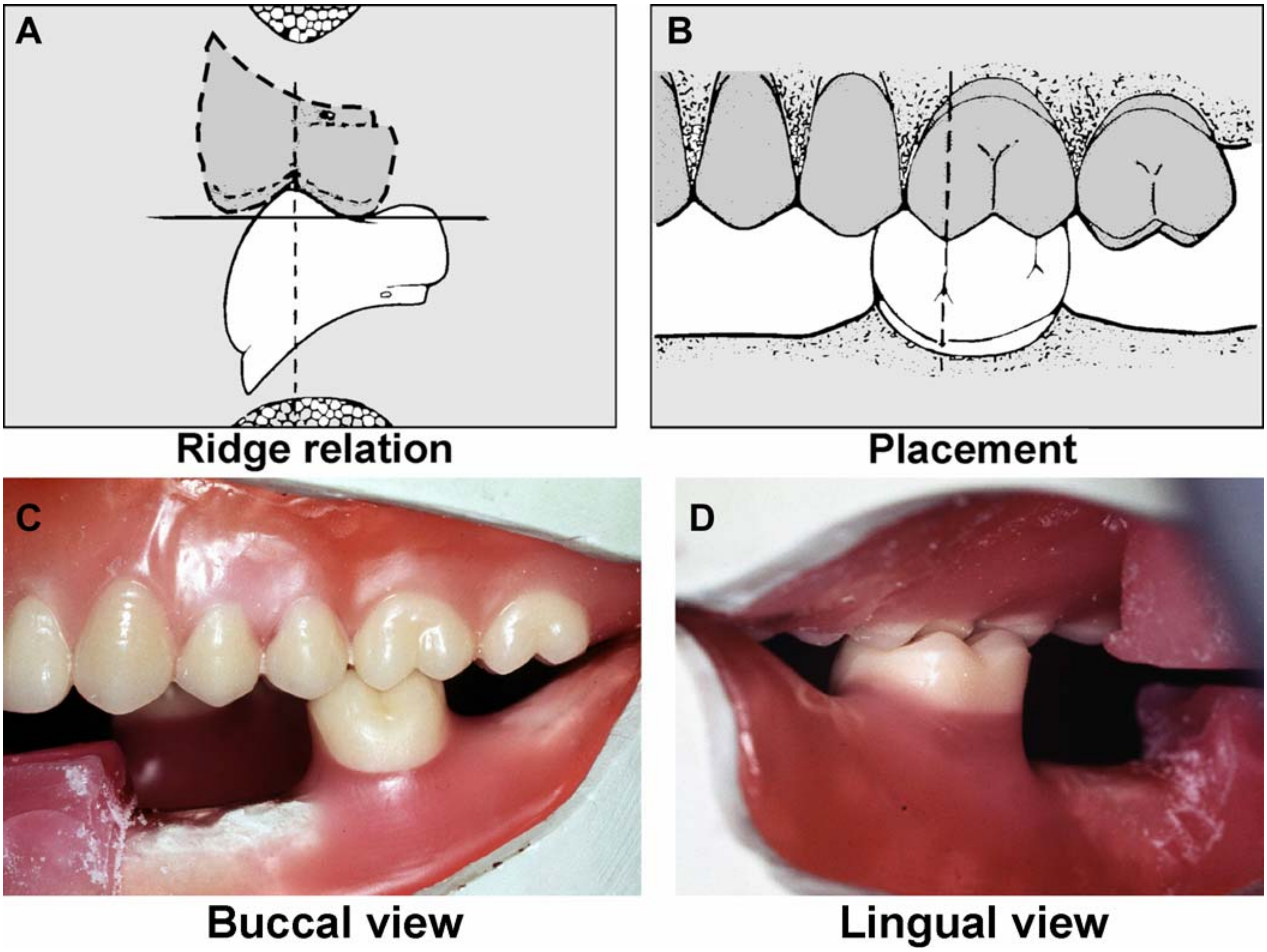


Figure 7.65. Maxillary Arch Arrangement of Pilkington-Turner Posterior Teeth.



7.78.1.2. **Working Occlusion (Figure 7.67).** Lock down the condyle element, release the right condyle element, and move the upper member to the right. Always incorporate sideshift during the right working movement by pushing the condylar guide to the right. From the buccal view, the working relation of the lower first molar against the upper first molar shows mesial and distal cusp ridges of buccal cusps in contact. The mesial cusp ridge of the mesiobuccal cusp of the mandibular first molar contacts the distal cusp ridge of the buccal cusp of the maxillary second premolar. From the lingual view, the mesiolingual cusp of the upper first molar contacts the cusp ridges that help form the lingual developmental groove of the lower first molar.

Figure 7.66. Mandibular First Molar (Centric Occlusion).



7.78.1.3. **Balancing Occlusion (Figure 7.68).** To establish balancing contacts, lock the right condyle element down and release the one on the other side. Move the upper member to the left with one hand while pushing the condylar guide to the left with the thumb of the other hand. From a buccal view, the mesiolingual cusp of the maxillary first molar slides through the distobuccal groove of the lower first molar, and the lingual cusp of the maxillary second premolar contacts the mesial incline of the triangular ridge associated with the lower first molar's mesiobuccal cusp.

7.78.1.4. **Protrusive Occlusion (Figure 7.69).** From the buccal view, the mandibular buccal cusps contact the distal inclines of the cusp ridges in the maxillary arch. From the lingual view, the maxillary lingual cusps contact the mesial inclines of the cusp ridges in the opposing arch.

7.78.2. **Mandibular Right First Molar.** Follow the same directions as for setting the lower left first molar (paragraph 7.78.1).

Figure 7.67. Balanced Occlusion (Working Position).

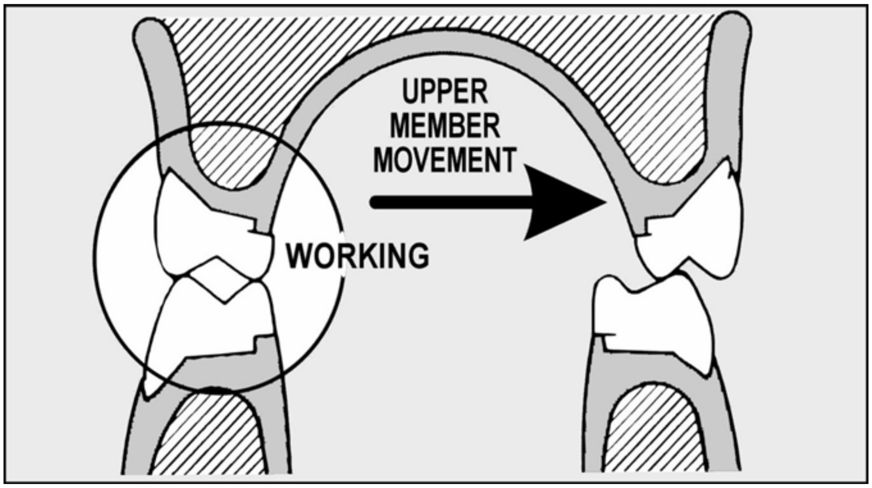


Figure 7.68. Balanced Occlusion (Balancing Position).

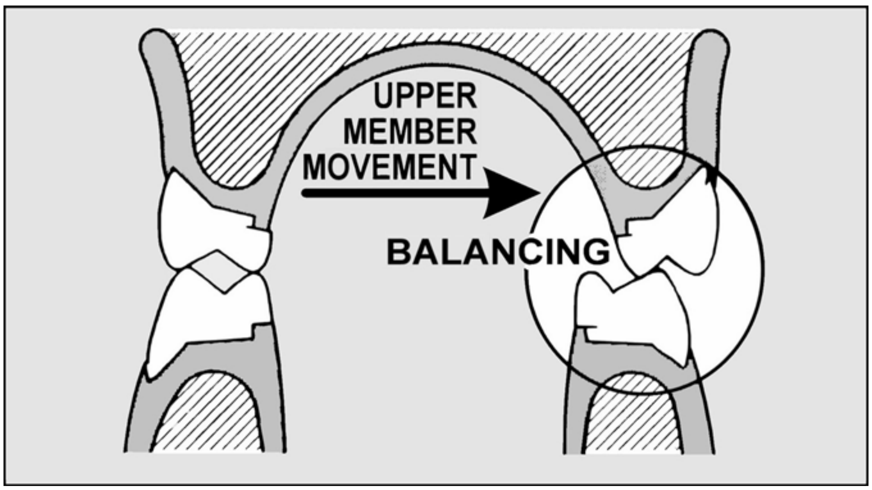
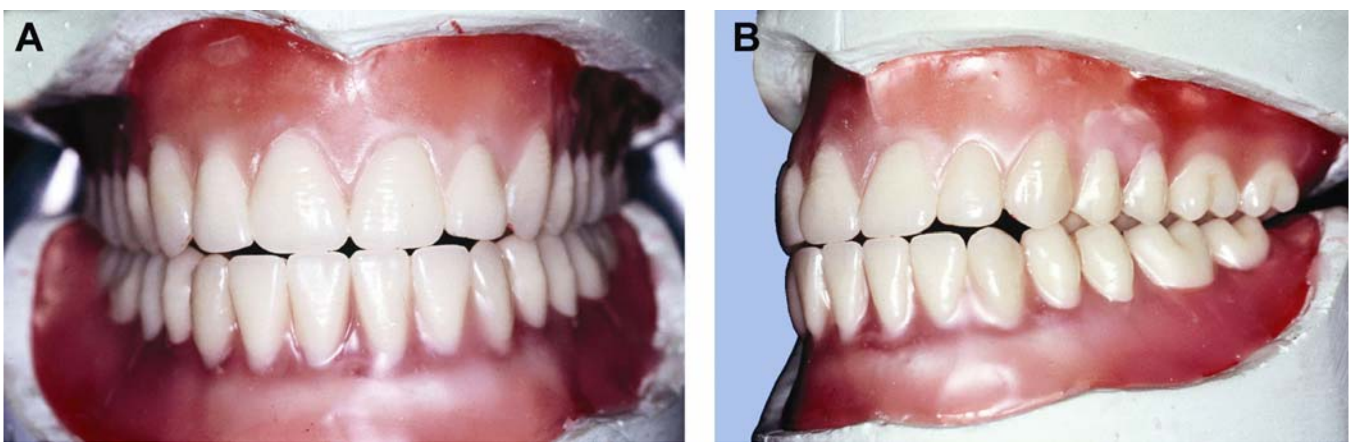


Figure 7.69. Balanced Occlusion (Protrusion).



7.78.3. **Set the Incisal Guide Table.** After the lower right and left first molars are positioned in the setup, set the incisal guide table as follows:

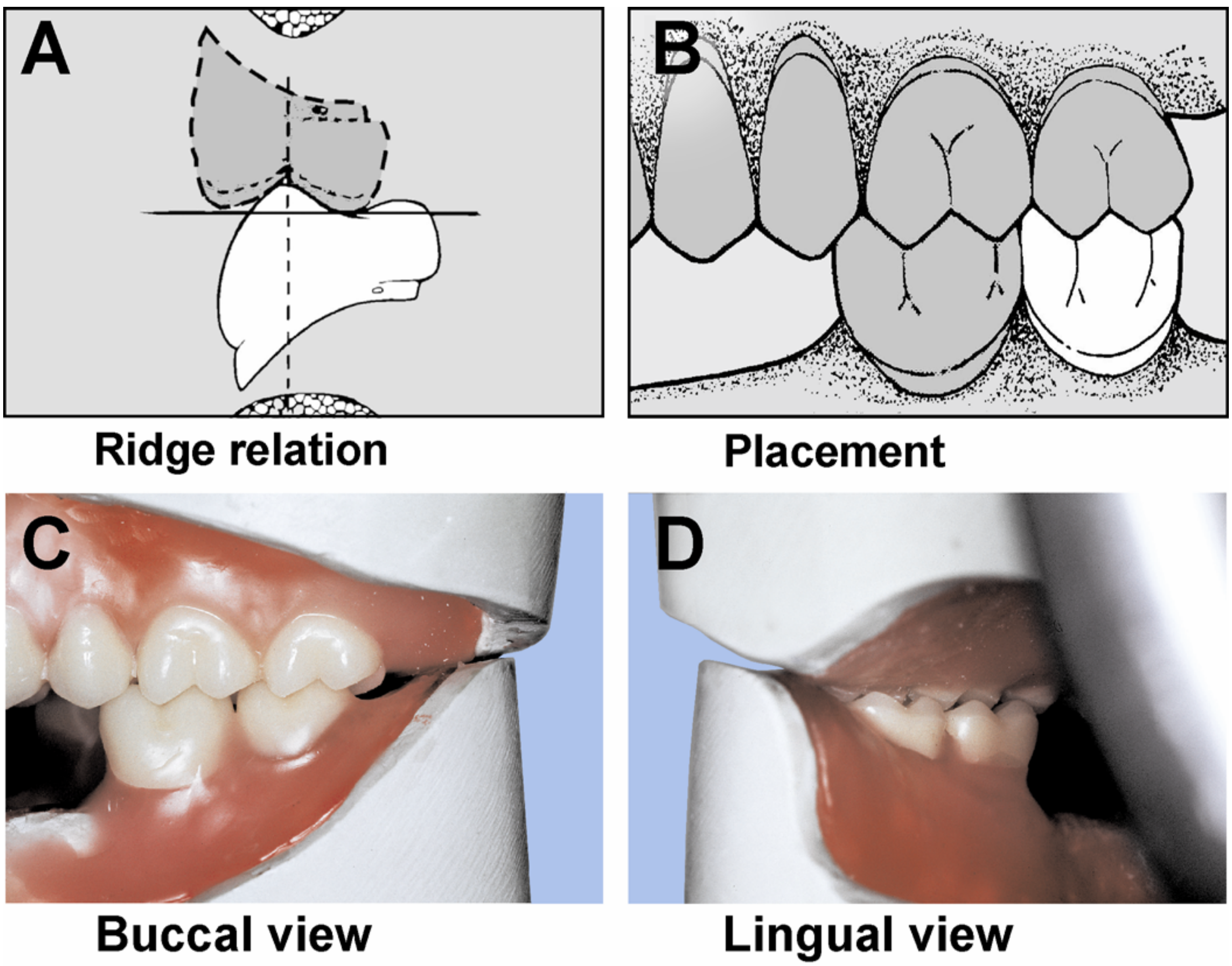
7.78.3.1. Adjust the table to match the incisal guide pin's protrusive rise.

7.78.3.2. Adjust the wings to match the incisal guide pin's rises to the right and left. The protrusive slant of the incisal guide table and the wing adjustments should be set so they are barely in contact with the pin. The adjusted table and wings help maintain the teeth previously set in their original positions.

7.78.4. **Mandibular Left Second Molar.** Open the articulator. Attach a softened piece of wax to the mandibular second molar. Position the tooth distal to the mandibular first molar on the record base.

7.78.4.1. **Centric Occlusion (Figure 7.70).** From the buccal view, the triangular ridge of the mesiobuccal cusp of the upper second molar rests in the buccal groove of the lower second molar. The mesiobuccal cusp of the lower second molar fits between the maxillary first and second molars and contacts their marginal ridges. From the lingual view, the mesiolingual cusp of the maxillary second molar fits directly into the central fossa of the mandibular second molar.

Figure 7.70. Mandibular Second Molar (Centric Occlusion).



7.78.4.2. **Working Occlusion (Figure 7.67).** Move the upper member of the articulator to make the left side of the arranged teeth, the working side. From the buccal view the working relation of the lower second molar against the upper second molar has mesial and distal cusp ridges of buccal cusps in contact. The mesial cusp ridge of the mesiobuccal cusp of the mandibular second molar contacts the distal cusp ridge of the distobuccal cusp of the maxillary first molar. From the lingual view the mesiolingual cusp of the upper second molar contacts the cusp ridges that form the lingual developmental groove of the lower second molar.

7.78.4.3. **Balancing Occlusion (Figure 7.68).** Move the upper member of the articulator to make the left side of the arranged teeth, the balancing side. In the buccal view, the mesiolingual cusp of the upper molar slides through the distobuccal groove of the lower second molar. The distolingual cusp of the upper first molar contacts the mesial incline of the triangular ridge of the mandibular second molar's mesiobuccal cusp.

7.78.4.4. **Protrusive Occlusion (Figure 7.69).** From the buccal view, the mandibular buccal cusps contact the distal inclines of the cusp ridges in the maxillary arch. From the lingual view, the ML cusps contact the mesial inclines of the cusp ridges in the opposing arch.

7.78.5. **Mandibular Left Second Premolar.** Open the articulator to position the left second premolar. Attach a piece of softened wax to the premolar and position it on the record base mesial to the first molar. Align the facial cusp anterioposteriorly with the buccal cusp of the lower first molar.

7.78.5.1. **Centric Occlusion (Figure 7.71).** From the buccal view, close the articulator and adjust the mandibular second premolar to make its buccal cusp fit between the maxillary first and second premolars. The tip of the cusp contacts the mesial marginal ridge of the upper second premolar as well as the distal marginal ridge of the upper first premolar. From the lingual view, the lingual cusp is located at the lingual embrasure between the upper first and second premolars.

7.78.5.2. **Working Occlusion (Figure 7.67).** Move the upper member of the articulator to make the left side the working side. From the buccal view, the distal cusp ridge of the mandibular second premolar's buccal cusp contacts the mesial cusp ridge of the maxillary second premolar's buccal cusp. The mesial cusp ridge of the lower second premolar's buccal cusp contacts the distal cusp ridge of the maxillary first premolar's buccal cusp. From the lingual view, the lingual cusp of the lower second premolar moves further into the embrasure between the maxillary first and second premolars.

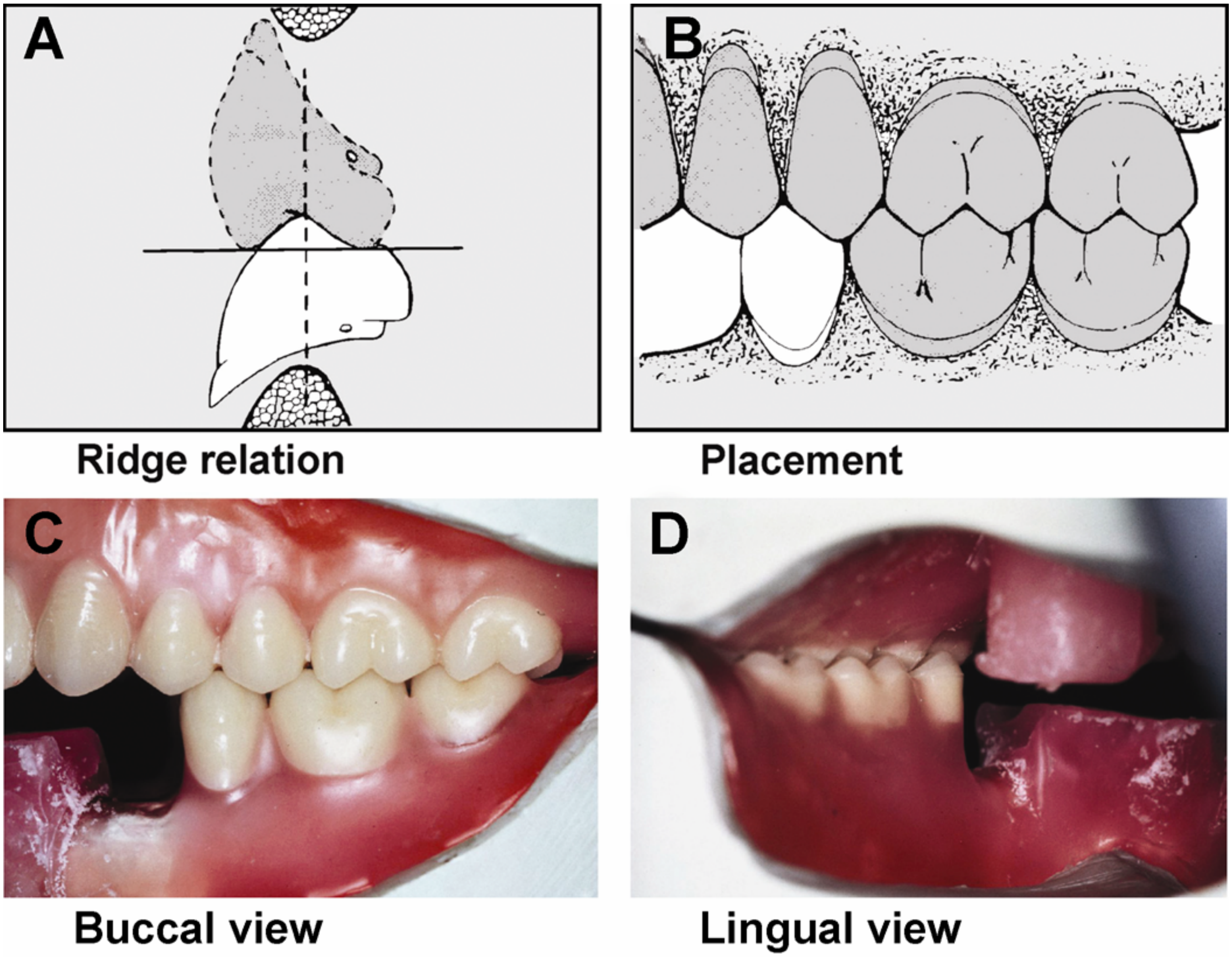
7.78.5.3. **Balancing Occlusion (Figure 7.68).** Move the upper member of the articulator to make the left side the balancing side. The mesial incline of the lower second premolar's buccal cusp triangular ridge contacts the lingual cusp of the upper first premolar.

7.78.5.4. **Protrusive Occlusion (Figure 7.69).** The mandibular buccal cusps contact the distal inclines of cusp ridges in the maxillary arch. The ML cusps contact the mesial inclines of cusp ridges in the opposing arch.

7.78.6. **Mandibular Right Second Molar and Second Premolar.** Set these teeth in centric occlusion (Figure 7.72). Adjust them for working and balancing contacts.

7.78.7. **Mandibular First Premolars.** The only mandibular posterior teeth remaining to be placed are the first premolars. Position them after the mandibular anterior teeth are arranged. It is sometimes necessary to reduce the mesiodistal dimensions of the mandibular first premolar to fit it in place (Figure 7.73). After the mandibular anterior teeth are set, orient the mandibular first premolars in the following manner:

Figure 7.71. Mandibular Second Premolar (Centric Occlusion).



7.78.7.1. **Centric Occlusion.** Adjust the mandibular first premolar so its buccal cusp fits between the maxillary canine and first premolar when the articulator is closed.

7.78.7.2. **Working Occlusion.** The mesial cusp ridge of the mandibular first premolar's buccal cusp contacts the distal cusp ridge of the maxillary canine. The distal cusp ridge of the mandibular first premolar's buccal cusp contacts the mesial cusp ridge of the maxillary first premolar.

7.78.7.3. **Balancing Occlusion.** The mandibular first premolar has no balancing contact with the maxillary teeth during a balancing excursion.

7.78.7.4. **Protrusive Occlusion.** The mesial cusp ridge of the mandibular first premolar's buccal cusp contacts the distal cusp ridge of the maxillary canine.

Figure 7.72. Right Side Mandibular Posterior Teeth (Centric Occlusion).

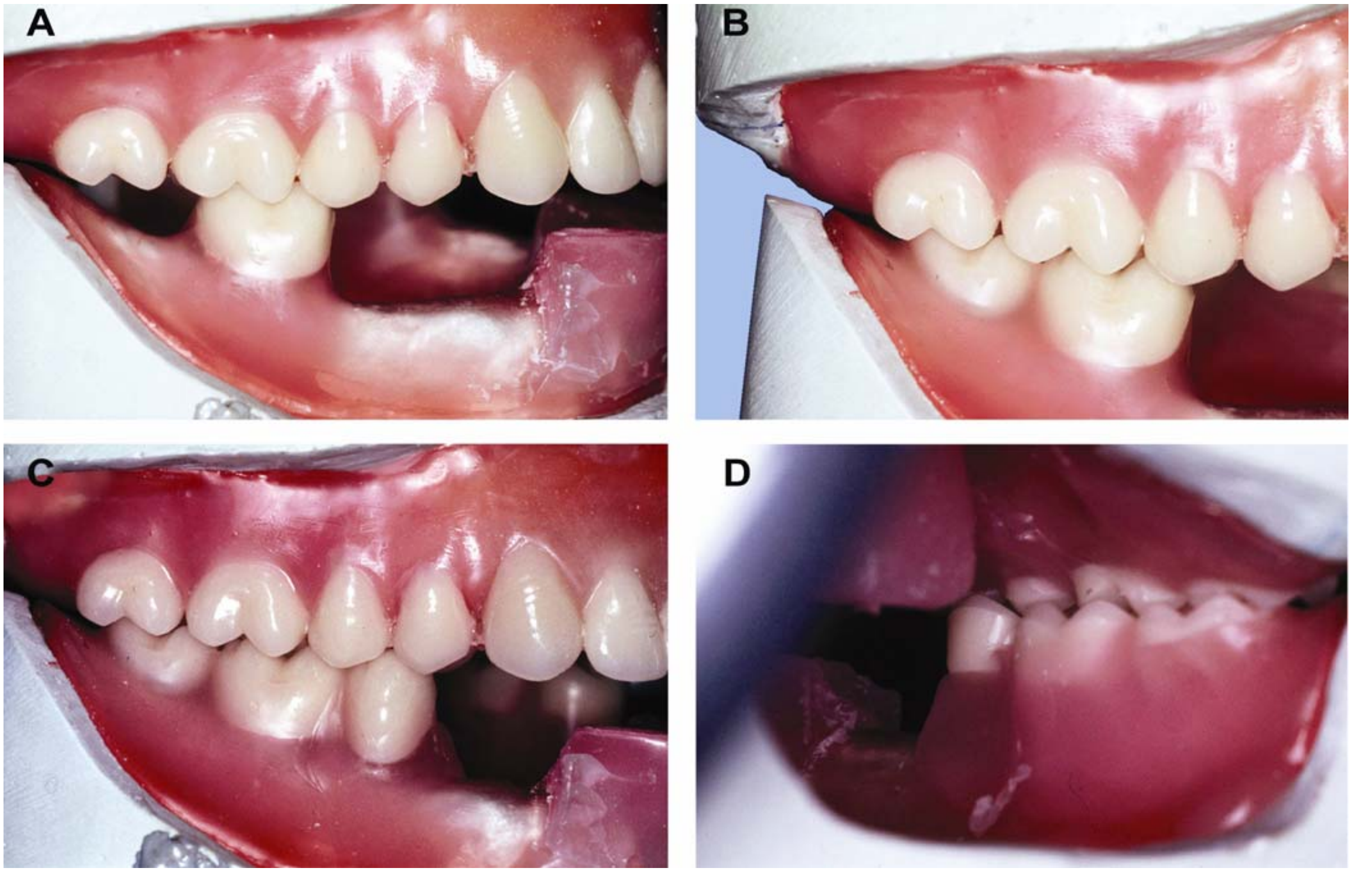
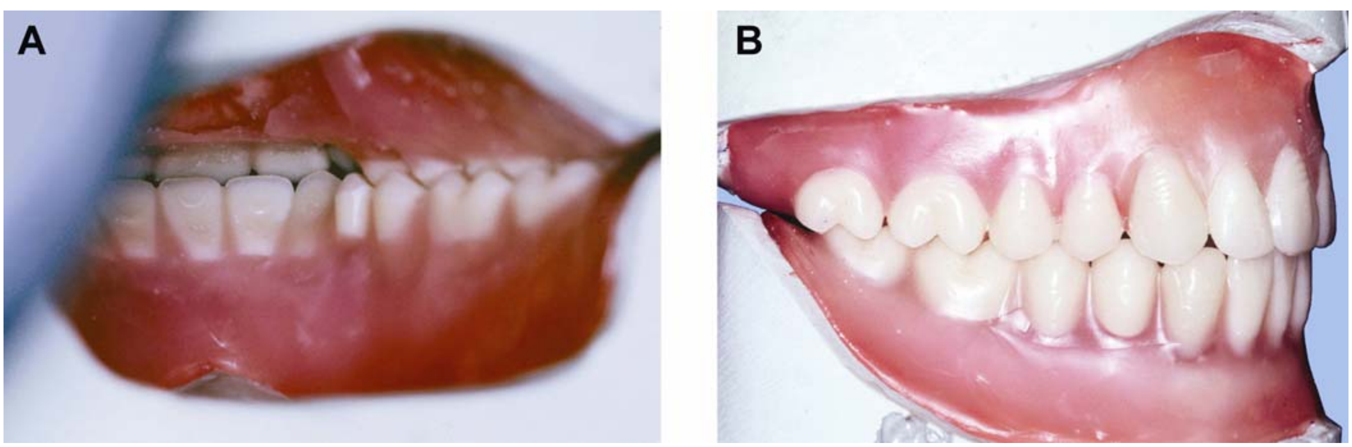


Figure 7.73. Positioning the Mandibular First Premolars.



7.79. Setting Mandibular Anterior Teeth for Balance. At this point, the upper anterior teeth, upper posteriors, and lower posteriors are set. After the right and left first molars are placed, the working, balancing, and protrusive rises out of centric occlusion are determined for the remaining teeth in the setup. The incisal guide table and wings are then adjusted to prevent teeth from shifting in soft wax. The lower second molars and premolars are set to match the rises. For the lower anterior teeth, follow these procedures:

7.79.1. **Centric Occlusion:**

7.79.1.1. **Overall Alignment.** Use the basic alignment pattern discussed in paragraphs 7.72 through 7.75.6.2 and shown in Figure 7.61. Also see Figure 7.74.

7.79.1.2. **Horizontal Overlap.** Between 1 and 2 mm of horizontal overlap is an acceptable range in all cases where the ridges are normally related (Class I). Class II ridge relations require more than a 2 mm horizontal overlap. The incisors are edge to edge in Class III ridge relations.

7.79.1.3. **Vertical Overlap.** The amount of vertical overlap can be expected to change directly with increases or decreases in posterior cusp height. The 30-degree posteriors can generate as much as 2 mm of vertical overlap between upper and lower anterior teeth. When 20-degree posteriors are used, the amount of vertical overlap required might be 1 mm. The rule of thumb is since horizontal overlap is more or less standard for normal ridge relations (1 to 2 mm), use enough vertical overlap to make the anterior teeth balance in working and protrusive contact relations.

7.79.2. **Working Occlusion (Figure 7.67).** When the anterior teeth are in a right or left working test position, the labioincisal edges of the mandibular central and lateral incisors are in contact with the linguoincisal edges of the maxillary central and lateral incisors on the working side. The mandibular canine interdigitates with the distal portion of the maxillary lateral incisor's incisal edge and the mesial cusp ridge of the maxillary canine. In the posterior segments, the teeth show working side contacts characteristic of balanced occlusion.

7.79.3. **Balancing Side Occlusion (Figure 7.68).** The maxillary anterior teeth do not contact the mandibular anterior teeth on the balancing side. The lingual cusps of the maxillary posterior teeth are in contact with the buccal cusps of opposing mandibular posterior teeth.

7.79.4. **Protrusive Occlusion (Figure 7.69).** When the anterior teeth are in the protrusive test position, the maxillary and mandibular incisors touch, edge to edge. The mesial cusp ridge of the mandibular canine contacts the distal part of the maxillary lateral incisor's incisal edge. Simultaneously, the buccal cusps of posterior teeth are in contact, just short of a tip to tip orientation.

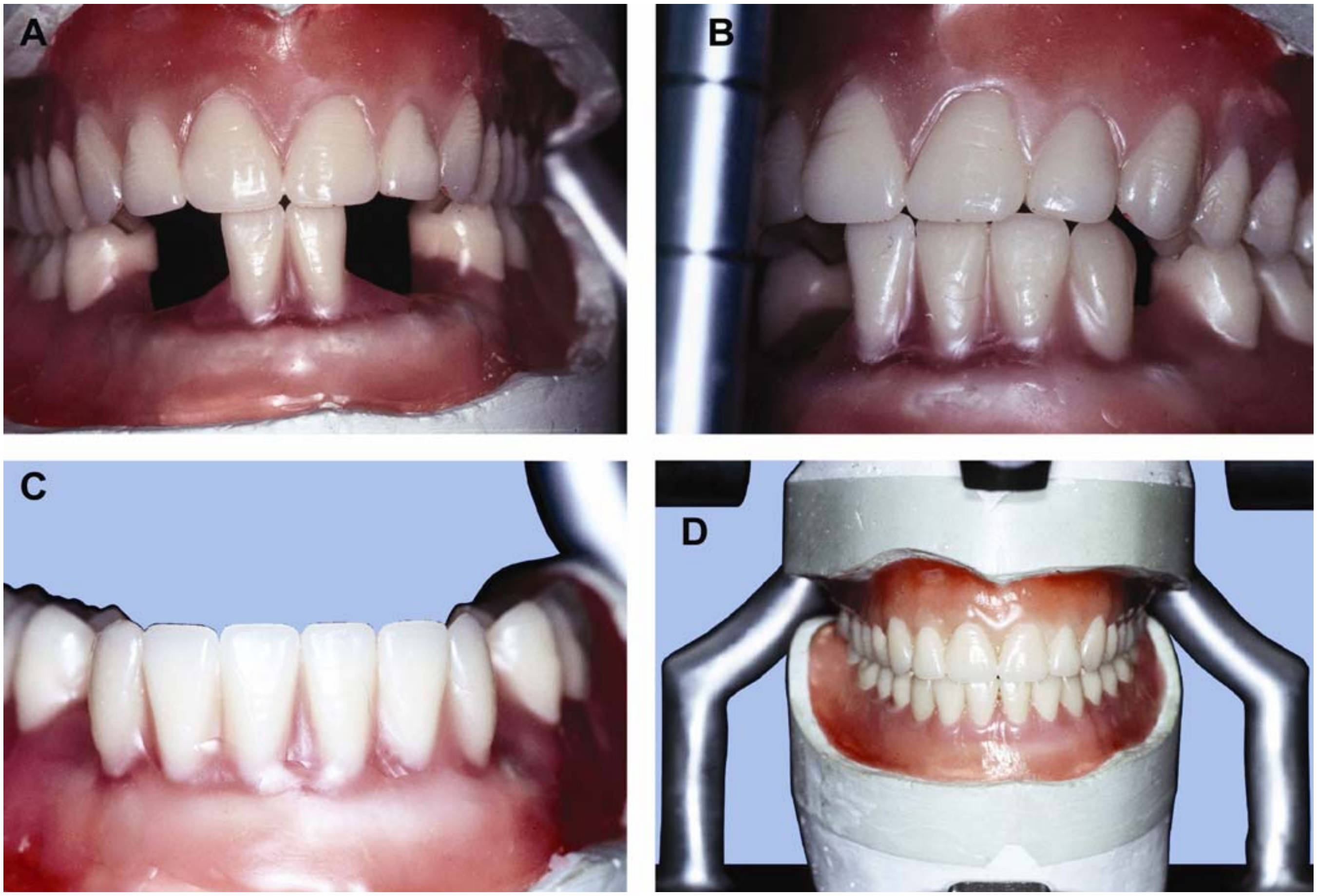
7.80. Balanced Complete Denture Occlusion Using 0-Degree Teeth:

7.80.1. The maxillary anterior teeth are set to achieve the desired esthetic result. The mandibular anterior teeth are arranged in centric occlusion with an amount of horizontal overlap that fits the occlusal classification of the patient (for example, Class I is 1 to 2 mm). A slight amount of vertical overlap is incorporated (0.5 - 1 mm).

7.80.2. The occlusal plane is formed by using a 20-degree curved plate positioned on the incisal edges of (mandibular) anterior teeth and the highest part of both retromolar pads (Figure 7.54). The buccal cusps of the mandibular posteriors are placed in a straight line over the crest of the mandibular ridge. The teeth are set so the occlusal surfaces contact the undersurface of the template. The upper posteriors are articulated with the lower posteriors to complete the setup. Make sure there is at least 1 mm of horizontal overlap in the posterior segments of the setup to prevent cheek biting.

7.80.3. The vertical overlap between the upper and lower anterior teeth is readjusted for balance. The objective is multiple contacts on the right and left in anterior and posterior areas during working, balancing, and protrusive occlusion.

Figure 7.74. Setting Mandibular Anterior Teeth in Centric Occlusion.



Section 7O—Monoplane Complete Denture Occlusion

7.81. Overview. In the expression monoplane occlusion it is implied that 0-degree (no cusps) posterior teeth are used. In this denture occlusion, 0-degree teeth are set on a flat plane (no compensating curve).

7.82. Tooth Contact Characteristics:

7.82.1. **Anterior Teeth.** In centric occlusion, anterior teeth normally have a vertical overlap of 0.0 mm and 1 to 2 mm of horizontal overlap.

7.82.2. **Working Side.** There are isolated, unprogrammed contacts among a few upper and lower teeth on the working side.

7.82.3. **Balancing Side.** On the balancing side, there is usually no contact between any of the upper and lower teeth.

7.82.4. **Protrusive.** When the incisors are edge to edge, there is no contact posteriorly.

7.83. Advantages of Monoplane Dentures:

7.83.1. Monoplane dentures are somewhat easier to set than completely balanced dentures.

7.83.2. Monoplane dentures function well in almost all patients. It is the denture occlusion of choice for patients with poor ridges. A set of monoplane dentures minimizes horizontal pressures on the residual ridge. Due to the absence of inclined planes, the ridges are subject to vertical pressures which are considered less damaging.

7.83.3. The monoplane principle is the denture occlusion of choice for Class II and Class III jaw relationships. It is the denture occlusion of choice for crossbite cases.

7.84. Disadvantages of Monoplane Dentures:

7.84.1. The 0-degree teeth don't look as natural as cusped teeth.

7.84.2. The 0-degree teeth might not break up food as well as cusped teeth.

7.84.3. Monoplane dentures have more of a tendency to tip than balanced complete dentures. The lack of protrusive balance is a special invitation to tipping.

7.85. Articulator Settings. Horizontal condylar guidance is set at 30 degrees, lateral condylar guidance is set at 15 degrees, and the incisal guide table is set at 0 degrees.

7.86. Denture Tooth Setting Order. Centric occlusion is the only position in which there are multiple, evenly distributed contacts between maxillary and mandibular teeth, and these contacts appear in the posterior areas.

7.86.1. **Maxillary Anterior Teeth.** Set the maxillary anterior teeth to match the contour of the occlusion rim.

7.86.2. **Mandibular Anterior Teeth (Centric Occlusion Position).** A standard alignment pattern is used with 0 mm vertical overlap. The horizontal overlap is highly variable and depends on the patient. (For example, Class I is 1 mm, Class II is 5 mm or more, and Class III is 0 mm.) The facial aspect of the mandibular anterior teeth should not extend forward of a line dropped perpendicular from the occlusal plane to the mandibular labial sulcus.

7.86.3. **Mandibular Posterior Teeth.** The buccal cusps of the mandibular posteriors should be set over the crest of the ridge. The front part of a flat plate is set on the incisal edges of the mandibular anterior teeth, and the posterior part of the plate is set at the heights of the retromolar pads. The mandibular posteriors area managed to contact the undersurface of the plate (Figure 7.54). The distofacial plane of the mandibular canine and the buccal surfaces of the mandibular posteriors fall on a straight line (no second buccal alignment).

7.86.4. **Maxillary Posterior Teeth (Centric Occlusion Position).** The buccal aspect of the maxillary posteriors should not be set lateral to a line dropped perpendicular from the occlusal plane in to the depth of the buccal sulcus. The maxillary posteriors are positioned to make maximum contact with the mandibular posteriors. At least a 1 mm horizontal overlap is included in the posterior segments to prevent cheek biting (Figure 7.75). When cusped teeth are used, the cusps in one quadrant have to fit into fossae and embrasures of teeth in the opposing quadrant. This kind of relationship is desirable, but not mandatory with 0-degree teeth. From an anterioposterior point of view, 0- degree cusps in one quadrant do not have to fit into embrasures and fossae in the other.

7.87. Problem of Protrusive Balance:

7.87.1. The heels of monoplane mandibular dentures have a tendency to flip up when anterior teeth are brought into protrusive contact. To compensate for a lack of protrusive balance in monoplane dentures, dentists sometimes request a modification of the flat plane principles.

7.87.2. The plane of occlusion is set flat in the premolar and first molar areas. However, the maxillary and mandibular second molars are slanted enough in centric occlusion (approximately 15 degrees) to produce bilateral posterior contact when the incisors are in protrusive (edge to edge) occlusion (Figure 7.76). The slanting of the maxillary and mandibular second molars creates a very limited Curve of Spee that helps overcome the Christensen's Phenomenon.

Figure 7.75. Posterior Horizontal Overlap of Flat Plane Teeth.

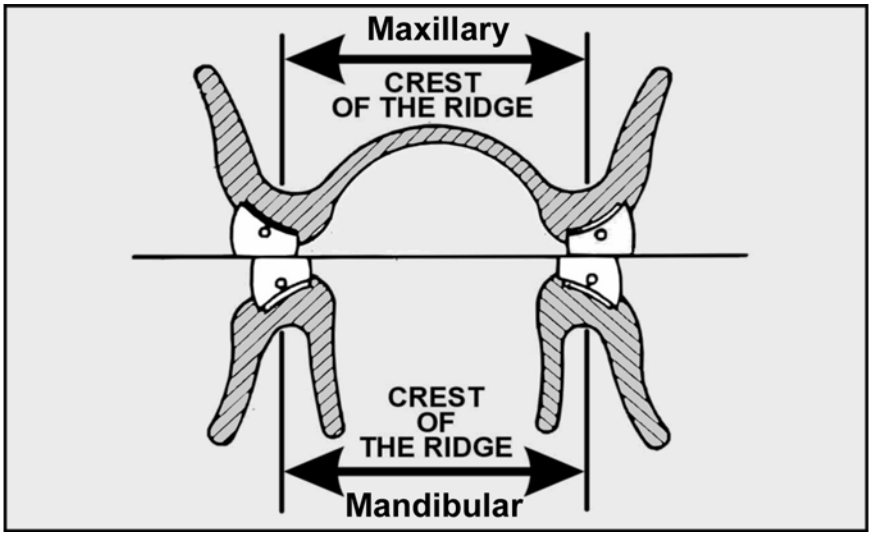
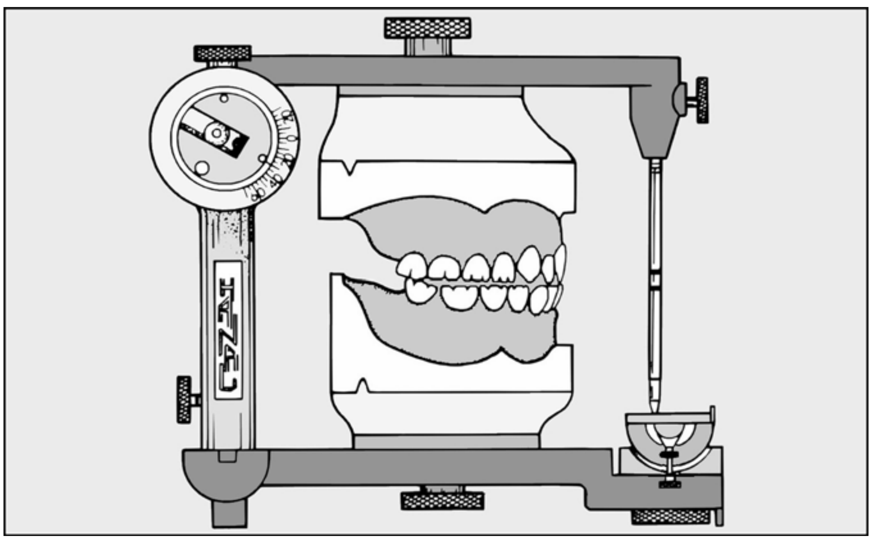


Figure 7.76. Protrusive Balance Compensation in Monoplane Denture Occlusions (Second Molar Slant).



Section 7P—Crossbite Complete Denture Occlusion

7.88. Crossbite Condition in the Natural Dentition:

7.88.1. **Anterior Crossbite.** One or more of the mandibular teeth are facial to the maxillary anteriors instead of being positioned in the normal facial-lingual relationship.

7.88.2. **Posterior Crossbite.** The normal buccolingual relationship of mandibular to maxillary posterior teeth is reversed. That is, instead of having the buccal cusps of mandibular posteriors hitting in the fossae and marginal ridge areas of maxillary teeth, the buccal cusps of the maxillary posteriors occlude in the fossae and marginal ridge areas of mandibular posteriors.

7.88.3. **Crossbite Variations.** Crossbite relations may be limited exclusively to the anterior area. The condition might be present in the posterior area of one side only, in the anterior area on one side only, or in the posterior segments of both sides and in the entire anterior region.

7.89. Crossbite Condition in Complete Denture Construction. In this condition, the arch form of the mandibular residual ridge appears to be larger than the arch form of the maxillary. Two reasons why maxillary and mandibular ridge relations might dictate denture tooth crossbite are as follows:

7.89.1. When natural teeth that have been in crossbite are extracted, the residual ridges will probably be in crossbite.

7.89.2. Maxillary and mandibular ridges that might have been normally oriented at one time can change into a crossbite relationship because of drastic resorption in the maxillary and mandibular arches. (That is, the upper arch narrows and the lower arch widens.) Sometimes, crossbite ridge relationships are only marginally abnormal. To make a rational decision for or against a crossbite denture occlusion, an imaginary line perpendicular to the occlusal plane is extended into the depth of the maxillary buccal sulcus. If the buccal surfaces of the maxillary posterior teeth have to be set laterally to that line for their sulci to fall over the crest of the mandibular ridge, the ridges are in enough crossbite to justify setting a crossbite denture occlusion.

7.90. The 0-Degree Teeth Set in Crossbite (Monoplane Arrangement):

7.90.1. **Articulator Settings.** Horizontal condylar guidance is set at 30 degrees, lateral condylar guidance is set at 15 degrees, and incisal table is set at 0 degrees.

7.90.2. **Denture Tooth Setting Order.** Centric occlusion is the only position in which there are multiple, evenly distributed contacts between maxillary and mandibular posterior teeth as follows:

7.90.2.1. **Maxillary Anterior Teeth.** The maxillary anterior teeth are set to match the contour of the occlusion rim.

7.90.2.2. **Mandibular Anterior Teeth (Centric Occlusion Position).** Use a standard alignment pattern with 0 mm vertical overlap. The horizontal overlap is highly variable and depends on the type case being set Class I-1 mm; Class III-0 mm) or perhaps the use of a negative horizontal overlap. A negative horizontal overlap is where the incisal edges of the mandibular anterior teeth are forward of the maxillary anterior teeth in centric occlusion. It is not unusual to need a mandibular anterior tooth form with a larger mesiodistal width than the manufacturer's guide suggests.

7.90.2.3. **Mandibular Posterior Teeth.** The buccal cusps of the mandibular posterior teeth are set over the crest of the mandibular ridge. Set the front part of a flat plate on the incisal edges of the mandibular anterior teeth and situate the posterior part of the plate at the heights of the retromolar pads. Arrange the mandibular posterior teeth to contact the undersurface of the plate. Sometimes the posterior residual ridge segments in these cases are so long that a third mandibular premolar is added to the setup.

7.90.2.4. **Maxillary Posterior Teeth.** The maxillary arch in these kinds of cases can be rather small. It might be necessary to omit premolar teeth from the setup. Position the maxillary posterior teeth to make maximum contact with the mandibular posteriors. Be sure to incorporate at least 1 mm of negative horizontal overlap in the posterior segments to prevent cheek biting.

7.90.2.5. **Supplemental Considerations (Figure 7.77):**

Figure 7.77. Flat Plane Posteriors Set in Posterior Crossbite.

7.90.2.5.1. When a normal upper to lower ridge relationship exists in the anterior area, it is necessary to provide a "crossover" where the buccal cusps of mandibular teeth, which negatively overlap maxillary teeth, cross the line of the maxillary buccal cusps to blend with the incisal edges of mandibular anterior teeth. This is usually done by setting the mandibular second premolar in an end-to-end relationship to the maxillary first and second premolars and completing the "crossover" with the mandibular first premolar (Figure 7.78).

Figure 7.78. The 30-Degree Posteriors in Crossbite (Quadrant Reversal Arrangement).

7.90.2.5.2. People with anterior crossbites usually have a limited ability to protrude the lower jaw. Protrusive balance problems are rarely a concern.

7.91. Cusped Teeth Set in Crossbite:

7.91.1. **Quadrant Reversal Arrangement, Using 30-Degree Posteriors:**

7.91.1.1. In this procedure, the maxillary left posterior denture teeth are set on the mandibular right side, the maxillary right denture teeth are set on the mandibular left side, the mandibular left teeth are set on the maxillary right side, and the mandibular right teeth are set on the maxillary left side (Figure 7.78). The tooth setting sequence is maxillary anteriors, mandibular anteriors, mandibular posteriors, and maxillary posteriors.

7.91.1.2. Develop the occlusal plane by setting the lower posterior teeth on the crest of the mandibular ridge, against the undersurface of a 20-degree curved plate. The three points that determine the plane are the mandibular anterior teeth and bilaterally the heights of the retromolar pads. The posterior teeth in the maxillary arch are set with their buccal cusps in the fossae and embrasures of the mandibular teeth, thus reversing the normal stamp cusp and shearing cusp relationships.

7.91.1.3. It might be necessary to provide a “crossover” point—a specific area of transition, usually located in the premolar regions, where the negatively overlapping buccal cusps of mandibular posterior teeth in crossbite “crossover” the line of the maxillary buccal cusps to blend with the mandibular anterior teeth. Except for the significant differences mentioned, the arrangement of the teeth is very similar to that of a normal case in characteristics such as compensating curve and general alignment principles. It is difficult, but possible, to create balanced complete dentures with this setup.

7.91.2. **Standard Arrangement, Using 20-Degree Posteriors:**

7.91.2.1. Denture teeth occupy their ordinary places in a dental arch without the quadrant reversal just described. However, the normal stamp cusp and shearing cusp relationships are reversed (Figure 7.79). When this method is used, a mandibular tooth one size larger than the maxillary tooth is sometimes necessary, depending on the difference in size between the maxilla and mandible.

Figure 7.79. The 20-Degree Teeth in Crossbite (Standard Arrangement).

7.91.2.2. The tooth setting order is maxillary anteriors, maxillary posteriors, mandibular posteriors, and mandibular anteriors. The maxillary anteriors are set for the desired esthetics. The upper posteriors are positioned so the buccal cusps are directly over the crest of the mandibular ridge. Create the first and second buccal alignments typical of cusped maxillary posteriors.

7.91.2.3. Use a flat plate as a guide in developing the occlusal plane and associated compensating curve. The three points that determine the plane of occlusion are the upper anterior teeth and points found bilaterally two-thirds of the way up the retromolar pads.

7.91.2.4. Set the mandibular posteriors so the buccal cusps of the maxillary posteriors hit in the fossae and embrasures of the mandibular posterior teeth. Set the mandibular teeth for acceptable esthetics. If normal anterior horizontal and vertical overlaps are indicated, position the premolars to achieve a smooth "crossover."

Section 7Q—Lingualized Complete Denture Occlusion

7.92. Definition. A balanced (bilateral) occlusion is founded on maxillary posterior lingual cusps contacting mandibular posterior fossas. A lingualized occlusion is a compromise, using anatomic and nonanatomic posterior tooth forms.

7.93. Lingualized Denture Occlusion Technique. The lingualized denture occlusion technique uses 20-, 30-, or 33-degree maxillary posterior teeth arranged along a standard compensating curve. The maxillary posteriors are set against 0-degree mandibular posterior teeth with only the lingual cusps of the maxillary posterior teeth contacting their opponents in centric occlusion (Figure 7.80). In lateral excursions, the overall effect resembles bilateral balance.

Figure 7.80. Posterior Tooth Relationship (Lingualized Occlusion).

7.94. Advantages of the Technique:

7.94.1. It can be used in most denture combinations and easily adapted for Class II and III patients.

7.94.2. It uses cusped maxillary teeth. This is particularly helpful when the patient places a high priority on esthetics and a nonanatomic occlusal scheme is indicated by oral conditions such as severe alveolar ridge resorption. The cusp form is more natural in appearance compared to nonanatomic tooth forms.

7.94.3. It maximizes cutting efficiency with minimized lateral forces.

7.94.4. Bilateral mechanical balanced occlusion is readily obtained.

7.95. Disadvantages of the Technique:

7.95.1. Tipping of the denture while functioning can result with improperly set denture teeth.

7.95.2. Some modification of mandibular posterior teeth may be required before setting of the denture teeth can begin.

7.96. Setting the Lingualized Denture:

7.96.1. Start with the casts and occlusion rims mounted on a semi-adjustable articulator. Ensure the articulator settings are 30 degrees horizontal and 15 degrees lateral if no further guidance is provided by the dentist.

7.96.2. Set maxillary and mandibular anterior teeth first, using Sequence #2 (paragraph 7.65.2).

7.96.3. Maxillary tooth setup should be in alignment with the labial contour of the maxillary occlusal rim.

7.96.4. Ensure a 1 mm vertical and horizontal overlap for esthetics. Vertical overlap exceeding 1 mm may jeopardize the balance during excursive movements, causing denture dislodgment.

7.96.5. Open the occlusal vertical dimension prior to setting posterior teeth by lowering the incisal guide pin .5 mm. This will allow adequate room for selective grinding of posterior teeth.

7.96.6. Begin setting mandibular posterior teeth using a 20-degree curved template. Position the posterior of the template at the height of the retromolar pads and ensure the anterior portion of the template rests on the incisal edges of the mandibular anterior teeth. Proceed with setting mandibular posterior teeth described in Sequence #2, ensuring the central sulcus is placed over the crest of the mandibular ridge.

7.96.7. Position maxillary posterior teeth on the occlusion rim and observe the following guidelines:

7.96.7.1. Position the stamp cusps into the central sulcus areas of the opposing mandibular teeth (Figure 7.81), which will ensure chewing forces are directed over the crest of the ridge only.

7.96.7.2. Elevate the shearing cusp approximately 1 mm to avoid any contact with the opposing denture teeth (Figure 7.81). ***NOTE:*** No contact will exist at anytime between maxillary shearing cusps and mandibular denture teeth.

7.97. Restoring Occlusal Vertical Dimension:

7.97.1. Close vertical dimension by raising the incisal guide pin .5 mm.

7.97.2. Occlude dentures with articulating paper grinding high spots in sulcus of mandibular posteriors. Deepen fossa or grind inclines marked by articulating paper until the pin touches the table. At no time should the maxillary stamp cusps be ground upon (except during final selective grinding when there has been obvious tooth movement during processing of the denture base).

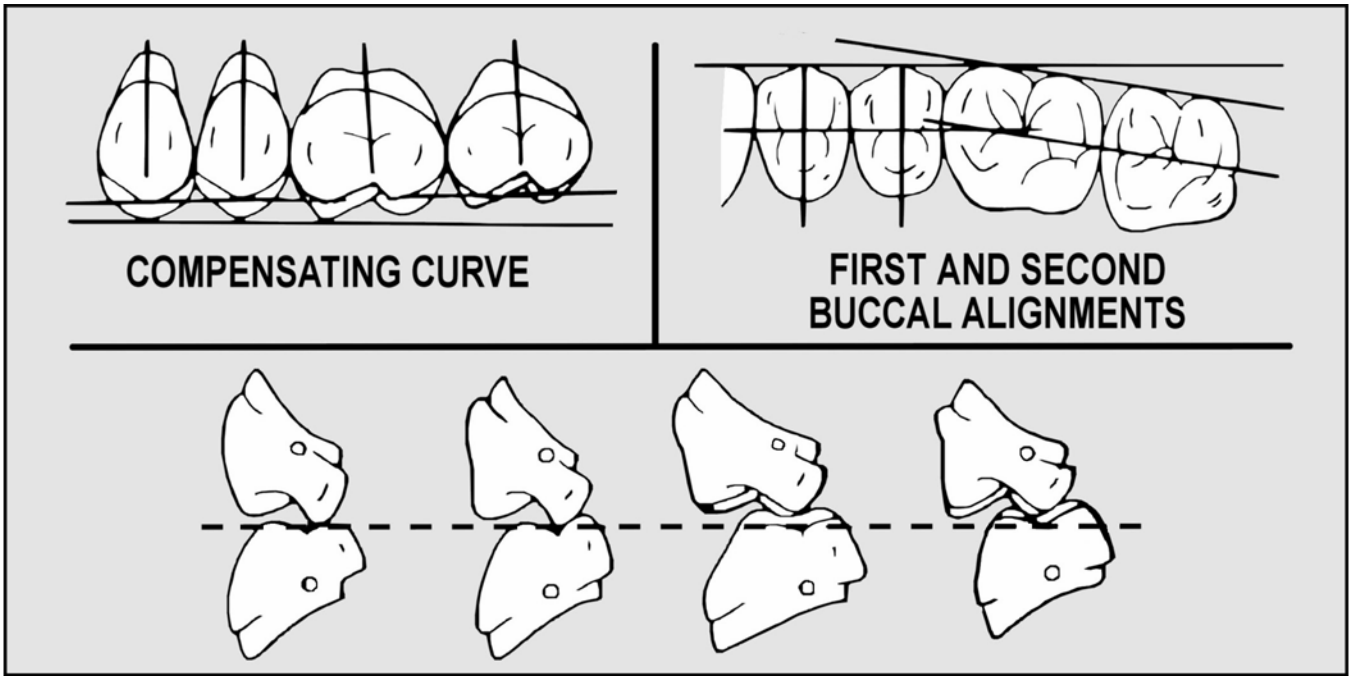
7.98. Tooth Contact Characteristics:

7.98.1. **Working Side.** Working side contacts will result from the lingual inclines of the maxillary lingual cusps contacting the lingual cusp regions of the mandibular teeth in lateral excursions.

7.98.2. **Balancing Side.** Contacts will result from the buccal inclines of the lingual cusps on the maxillary teeth gliding across the buccal cusp regions of the mandibular teeth in lateral excursions.

7.98.3. **Protrusive.** Anterior and posterior contacts should be evenly distributed to prevent tipping of the denture.

Figure 7.81. Maxillary Arch Arrangement for Lingualized Occlusion.



Section 7R—Wax Trial Dentures

7.99. Wax Pattern of the Denture Base (Wax-Up):

7.99.1. A wax-up is formed around a completed tooth arrangement. The pattern is a simulation of soft tissues attached to the teeth, alveolar processes, and palate. The combination of teeth and wax-up on a record base is called a *trial denture* because the dentist tests its appearance and function in the patient's mouth.

7.99.2. The trial denture then becomes a pattern for forming a mold. Denture base plastic is converted from a dough to a solid in the mold. Based on this series of events, there are two places in a complete denture procedure where soft tissue contours must be simulated in wax—the wax-up for try-in (paragraph 7.100) and the final wax-up (paragraph 7.101).

7.99.3. The dentist usually requests a try-in after the denture teeth are set in occlusion on the record base. The wax-up is usually not characterized because the dentist often makes changes to this trial denture. The evaluation of the wax trial denture in the patient's mouth permits the dentist to establish the final tooth position. After the try-in and before wax denture investing procedures, a detailed final wax-up is done.

7.99.4. Waxing and contouring procedures reproduce the appearance of natural gingival tissues as closely as possible. The external surfaces of the denture bases are shaped to promote cleanliness and denture retention.

7.100. Wax-Up for Try-In. The wax-up is of the basic, standardized variety with no provision for individual characterization. Procedures are as follows:

7.100.1. **Spot-Luting the Record Bases to the Casts With Molten Wax.** Start by locking down the right and left condyle elements. Hold the maxillary and mandibular wax trial dentures in centric occlusion. Be sure the incisal guide pin is touching the incisal guide table. Lute the bases down in enough places so they do not move, but when the time comes for try-in they can be easily removed from their respective casts.

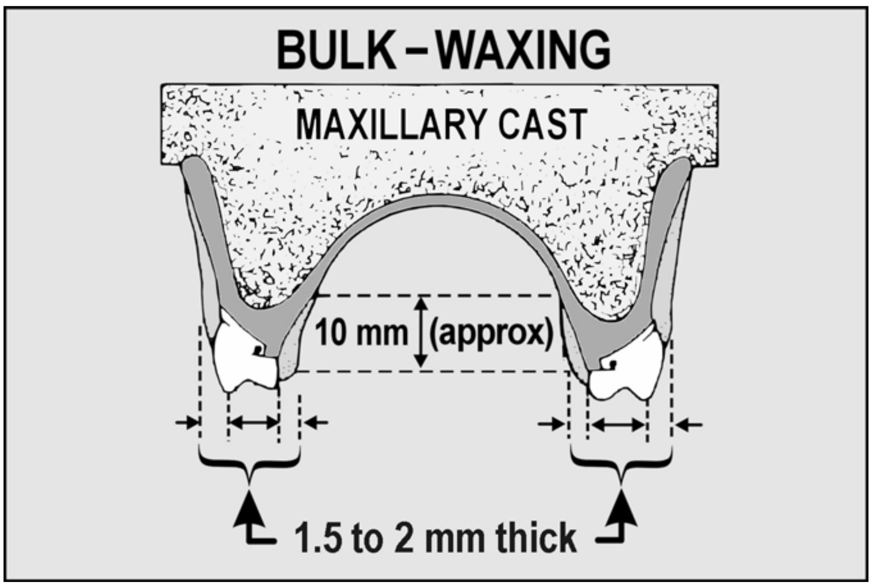
7.100.2. **Bulk-Waxing the Facial and Lingual Surfaces.** Because the record base probably won't have enough wax covering the facial and lingual areas to do an adequate contouring job, more wax should be added. The easiest and fastest way to add a lot of wax is to use an eyedropper and an electric wax heater. To prevent the wax from freezing in the dropper, warm the glass in a Bunsen burner flame. Use the dropper to carry wax and to spread it onto the trial denture surfaces. A large wax spatula can be used, but the procedure becomes more time-consuming. Procedural steps are listed individually for maxillary (paragraph 7.100.2.1) and mandibular (paragraph 7.100.2.2) trial dentures.

7.100.2.1. **Bulk-Waxing the Maxillary Trial Denture:**

7.100.2.1.1. **General.** Fill all of the interproximal areas with wax. Ensure wax is not added to the facial and lingual sections at the same time. When applying bulk wax, allow wax time to sufficiently cool on the facial surface before adding wax to the lingual surface. This will avoid tooth movement in the trial denture wax-up.

7.100.2.1.2. **Facial Surface.** The wax over the collars of the teeth should be 1.5 to 2 mm thick and extend from just above the collars down to the sulci of the cast (Figure 7.82). If the border of a flange does not fill a sulcus, correct the discrepancy by adding wax.

Figure 7.82. Bulk-Waxing Trial Dentures.

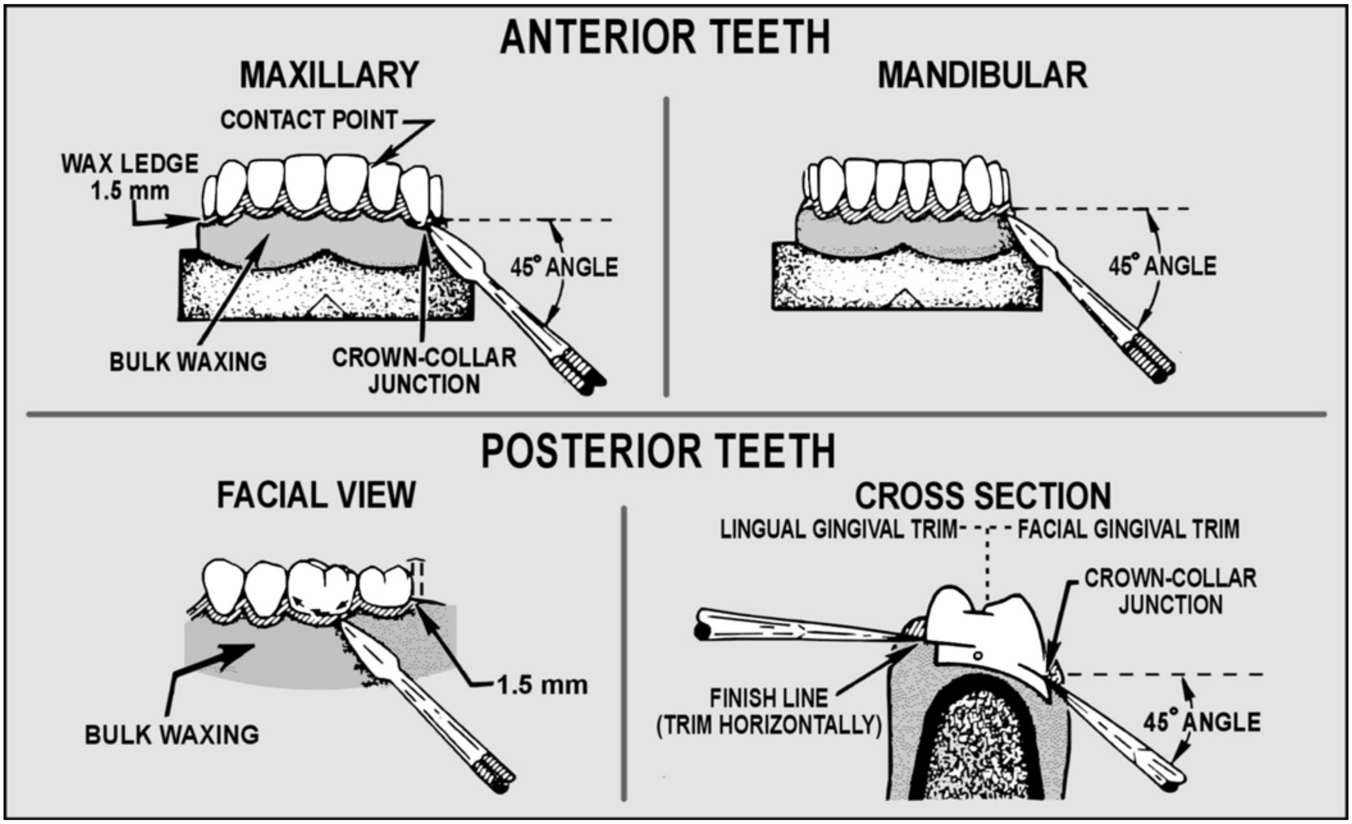


7.100.2.1.3. **Lingual Surface.** The wax layer starts occlusal or incisal to the denture tooth finish lines and proceeds about 10 mm toward the palatal vault. Wax near the finish lines should be 1.5 to 2 mm thick. The lingual wax is blended into the palatal area of the record base to make a smooth transition.

7.100.2.2. **Bulk-Waxing the Mandibular Trial Denture.** After bulk-waxing the upper trial denture, check the occlusion because denture teeth tend to drift in warm wax. Maxillary and mandibular denture teeth must meet in centric occlusion while the pin is on the table. Except for palatal blending, which is not a consideration, the steps used for the maxillary setup may also be used for the facial and lingual surfaces of the mandibular trial denture.

7.100.3. **Performing Gingival Trimming (Figure 7.83).** In this procedure, the objective is to simulate the appearance of natural tissue near the necks of the denture teeth without creating food traps. In keeping with this objective, the interdental papillae must always extend to the area of tooth contact and fill the gingival embrasure and the papillae must be convex in all directions. The following steps apply to both the upper and lower arches: (***NOTE:*** Keep the point of the carver against the denture tooth surface.)

Figure 7.83. Gingival Trimming.



7.100.3.1. **Facial Gingival Trim.** Hold the carver at 45 degrees to the horizontal. In one or two continuous, curving motions, remove wax down to the junction between the crown and the collar. Perform the procedure around each tooth.

7.100.3.2. **Lingual Gingival Trim.** Hold the carver horizontally. Trim around the lingual surfaces of the denture teeth at a level slightly occlusal or incisal to the denture tooth finish lines (about 0.5 to 1 mm). Do not remove wax from under the finish lines.

7.100.4. **Contouring the Wax Denture (Festooning):**

7.100.4.1. **Wax-Contouring Objectives.** The three objectives in wax-contouring are as follows:

7.100.4.1.1. To simulate the root eminences (Figure 7.84) and attached gingiva (Figure 7.85). In the mouth, the attached gingiva is directly bound to the bone and is relatively immobile. It extends from the free gingiva toward the sulcus for a variable distance of 3 to 8 mm. The band of attached gingiva is widest in the anterior regions and narrows posteriorly. The root emineces are most visible in the attached gingival areas.

Figure 7.84. Maxillary Arch Root Eminences.

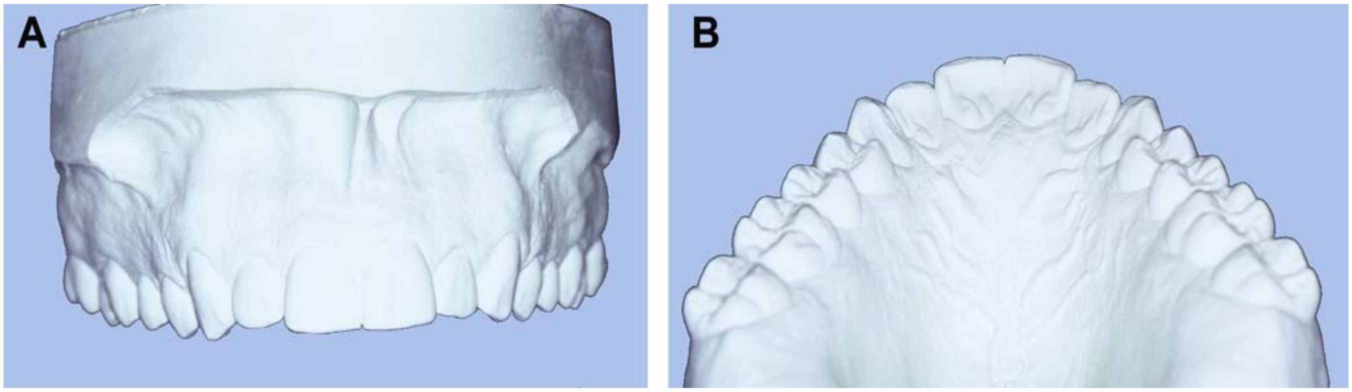
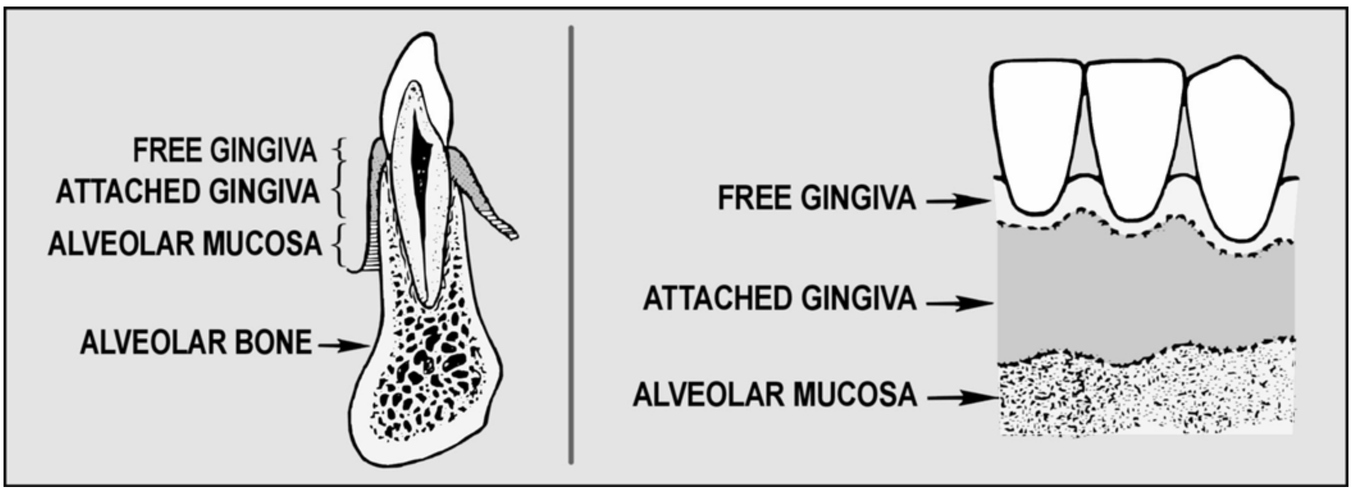


Figure 7.85. Mucosal Covering of the Alveolar Process.



7.100.4.1.2. To simulate the soft tissue contours of the alveolar mucosa (Figure 7.85). The alveolar mucosa is loosely bound to the bone. The alveolar mucosa begins where the attached gingiva ends and then extends into the depth of a sulcus.

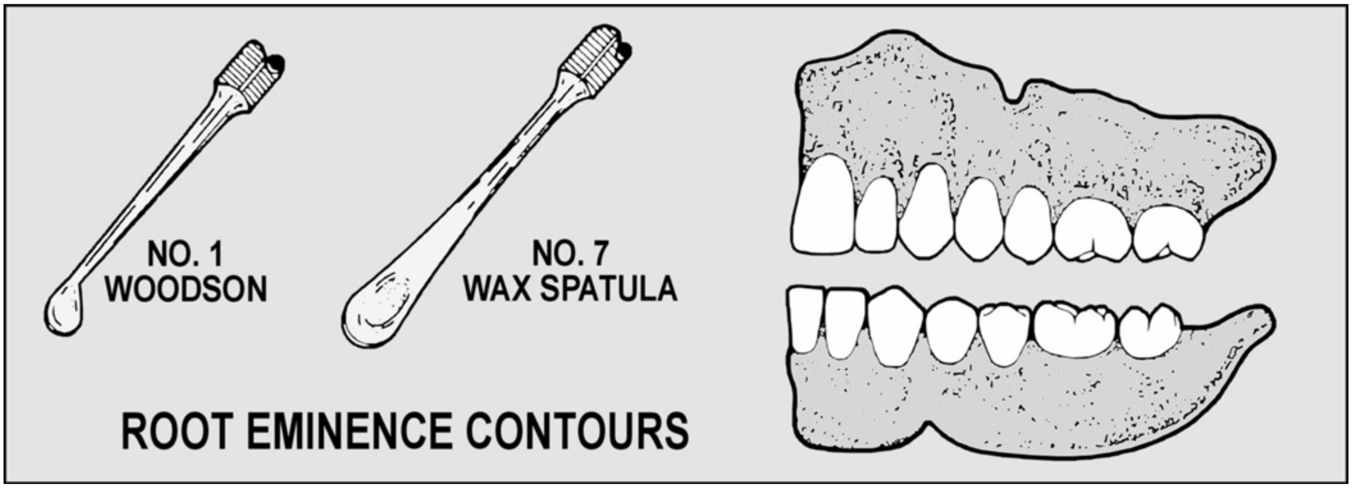
7.100.4.1.3. To shape the buccal and lingual surfaces of the denture base in a way that promotes denture retention. When gingival trimming procedures were performed, a pointed instrument had to be used to make sharp, clean cuts. In contrast, contouring wax requires forming convexities and concavities that blend with one another. To achieve these effects, round-ended instruments work best. The large end of a Woodson instrument or a #7 wax spatula should produce the desired result (Figure 7.86).

7.100.4.2. **Shaping Root Eminences.** Proper root eminence form is an aid to creating a natural appearance for the denture base, as follows:

7.100.4.2.1. **Facial Surface Eminences:**

7.100.4.2.1.1. In the anterior area, the maxillary canine eminence is the longest and most prominent, the lateral incisor has the shortest eminence, and the central incisor eminence has an intermediate length (compared to the eminence of the canine and the lateral incisor).

Figure 7.86. Shaping Root Eminences.



7.100.4.2.1.2. Looking at a mandibular trial denture, the canine's eminence is also the longest, the central incisor's eminence is the shortest, and the eminence of the lateral incisor has a length midway between the length of the canine and the central incisor.

7.100.4.2.1.3. Whereas anterior root eminences are relatively prominent, posterior root eminences are less prominent and generally shorter. Premolar eminences are slightly longer than molar eminences. When creating the illusion of root eminences, ensure the concave areas between the roots blend smoothly into the convex eminence areas. Produce eminences and concavities that are round and irregular in height. *Avoid deep, parallel, V-shaped concavities that look like ditches aligned with a ruler.*

7.100.4.2.2. **Lingual Surface Eminences.** Eminences and concavities are more subtle than the least prominent ones on the facial surface. In the maxillary arch, the lingual festooning is supposed to merge smoothly into the contours of the palatal vault.

7.100.4.2.3. **Buccolingual Width of the Gingival Trim.** After contouring the eminences, the thickness of the gingival trim at the junction between the wax and the denture teeth should equal a relatively uniform 1 mm around the arch.

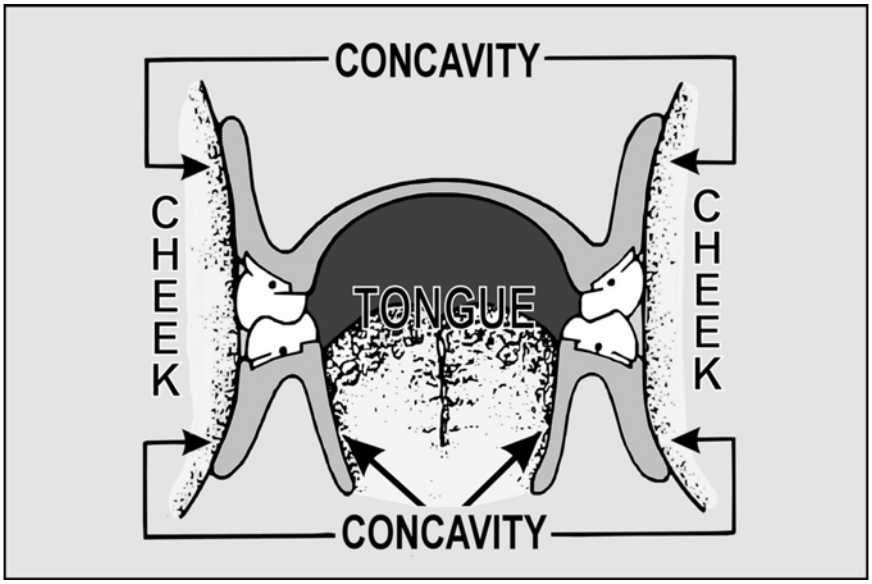
7.100.4.3. **Shaping Trial Denture Flanges.** Muscle action on properly contoured flanges tends to seat dentures more firmly on the residual ridges and improve their retention in the mouth (Figure 7.87).

7.100.4.3.1. **Labial Flanges (Maxillary and Mandibular).** Labial flanges are made slightly concave to accommodate the natural drape of the orbicularis oris muscle.

7.100.4.3.2. **Buccal Flanges (Maxillary and Mandibular).** These flanges are made concave to allow for the natural drape of the buccinator muscle. The buccal shelf area of the mandibular buccal flange is somewhat more concave than its counterpart flange in the upper denture.

7.100.4.3.3. **Lingual Flange (Mandibular Denture).** Make the flange concave to allow for the borders of the tongue.

Figure 7.87. Shaping Trial Denture Flanges.



7.100.5. **Lightly Flaming the Gingival Trim and Mucosal Contouring.** Apply the flame to one surface at a time. Generalized heating causes tooth movement. Remember that interdental papillae must be convex in all directions. Blunt the crests slightly; do not leave them needle-sharp.

7.100.6. **Checking and Correcting the Occlusion.** The teeth must meet in centric occlusion, and the incisal guide pin must touch the incisal guide table. Also, check the lateral excursions.

7.100.7. **Touching Up the Wax.** If the wax has been disturbed or any excess wax is on the teeth or flange borders, now is the time for touching up these areas. The trial dentures are now ready for the dentist to evaluate while they are in the patient's mouth.

7.101. Final Wax-Up. The assumptions at this point are that (1) a basic wax-up was done, and (2) the dentist performed a try-in, made adjustments, and returned the wax trial denture to the laboratory. The basic wax-up's gingival trim has more or less been ruined by the necessary adjustments. To produce a final, characterized wax-up, the steps in paragraphs 7.101.1 through 7.101.3 must be followed.

7.101.1. **Perform the Maxillary Denture Final Wax-Up:**

7.101.1.1. Remove the maxillary wax trial denture from the cast and set it aside for the moment.

7.101.1.2. Create a posterior palatal seal as follows:

7.101.1.2.1. A posterior palatal seal is a feature incorporated into a maxillary denture to offset denture processing changes in the acrylic and improve denture retention. (***NOTE:*** This seal is not recommended for the positive-pressure, injection-molded technique SR Ivocap®.) In processing, the denture acrylic shrinks away from the cast slightly. This shrinkage is most obvious along the posterior border of the maxillary denture. If compensation is not made for this distortion, the posterior border of the denture will not touch the patient's tissue when the denture is placed in the mouth. As a result, air enters between the denture base and the mouth tissues, and the denture falls away from the patient's ridge and the palate.

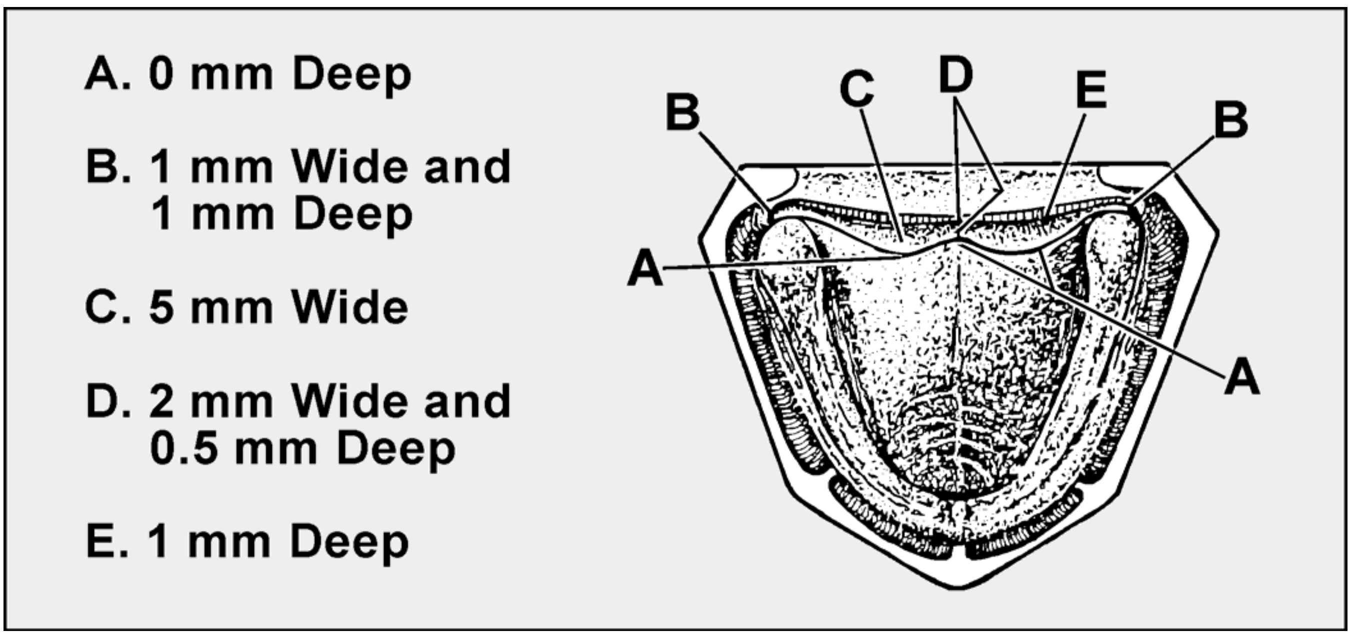
7.101.1.2.2. The dentist may develop a posterior palatal seal in the final impression while the patient is present. If the dentist does not choose to do this, he or she may ask the technician to create the seal. The seal is actually cut into the master cast, and an acceptable time to do this is after the dentist performs the wax denture try-in. The most desirable time to do this is before the record base is fabricated.

7.101.1.2.3. The last chance anyone has to do this is after the wax denture boilout procedure. The outline and depth of the posterior palatal seal preparation on the cast depends on the anatomy of the mouth, condition of the tissues, and desires of the dentist. This makes it imperative for the dentist to assume complete responsibility for prescribing the location, depth, width, and outline of the seal. If the dentist does not prepare the cast, he or she must furnish the technician complete and explicit instructions so no doubt remains about the procedures to execute.

7.101.1.2.4. The posterior border of the denture is determined at the vibrating line the dentist has marked on the cast. In the absence of a marking, the posterior border of the denture is determined by using right and left pterygomaxillary notches and the palatine foveae. The posterior border of the maxillary denture and the posterior edge of the posterior palatal seal must coincide.

7.101.1.2.5. The form and dimensions of a popular kind of posterior-palatal seal are shown in Figure 7.88. A #6 round bur and a Roach carver perform the job satisfactorily.

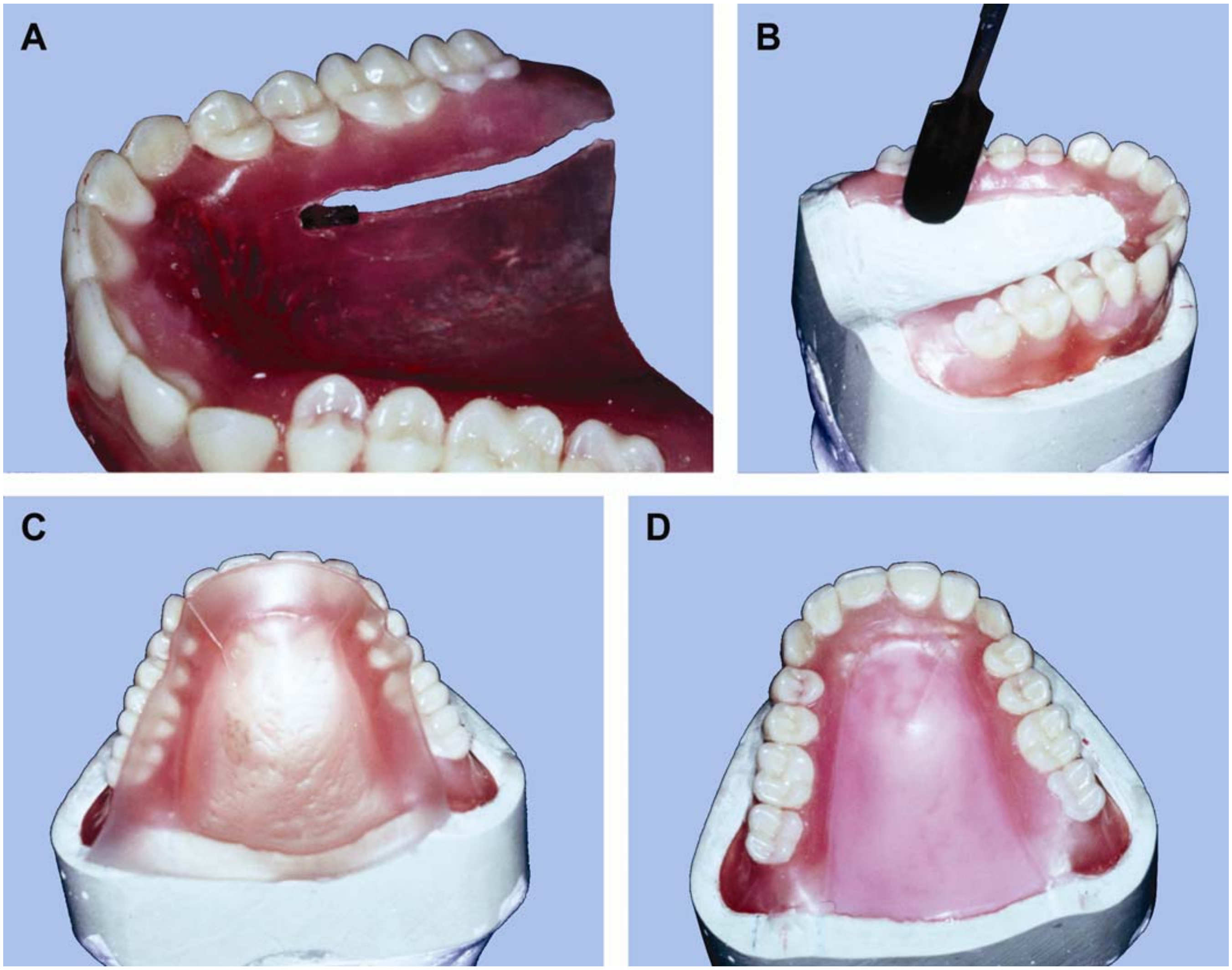
Figure 7.88. Shape and Dimensions of a Posterior-Palatal Seal.



7.101.1.3. Cut the palatal vault from the wax trial denture (Figure 7.89). Following a U-shaped line that is 5 to 6mm palatal to the lingual finish lines of the maxillary teeth, cut out the palatal area with a spiral plaster saw or palatal cutting bur. Apply as little pressure as possible across the heels of the record base. The compression will break it. Smooth the cut edge of the record base. Replace the wax denture on the cast and check the occlusion.

7.101.1.4. Completely seal the borders of the upper and lower record bases to their casts. Be sure to also seal down the palatal cut edge of the maxillary record base (Figure 7.89-B). While performing the sealing procedure, it is very important to lock down the condylar elements, place the wax dentures in centric occlusion, and hold the pin in contact with the table.

Figure 7.89. Uniform Palatal Thickness (Sheet-Wax Method).



7.101.1.5. Create a uniform palatal thickness. The patient's speech is affected if the palatal vault of the denture is too thick. Make a vault area thick enough so it is reasonably strong, but not so thick as to cause speech impairment. The sheet-wax and plastic pattern methods are as follows:

7.101.1.5.1. **Sheet-Wax Method for Creating Uniform Palatal Thickness:**

7.101.1.5.1.1. If the true rugae are to be reproduced in the denture, place a piece of .003-inch tinfoil over the anterior palatal area of the cast within the cutout portion of the record base. Adapt and burnish the tinfoil to the cast to form a matrix of the rugae. Remove the matrix from the cast without distorting it. By flowing melted baseplate wax into the grooves, reinforce the side that was in contact with the cast. Put the tinfoil reproduction aside.

7.101.1.5.1.2. Flash-wax the rugae region on the cast. To obtain a uniform thickness in the palatal area, place a layer of soft 28 gauge (ga) wax in the cutout part of the record base and adapt the wax to the cast (Figure 7.89-C). Cover this layer of wax with a softened baseplate wax (Figure 7.89-D). Be careful not to stretch or smash the wax sheets. Blend the edges of the wax sheets into the palatal contours. When the palatal area is smoothly and uniformly waxed, position the prepared tinfoil matrix accurately over the rugae area. Secure it to the baseplate wax by luting the outer border with a hot spatula.

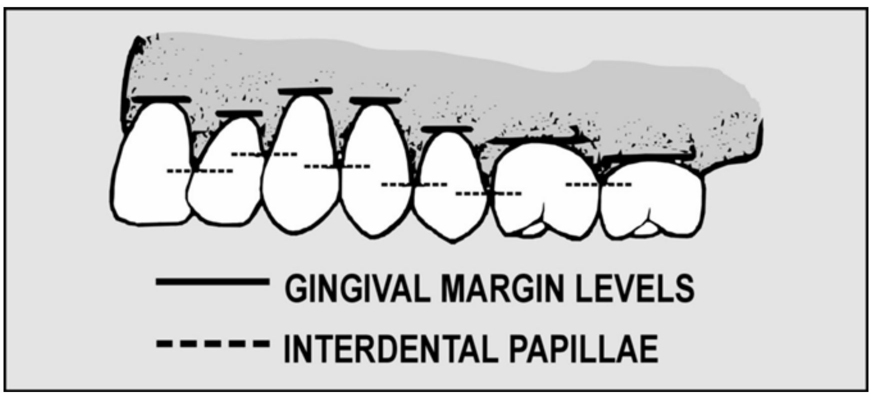
7.101.1.5.2. **Plastic Pattern Method.** Flexible plastic patterns that imitate the surface characteristics of the palatal vault, including rugae, are available in various sizes. To use them, pick one that matches the dimensions of the palatal cutout. Substitute the plastic pattern for the layer of baseplate wax in the sheet-wax method just described. Not all patients like the feel of simulated rugae in the roof of a denture. If a patient expresses dislike for the rugae simulation in a completed denture, it can always be ground away.

7.101.1.6. Bulk-wax as needed. Selectively bulk-wax the facial and lingual areas to the extent required.

7.101.1.7. Perform gingival trimming:

7.101.1.7.1. Use the basic, uncharacterized wax-up as a point of departure for developing a more natural appearing denture base. The regularity of the gingival trim should be broken up by varying the height and shape of the scallops and interdental papillae (Figure 7.90). As the figure shows, it is typical for the maxillary canine gingival margin to be the highest in the quadrant and for the first premolar margin to be slightly lower. This relationship is frequently ignored. Many technicians incorrectly persist in producing a gross step between the heights of the canine and first premolar gingival margins.

Figure 7.90. Characterized Gingival Trimming.



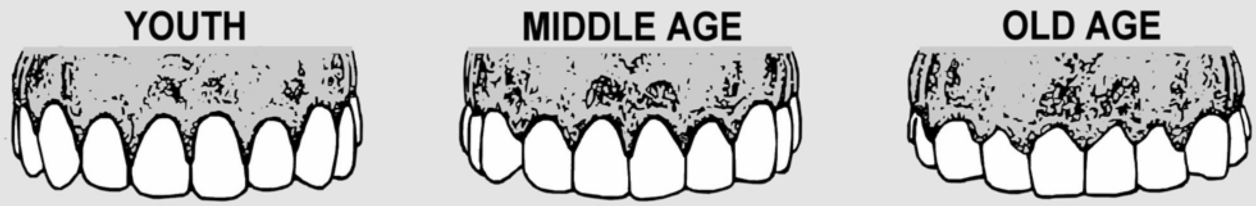
7.101.1.7.2. The architecture of a person's gingiva changes with age. (See Figure 7.91 for the age factor in gingival trimming.) On young people, use a half-circle gingival trim. With middle-aged persons, use a half-circle and half-oval gingival trim on different teeth. In elderly persons, produce a combination of half-oval and blunted "V" gingival trims. Expose a little of the collar on a couple of teeth to imitate recession of the gingival margins.

7.101.1.7.3. Because interdental papillae also recede as people get older, it is good to simulate this characteristic in dentures. However, do not use this as a license to indiscriminately dig wax out of interproximal areas. The more pressing obligation is to avoid creating food traps.

7.101.1.8. Produce root eminences and flanges. The same rules apply that were presented for the basic wax-up. Do not produce deep, straight, parallel slots between eminences. All eminences and concavities must blend into one another. Flange surfaces are mostly concave to aid in denture retention.

Figure 7.91. Gingival and Papillary Contours.

PATIENT'S AGE	NECK SCALLOP	PAPILLA SHAPE
YOUTH	⌒ CIRCLE	V POINTED
MIDDLE AGE	⌒ OVAL	V IN BETWEEN ↕
OLD AGE	∧ "V"	∪ BLUNT



7.101.1.9. Accomplish stippling. Stippling effects make a denture base appear more natural by breaking up the continuity of large, reflective surfaces. The result is much more pleasing than a glossy, shiny look. Using these techniques, there should be no stippling within 1 mm of the gingival margins and 3 mm of the peripheral borders. While working with the wax-up, stippling may be accomplished by one of the following methods:

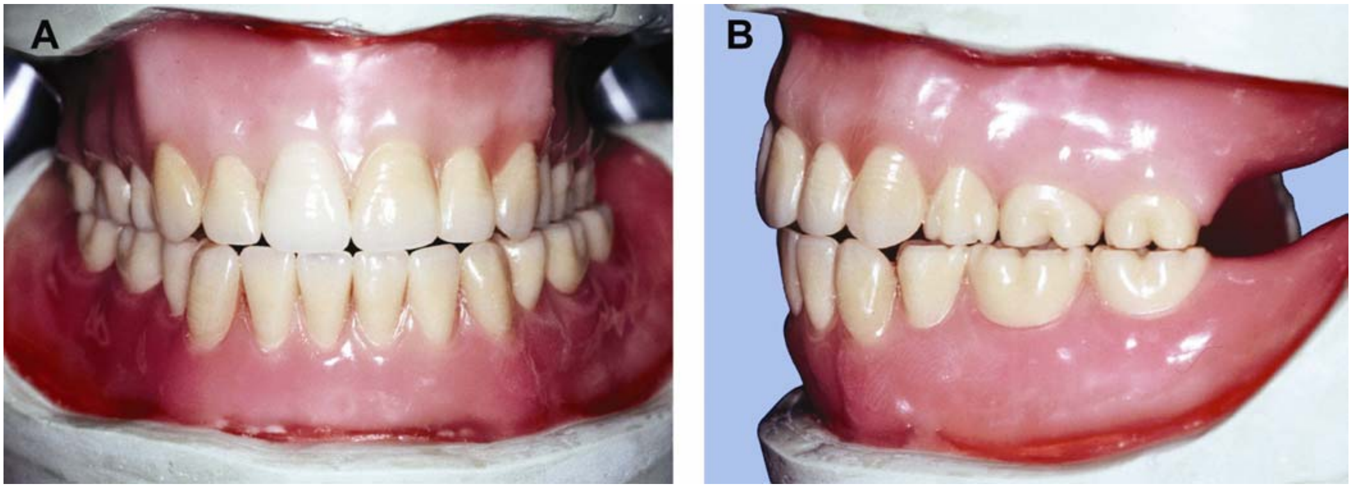
7.101.1.9.1. **Positive Stippling (Blow-On Technique).** Place paper tape on the facial surfaces of the teeth. Pick up molten wax with an appropriate instrument (for example, a #7 wax spatula). Blow the wax off the instrument onto the denture's facial surfaces to impart a bumpy effect. Lightly flame the denture wax-up following the application of blow-on stippling to remove sharp corners from the stippled area. Stippling should be most evident in areas that replicate attached gingiva and concave portions of the denture base.

7.101.1.9.2. **Negative Stippling (Denture Brush Technique).** Stab the denture brush repeatedly into the wax where stippling is desired, leaving many tiny holes and flecks of wax on the high and low contours of the wax denture. Carefully pass a low, brush flame over the roughened areas. The objective is to cause the wax flecks to disappear, the high contours to glaze somewhat, and the most prominent stippling to remain in areas that replicate attached gingiva and concave portions of the denture base.

7.101.2. **Perform a Mandibular Denture Final Wax-Up.** With the exception of palatal contouring considerations, the rules for characterizing a maxillary wax denture are essentially the same as its mandibular counterpart. See Figure 7.92 for a finished wax-up.

7.101.3. **Check the Occlusion.** No matter how good the characterized wax-up looks or how proud you might be of the results, the wax-up is not finished until the occlusion is verified. Balanced complete dentures must show multiple, bilateral posterior contacts in centric occlusion with the incisal guide pin touching the incisal guide table. Check lateral excursions. Balanced complete dentures should have both *cross-tooth* and *cross-arch* contacts in working excursions.

Figure 7.92. Completed Characterized Wax-Up.



Section 7S—Flasking (Investing) Wax Dentures

7.102. Overview. Dental laboratory technology techniques and procedures continue to grow at an ever-increasing pace. Technicians now have a multitude of alternative techniques to choose from to process denture bases. Depending on the technique selected by the dentist, a technician can use different types of flasks. Therefore, this section includes a specific discussion of flask components with their respective technique (that is, compression flask, positive pressure injection flask, and sleeved pour technique flask).

7.103. Definition. For general purposes, a *flask* is a metal or plastic (microwave safe) case used to make sectional molds for processing acrylic resin during the fabrication of denture bases and other prosthetic appliances. *Flasking* is the process of investing the final wax-up in a flask to make a sectional mold.

7.104. Flasking Compression Molded Denture Bases:

7.104.1. **Types of Compression Flasks:**

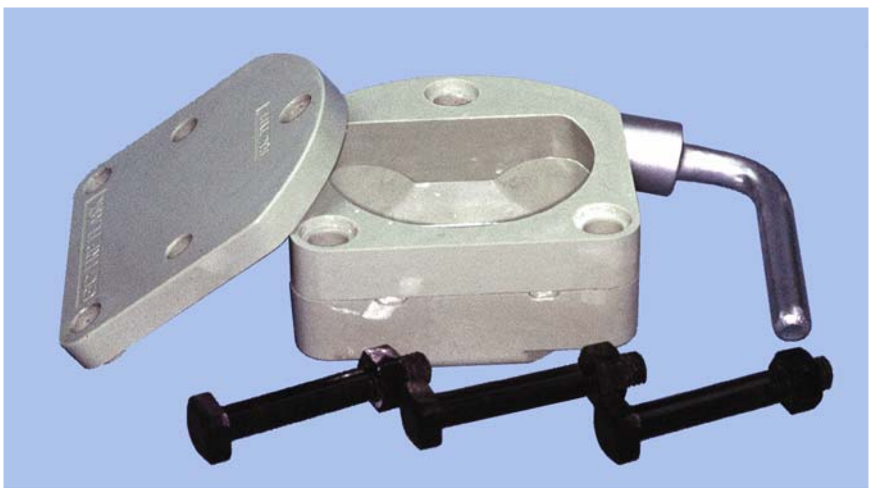
7.104.1.1. There are varying types of compression flasks available. The traditional flask is composed of brass and is used for heat-curing the denture base material (Figure 7.93). An alternate type of compression flask is a plastic flask used when microwave processing denture base material (Figure 7.94).

7.104.1.2. The traditional brass compression flask is composed of a lower section with a knockout plate in the bottom and an upper section with a separate lid. The plastic microwaveable flask is composed similarly; however, does not have a knockout plate.

7.104.1.3. Flasking is performed in three steps. The first step, called lower half flasking, requires one pour of dental stone in a flask's lower section. In the second step, the upper section of the flask is positioned on the lower section and dental stone is poured up to the incisal edges and occlusal surfaces of the teeth to form the upper half flasking. The last step consists of pouring the occlusal cap and placing the lid on the flask. The best results are obtained when all three sections are made in dental stone. ***NOTE:*** Except for the knockout plate, traditional brass flask parts are not interchangeable with parts from other flasks. Ensure all flask parts are numbered and the part numbers on the flask are identical. Failure to do so will create an unwanted processing error. (Microwaveable flask parts are all interchangeable.)

Figure 7.93. Brass Compression Molded Flask.

Figure 7.94. Microwaveable Compression Flask.



7.104.1.4. Clean, inspect, and lubricate all flask parts after every use. Clean the flask with a mild detergent under running water. Inspect the flask parts for stone particles. When cleaning a brass flask, ensure the flask guide pins are properly seated in the upper half of the flask. (***NOTE:*** The guide pins control the position of the upper half flask in relation to the lower half flask. Improper seating of the guide pins can cause flasking and deflasking errors.) A thin film of petrolatum or silicone spray applied to the flask makes stone removal easier. This action also prevents brass flasks from corroding.

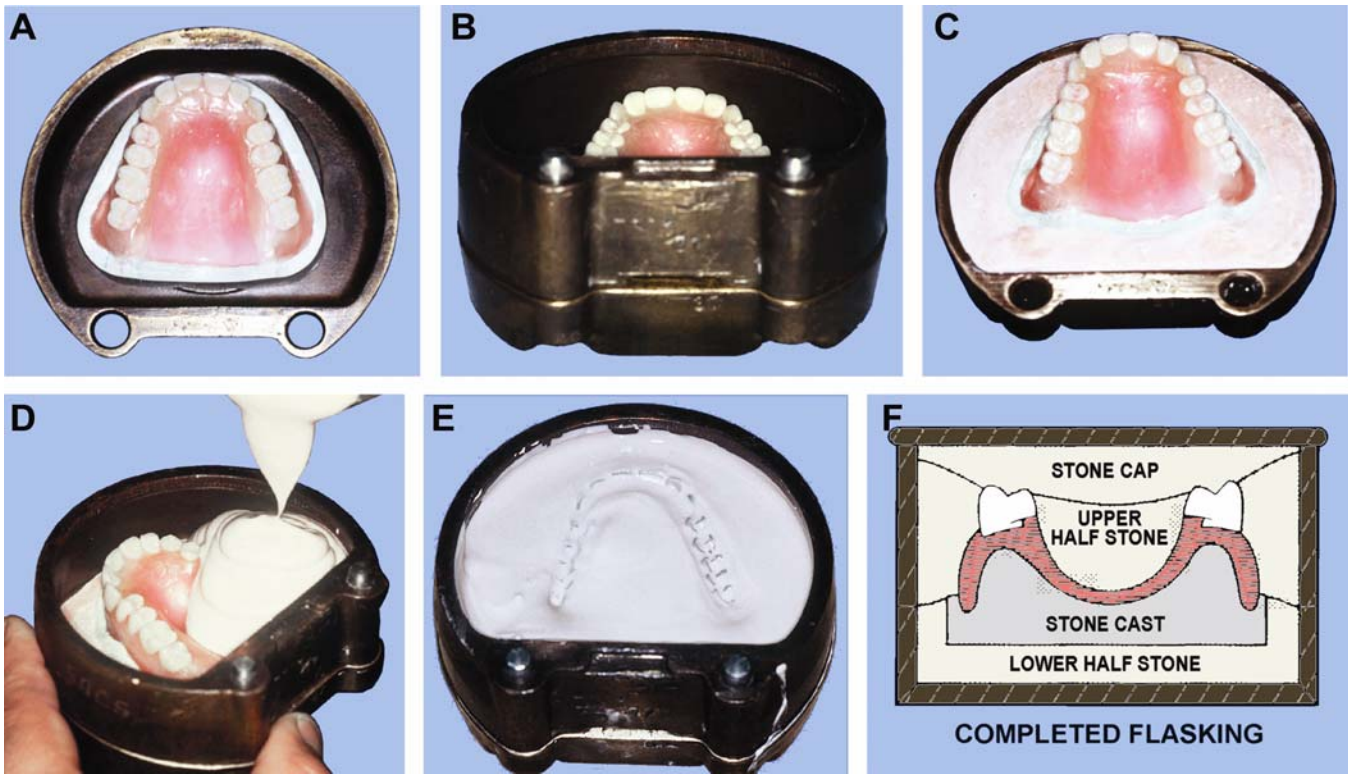
7.104.1.5. Ensure the cast and final wax-up clears the internal surface of the flask by certain essential minimums. ***NOTE:*** The length, width, and height of a cast must be evaluated within a flask before the cast is indexed and mounted in an articulator.

7.104.2. **Flasking the Maxillary Wax Denture (Figure 7.95):**

7.104.2.1. **Lower Half Flasking:**

7.104.2.1.1. Try the maxillary wax denture in the bottom half of the flask. There should be at least a 6 mm clearance between the base of the cast and the sides of the flask. Place the top half of the flask on the bottom half. Check for a minimum of 6 mm of clearance between the denture teeth and the rim of the top half. Remove the top half and brush a separating liquid (green soap or commercial stone to stone separator) on the base of the cast. This will ensure the dental stone separates cleanly from the master cast after the denture is processed.

Figure 7.95. Flasking the Maxillary Wax Denture.



7.104.2.1.2. When using a brass flask, position the knockout plate in the bottom half and make a fresh mix of dental stone. Fill the bottom half of the flask about three-quarters full with stone. Press the cast into the stone to within 3 mm of the bottom. (***NOTE:*** Ensure the denture's occlusal plane is as parallel to the base of the bottom half as possible.) Smooth the area between the edge of the cast and the edge of the flask with your fingers. Do not produce undercuts in the stone. Ensure the land area of the cast and the entire rim of the flask are cleanly and completely exposed.

7.104.2.2. **Upper Half Flasking:**

7.104.2.2.1. Check to see that there is 6 mm of clearance between the teeth and the rim of the top half. Make sure there is *metal-to-metal* contact between the edges of the bottom and top halves. Apply a stone to stone separator to exposed stone surfaces on the lower half flasking. Paint the wax denture with a surface tension reducing agent (debubblizer).

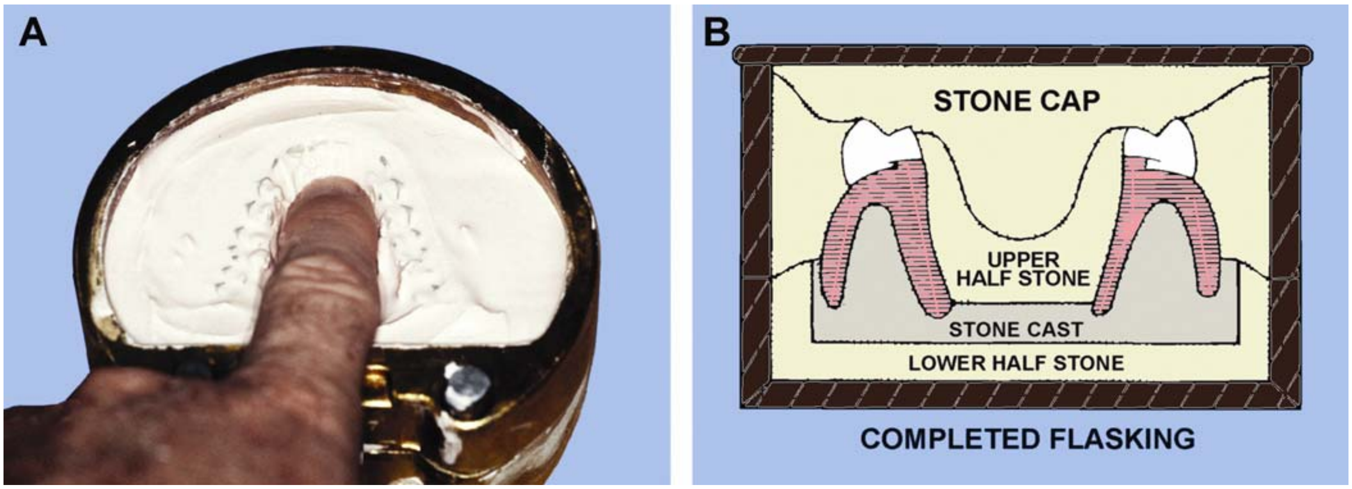
7.104.2.2.2. With the top half in place, pour stone to a level that barely covers the incisal edge and occlusal surfaces of the teeth. The objective is to ensure the stone flows into every detail of the wax-up in as bubble-free a manner as possible. While the stone is still soft, expose the incisal edges and occlusal surfaces of the teeth with two or three wipes of your finger. Do this quickly. A continual disturbance of dental stone that is setting weakens the stone.

7.104.2.2.3. Apply a coating of stone to stone separator to the top of the second pour after it has set. Do not use a separator that discolors denture teeth; instead, use a fluid such as liquid green soap.

7.104.2.2.4. The next step is to pour the cap and position the lid. Press the lid down until there is definite metal-to-metal contact around the entire rim. Remove any excess stone after the stone reaches the final set.

7.104.3. **Flasking the Mandibular Wax Denture (Figure 7.96):**

Figure 7.96. Flasking the Mandibular Wax Denture.



7.104.3.1. **Lower Half Flasking.** Lower half flasking a mandibular wax denture is done in the same way as a maxillary wax denture except as follows: do not flow dental stone into the tongue space area, be sure to reinforce the heels of the mandibular cast with dental stone, and do not forget to orient the wax denture's occlusal plane as parallel as possible to the base of the bottom half.

7.104.3.2. **Upper Half Flasking.** The directions are the same as for the maxillary wax denture. To facilitate deflasking a lower denture, wipe a trough into the tongue space of the upper half flasking, being careful not to create undercuts in the stone surface. (This action reduces the amount of stone in the tongue space and allows for easier removal during deflasking procedures.)

7.104.4. **Wax Elimination.** Let the dental stone in the flasks harden for at least 1 hour before attempting to eliminate the wax.

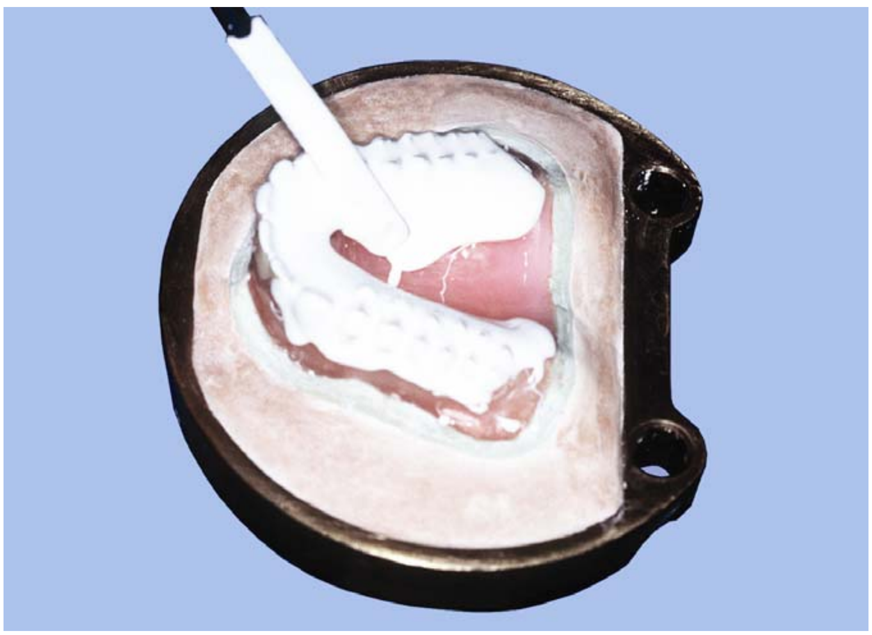
7.104.5. **Silicone Insulating Paste.** The use of this material is widely accepted when the method of processing the denture base does not involve the use of microwave energy. Silicone insulating paste is used as an investment coating material. After lower half flasking the cast, apply the silicone insulating paste to the wax denture base and teeth. Application of the silicone material is followed by completion of full flasking procedures. The flexible silicone insulating material has several advantages. It facilitates deflasking, reduces finishing time, serves as a moisture barrier, and eliminates the need for acrylic to stone separator in the upper mold cavity. Its disadvantages include the cost of the material and the tendency for the denture teeth to be dislodged from the mold. The procedures for full flasking the wax denture, using silicone insulating paste, are as follows:

7.104.5.1. Apply a stone to stone separator to the exposed stone surfaces on the lower half-flasking.

7.104.5.2. Mix the silicone insulating material base and catalyst together according to the manufacturer's directions. Five cc of the material are adequate for small dentures, but 10 cc may be needed for larger dentures.

7.104.5.3. Using a mixing spatula or gloved finger, apply the material to the denture base wax-up while maintaining an approximate thickness of 1 to 2 mm (Figure 7.97). Do not apply insulating paste to the incisal edges or occlusal surfaces of denture teeth. Gradually taper the material from the denture base to the incisal edges and occlusal surfaces, taking care not to overlap the material onto these surfaces. ***NOTE:*** Silicone insulating paste is a nonrigid material. Overlapping of the incisal edges and occlusal surfaces can cause vertical processing error and/or denture tooth dislodgment.

Figure 7.97. Alternate Flasking Method Using Silicone Mold Material.



7.104.5.4. To improve retention of the silicone insulating paste in the stone mold, sprinkle walnut shell particles or apply pieces of 4 by 4 gauze onto the surface of the silicone layer before it sets.

7.104.5.5. Remove any material that would prevent seating the upper flask rim. Seat the rim in place.

7.104.5.6. Fill the upper half with stone while the silicone insulating paste is still tacky. (***NOTE:*** Do not expose the incisal edges and occlusal surfaces during upper half flasking using this technique.) Follow final flasking procedures by pouring the stone cap and replacing the lid of the flask.

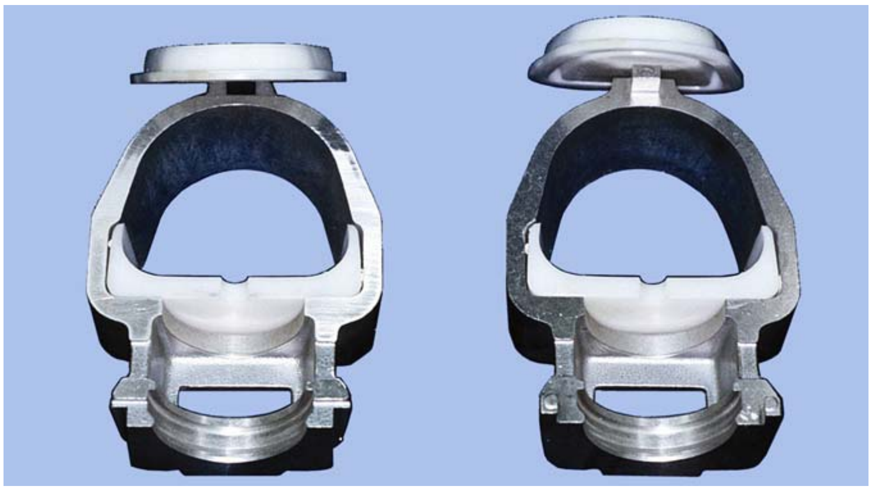
7.105. Flasking Positive Pressure Injection Molded Denture Bases:

7.105.1. **Positive Pressure Injection Flask:**

7.105.1.1. The flask is composed of upper and lower sections with an accompanying plastic cover for each (Figure 7.98). Flasking is performed in two steps. The first step requires one pour of dental stone in a flask's lower section and is called lower half flasking. In the second step, the upper section of the flask is positioned on the lower section and dental stone is poured, covering the incisal edges and occlusal surfaces of the teeth to form the upper half flasking. The best results are obtained when all sections are made in dental stone.

7.105.1.2. Clean, inspect, and lubricate all flask parts after every use. Clean the flask with a mild detergent under running water while inspecting for and removing stone particles. A thin film of petrolatum or silicone spray applied to the flask makes stone removal easier. ***NOTE:*** Flask parts are interchangeable with parts from other flasks.

Figure 7.98. Positive Pressure Injection Flask.



7.105.1.3. Make sure the cast and final wax-up clears the internal surface of the flask by certain essential minimums. ***NOTE:*** It is highly recommended that the length, width, and height of a cast be evaluated within a flask before the cast is indexed and mounted in an articulator.

7.105.2. **Flasking the Final Wax-Up:**

7.105.2.1. **Lower Half Flasking:**

7.105.2.1.1. The cast must be thoroughly saturated with SDS prior to investing. Try the wax denture in the bottom half of the flask with the lower cover in place. There should be at least a 1 cm of clearance between the base of the cast and the sides of the flask.

7.105.2.1.2. Place the top half of the flask on the bottom half. There should be 16 mm of clearance from the rim of the upper half flask to the incisal edges and occlusal surfaces. Remove the top half and brush a separating liquid (green soap or commercial stone to stone separator) on the base of the cast. (It is very important to separate the cast cleanly from the investment after the denture is processed.)

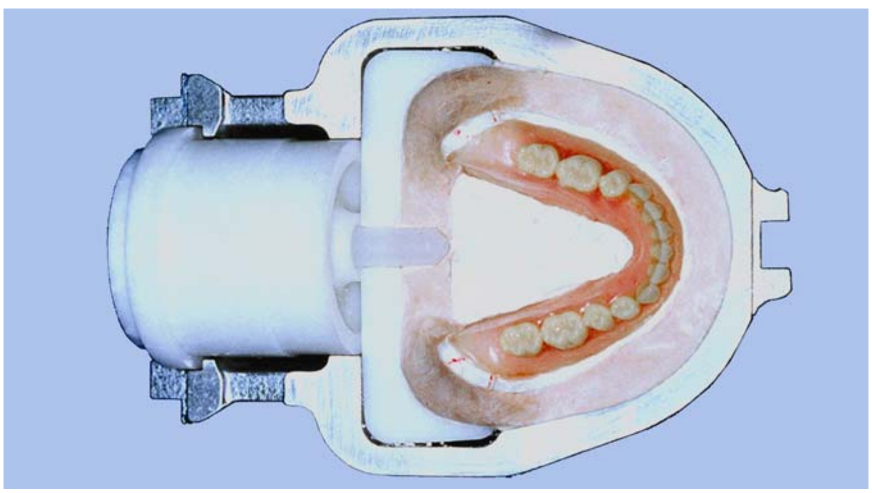
7.105.2.1.3. Make a fresh mix of dental stone and fill the bottom half about three-quarters full with stone. Press the cast into the stone to within 3 mm of the bottom and position the investment aid. Smooth the area between the edge of the cast and the edge of the flask with your fingers. Be sure not to produce undercuts in the stone. The land area of the cast, tongue space on mandibular dentures, and the entire rim of the flask should be clean and completely exposed. To ensure an optimal investment channel, level off the stone to the top of the investment aid (Figure 7.99). ***NOTE:*** Ensure the denture's occlusal plane is as parallel to the base of the bottom half as possible. Also ensure the dental stone does not extend above the top of the investment aid.

7.105.2.2. **Upper Half Flasking:**

7.105.2.2.1. Start by removing the investment aid and replacing it with the injection tube and funnel (Figure 7.100). It is very important not to damage the edges of the injection channel. This area forms a seal to resist back pressure during the injection process so the denture resin does not escape from the posterior shoulder of the flask.

Figure 7.99. Injection Mold Flasking the Wax Denture.

Figure 7.100. Injection Tube and Funnel Placement.



7.105.2.2.2. Position the flask's upper half over the lower half with the plastic cover in place. Ensure there is metal to metal contact of the flask halves and the plastic cover fully seats in the upper half of the flask. ***NOTE:*** If the plastic cover does not fully seat due to interference of the denture wax-up, reinvestment of the lower half may be necessary.

7.105.2.2.3. The formation of injection channels is now necessary prior to upper half flasking. Depending upon the type of prostheses being invested, it may be necessary to form one or several injection channels. For complete upper dentures and interim RPDs, one injection channel is usually sufficient (Figure 7.101). When investing a mandibular complete denture two injection channels are necessary (Figure 7.102.) For RPDs having isolated denture base areas, numerous injection channels may be necessary (Figure 7.103).

Figure 7.101. Placement of Injection Channel (Maxillary Denture).

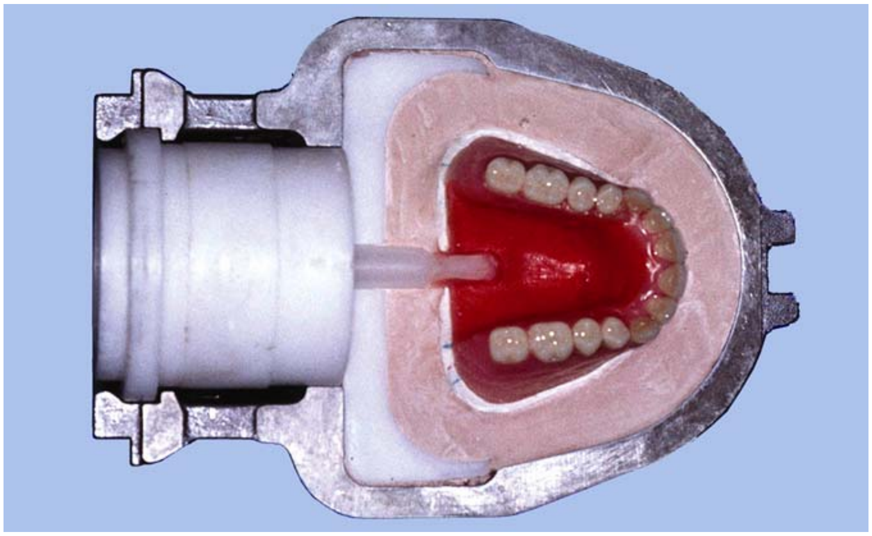
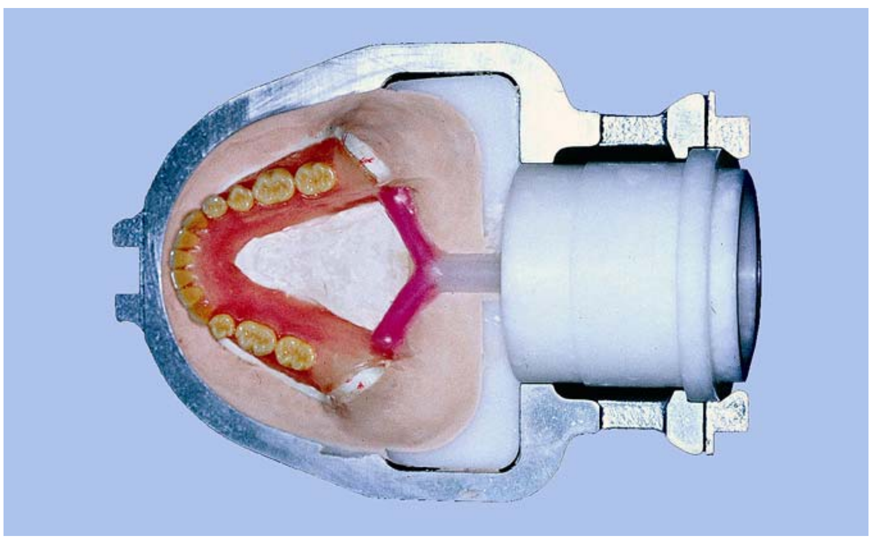


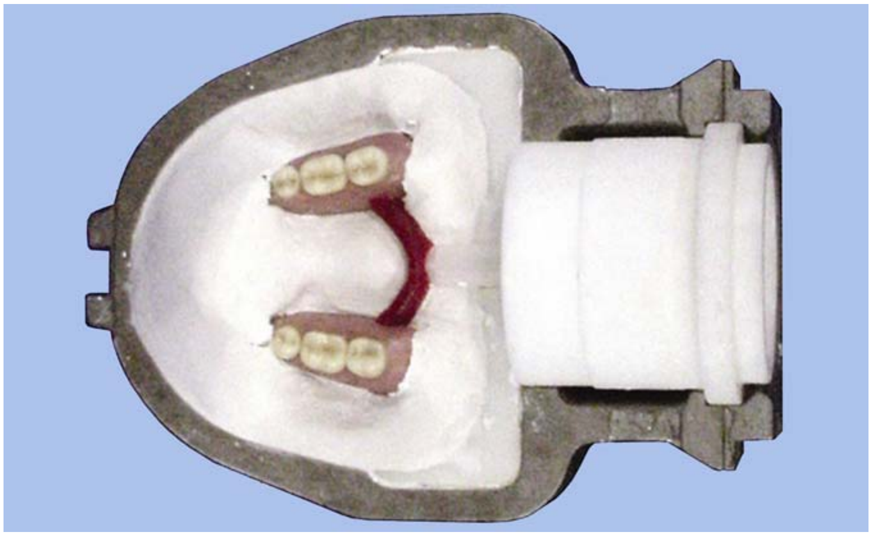
Figure 7.102. Placement of Injection Channel (Mandibular Denture).



7.105.2.2.4. When evaluating the need for and placement of investment channels, place the flask on end with the anterior teeth closest to the bench top and locate the highest areas of the wax-up (normally those areas closest to the injection tube). These areas will require an injection channel. However, when evaluating prostheses with multiple isolated denture base areas an injection channel is required for each. ***NOTE:*** The injection channel must be located at the highest portion of the wax-up within the area being injected.

7.105.2.2.5. Formation of the injection channel is done by applying rolled baseplate wax 3 to 5 mm in diameter to the lower half flasking. Apply the channel from the tip of the injection tube to the exact location on the denture base wax-up previously identified as requiring an injection channel. Using a hot instrument, seal the baseplate wax to the injection tube tip and the denture base. Complete the process by ensuring the wax-up is smooth paying special attention to the injection tube tip.

Figure 7.103. Placement of Injection Channel (Multiple Areas).



7.105.2.2.6. Begin the final stage of the flasking process by applying a stone-to-stone separator to the exposed stone surfaces on the lower half flasking. Paint the wax denture with a surface tension reducing agent (debubblizer).

7.105.2.2.7. With the top half in place, pour stone to a level that barely covers the incisal edge and occlusal surfaces of the denture teeth. Once the stone reaches a level covering the denture teeth, place a thoroughly soaked paper insert, which aids devestment, into the wet stone in the flask and continue to fill. When the flask is filled with stone, place the flask cover into position in the upper half flask and press down until completely seated. Remove any excess stone from the exterior of the flask.

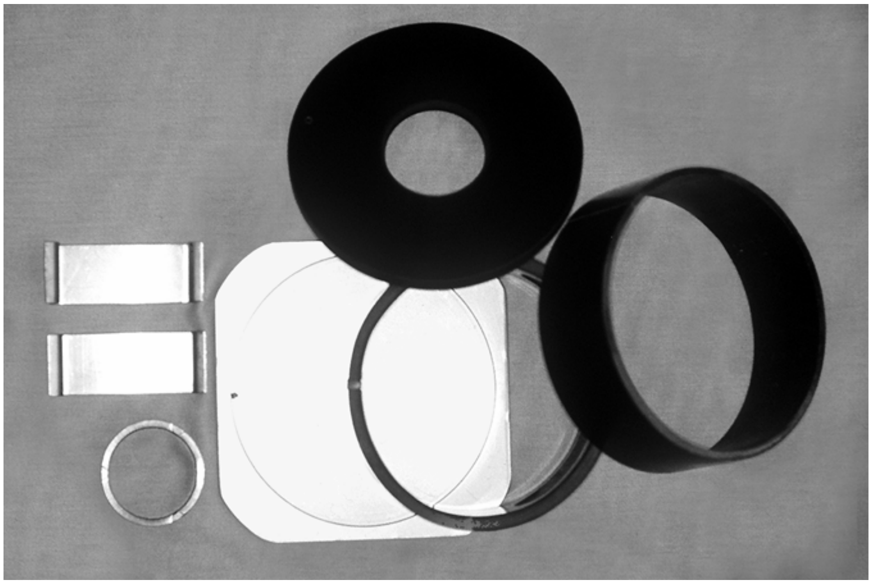
7.105.3. **Wax Elimination.** Let the dental stone in the flasks harden for at least 1 hour before attempting to eliminate the wax.

7.106. Flasking Liquid Pour Resin Denture Bases:

7.106.1. **Pour Flask.** The flask is composed of four major components with two flask spring clips and a pouring spout or reservoir (Figure 7.104). The outer flask sleeve is positioned over the inner flask sleeve with the top and bottom plates in place which form a seal preventing the molten hydrocolloid from escaping the flask. The locating pins found on the flask's bottom plate and top plate allow the technician to accurately reassemble the flask during processing. The flask spring clips are used to hold the flask together during pouring and processing, and the pour spout or reservoir allows the hydrocolloid additional material to draw from as it solidifies.

7.106.2. **Cast Preparation.** This technique employs the use of reversible hydrocolloid. Therefore, adequate cast preparation is necessary to facilitate the withdrawal of the cast from the solidified hydrocolloid and provide a means of accurately returning the cast to its proper orientation within the prepared mold. The following steps will help the technician take full advantage of the capabilities of this technique:

Figure 7.104. Unassembled Pour Flask.



7.106.2.1. Prepare the cast by trimming the base at a slight convergence angle toward the land area of the cast. This is best done before mounting the cast to the articulator.

7.106.2.2. Clean the land area of the cast by removing any wax debris. The land area must be 3 mm wide to provide an adequate seat when the cast is returned to the mold for processing.

7.106.2.3. Prepare the case for investment by evaluating areas of the cast not in the design that could potentially tear the hydrocolloid when the cast is lifted from the mold. Areas requiring blockout are usually located under the lingual bar of an RPD and deep sulcus areas. The use of modeling clay is the recommended method of blockout. The blockout material used should not be removed once the hydrocolloid has solidified within the mold, and the material should stay in place throughout the entire processing of the denture base.

7.106.2.4. Soak the cast in a 110 ^{o}F (38 ^{o}C) SDS water bath for 5 minutes. This prepares the cast to receive the molten hydrocolloid and allows the material to flow into the minute details of the wax-up. Presoaking the cast also prevents premature solidification of the duplicating material while investing.

7.106.3. **Preparing the Hydrocolloid for Pouring:**

7.106.3.1. If the laboratory has an auto-duplicator, simply draw enough material to fill the flask. If the laboratory does not have an auto- duplicator, prepare a batch of hydrocolloid using a pressure pot. A soldering stand, bunsen burner, pressure pot, and thermometer will be needed.

7.106.3.2. Start by placing diced cubes of hydrocolloid material into the pressure pot, place it on the soldering stand, and apply heat by using the bunsen burner. Only apply enough heat to melt the hydrocolloid. Be careful not to overheat the material!

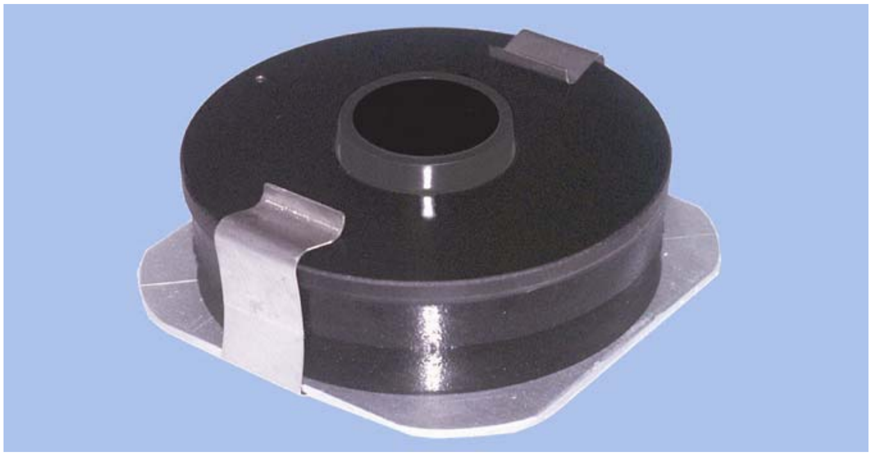
7.106.3.3. When the hydrocolloid is completely melted, pour the material into a 16 oz (473 cc) measuring cup and allow it to cool. Monitor the hydrocolloid constantly, using a thermometer. When the material reaches a temperature of 120 ^{o}F (49 ^{o}C), it is ready to pour. Pour the hydrocolloid into the flask as soon as it reaches the desired pouring temperature (paragraph 7.106.4).

7.106.4. **Pouring the Hydrocolloid:**

7.106.4.1. Place the exterior flask sleeve over the inner sleeve. The slit in the outer sleeve must be positioned over a solid area of the inner flask sleeve. If these two components are not positioned correctly, the molten hydrocolloid will escape the mold when poured.

7.106.4.2. Place the sleeves on the bottom plate. When positioning the sleeves on the bottom plate, ensure the locating pin properly articulates with the locating pin slot found on the inner sleeve (Figure 7.105).

Figure 7.105. Assembled Flask.



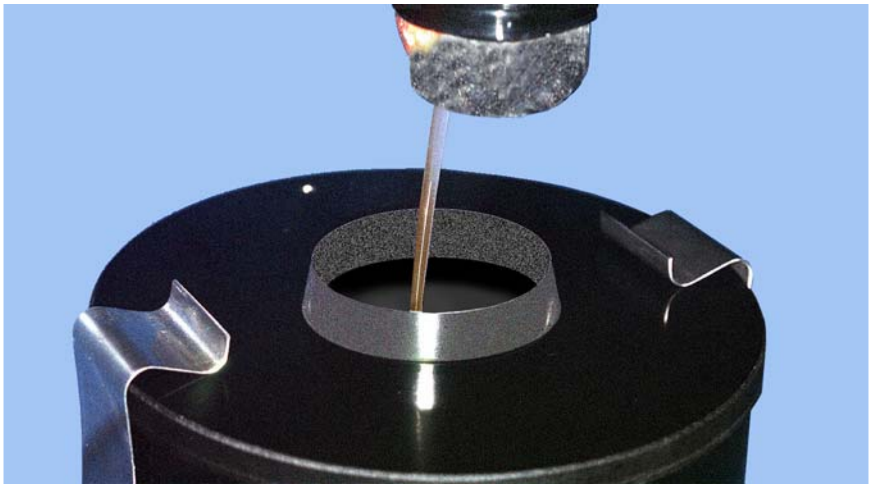
7.106.4.3. Position the cast in the flask (Figure 7.106). (***NOTE:*** Before the cast can be positioned in the flask, the technician must have identified where the sprues will be placed to pour the denture base.) When pouring some denture base areas, it may be necessary to wax sprue vents prior to investing.

Figure 7.106. Spruing Attachment Sites.

7.106.4.4. Mount the top plate with the reservoir and spring clips in place.

7.106.4.5. Pour the hydrocolloid into the flask filling it completely (Figure 7.107). Then place the flask in a cooling water bath. To promote rapid cooling of the hydrocolloid the flask should be immersed to three-quarters of its height.

Figure 7.107. Filling the Flask With Hydrocolloid.



7.107. Wax Elimination for Compression and Injection Molded Flasks. The purpose of wax elimination and mold preparation is to form a mold cavity into which acrylic resin can be packed.

7.107.1. **Equipment and Materials.** The following should be used:

7.107.1.1. Flask carrier. This equipment item safely carries flasks into and out of boiling water while maintaining constant compressive force on the flasks.

7.107.1.2. Boil-out tanks. A three-tank unit is most convenient. The first tank is used to soften wax and remove the bulk wax, the second tank is used for the detergent rinse, and the third tank is used for flushing the mold cavity with clean, hot water.

7.107.1.3. Insulated gloves. Always use protective gloves when handling hot flasks because the flask and the boiling water can cause burns.

7.107.1.4. Two plaster knives. Use the "screwdriver" ends to pry flask open.

7.107.1.5. Large dipper. Use a dipper that has a hole in the bottom.

7.107.1.6. Medium stiff bristled brush and a powered household detergent containing no bleach additives.

7.107.1.7. Tinfoil substitute or appropriate acrylic to stone separating medium and a brush.

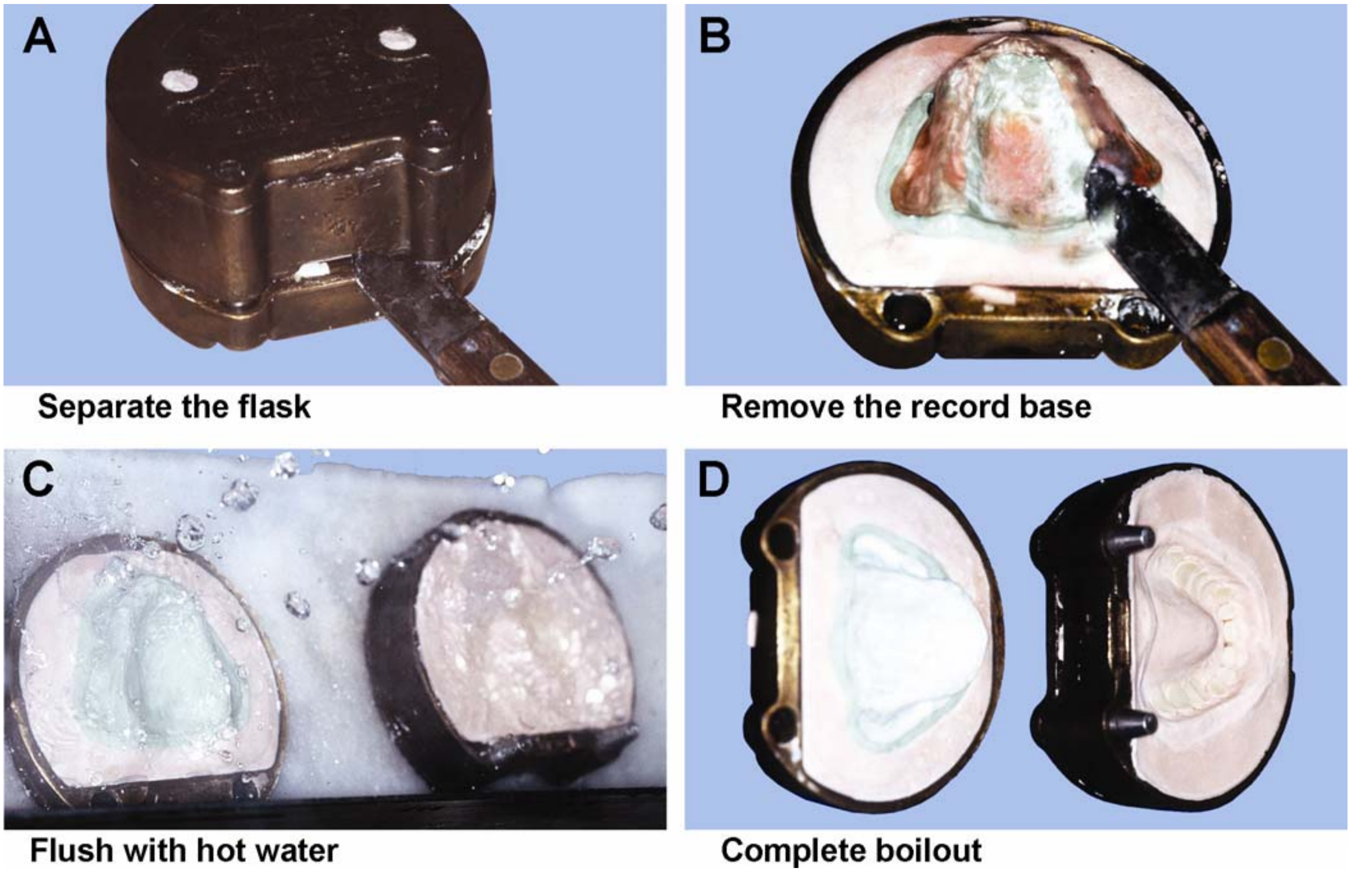
7.107.2. **Wax Elimination Procedures (Figure 7.108):**

7.107.2.1. Place the flask in boiling water for 5 minutes. The immersion time can vary according to the number of flasks in the water. Ideally, the wax should come out in one piece when the mold is separated. Too little time in the tank results in denture teeth being pulled out of the mold along with the cold wax. Conversely, too much heating time causes the wax to melt and soak into the mold.

7.107.2.2. Remove the flask from the first tank and open it. Use two plaster knives and pry both sides of the flask at the same time.

7.107.2.3. Lift out the record base and softened wax with a knife or forceps. Hopefully, the wax will come out in one piece.

Figure 7.108. Wax Elimination Procedures.



7.107.2.4. Using detergent solution from the second tank, clean and flush the mold. Use a brush that reaches into all of the recesses of the mold. Watch for denture teeth that might have come loose. Retrieve loosened teeth with forceps so they can be properly positioned later.

7.107.2.5. Flush the mold with clean, hot water from the third tank. Avoid cross-contamination of the three tanks. Ensure the water taken from the detergent or the clean hot water tanks to flush a mold runs off into the first, flask-heating tank. Because molten wax floats on water, use this trait to your advantage. When flushing a mold, do not use the last quarter inch of water in the dipper because it might contain suspended wax.

7.107.2.6. Set the mold on end to drain and dry. Let it cool enough to be handled safely.

7.108. Wax Elimination Using a Reversible Hydrocolloid Pour Technique Flask:

7.108.1. **Equipment and Materials.** (See paragraph 7.107.1).

7.108.2. **Wax Elimination Procedures:**

7.108.2.1. Remove flask from the cooling bath following complete solidification of the hydrocolloid. Remove the flask clamps and reservoir and trim away excess material from the reservoir.

7.108.2.2. Using plaster knives, lift the cast from the flask or hydrocolloid. (Be careful not to fracture the cast.) Remove the acrylic teeth and base plate from the wax-up.

7.108.2.3. Using detergent solution from the second tank, clean and flush the cast and teeth. Place the cast on the flask carrier and complete boilout procedures. Denture teeth can be placed in a strainer and flushed with boiling water to ensure complete wax removal (paragraph 7.107.2.4).

7.108.2.4. Flush the cast and teeth with clean, hot water from the third tank.

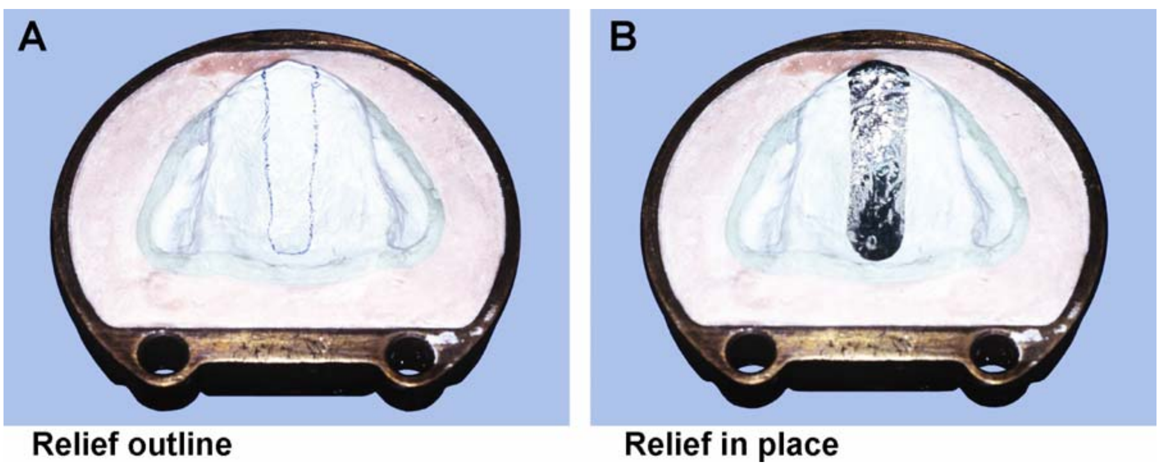
7.108.2.5. Set the cast on end to drain and dry. Place the teeth in a safe area to ensure the teeth are not lost or destroyed.

7.109. Mold Preparation for Compression and Injection Molded Flasks:

7.109.1. **Posterior Palatal Seal.** Placement of a posterior palatal seal is not recommended for injection molded processing. If traditional compression heat curing is the method of processing chosen, it is assumed that placement of the posterior palatal seal has already been accomplished on the maxillary cast (paragraph 7.101.1.2).

7.109.2. **Relief Areas.** Relief is occasionally required in a denture to reduce or eliminate pressure on selective and specific soft tissue areas designated by the dentist. When relief is prescribed, the incisive papilla, median palatine raphe, mental foramen, or tori formations are the structures most likely to receive special attention. To get the desired amount of relief, cut appropriate thicknesses of foil and glue them in place (Figure 7.109). Cyanoacrylate glue is recommended.

Figure 7.109. Median Palatine Raphe Relief.



7.109.3. **Loose Teeth.** Seat denture teeth that might have come loose during the wax elimination step.

7.109.4. **Applying Tinfoil Substitute:**

7.109.4.1. Because plaster and stone absorb fluid, seal the surface of the mold to prevent acrylic resin monomer from soaking into it during processing. If the monomer penetrates the mold's surface, the polymerized denture base fuses with the stone cast and the denture mold. If this occurs, the denture base is ruined.

7.109.4.2. Gypsum surfaces that contact unprocessed acrylic resin can be sealed with various separating media. To date, *tinfoil* is probably the best separator used. Applying tinfoil to a waxed denture is a tedious and time-consuming process for all but the most experienced technician. An alternative, popular method of preventing the mold surface from absorbing liquid resin is to paint the mold with a liquid alginate called *tinfoil substitute.*

7.109.4.3. To use the tinfoil substitute, eliminate all wax residue from the mold and carefully apply the separating material to seal the surface completely. The tinfoil substitute flows more readily and penetrates the mold surface better. This separating medium reacts chemically with the surface stone, creating a microscopic layer sealing the surface of the cast. A visible buildup of separator is not necessary for it to be effective.

7.109.4.4. The tinfoil substitute is rendered useless by gypsum particle contamination. ***NOTE:*** Never dip a used swab or brush into the bulk supply of tinfoil substitute. Instead, pour as much tinfoil substitute as is needed into a separate container and discard the unused material.

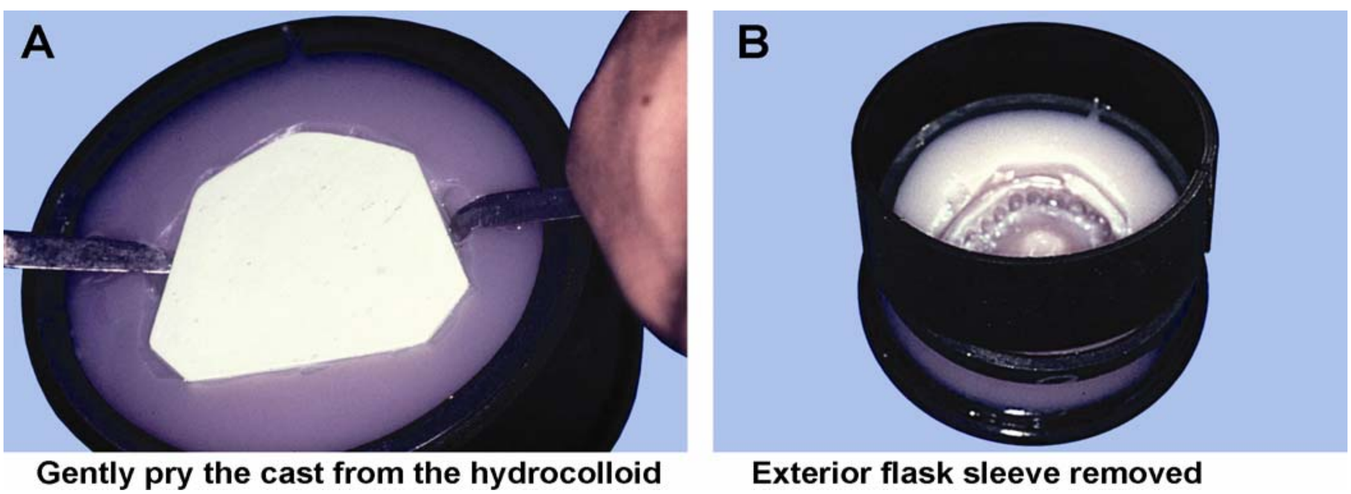
7.109.4.5. While the mold is still warm, apply a coat of separating material to the lower half of the flask (cast side). Paint the separator after the steaming action of the mold has stopped. (Steam escaping from the stone will cause separator that has been applied to lift from the stone surface.) Apply the second coat just before closing the flask during packing procedures (paragraph 7.117). Using two coats at different times is a safety precaution. If the polyethylene sheet tears during packing, the first coat of separating material prevents the acrylic resin from sticking to the cast in the area of the tear.

7.109.4.6. Paint two coats of separating material on the upper half of the flask (mold side). Apply the first coat after the clean mold has stopped steaming, and is still warm. Apply the second coat after the first coat dries. Try not to let the separator pool in interproximal areas. If tinfoil substitute has covered the ridgelap portion of the denture teeth, let it dry. Use a cotton-tipped swab, damp with acrylic monomer, to remove the film.

7.110. Mold Preparation Using a Reversible Hydrocolloid Pour Technique Flask:

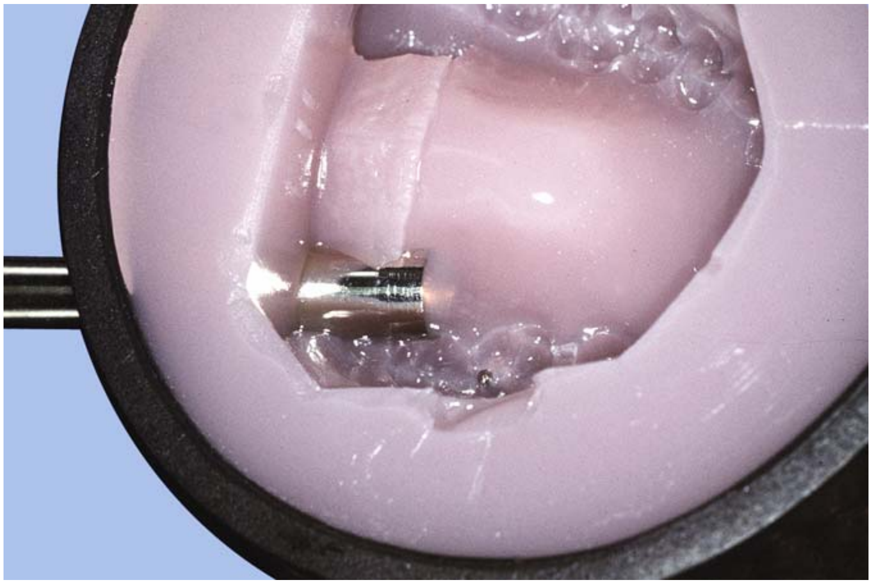
7.110.1. First, remove the cast by gently prying up on the base using two knifes (Figure 7.110-A). Next, remove the flask exterior sleeve to expose a window of solidified hydrocolloid material (Figure 7.110-B).

Figure 7.110. Removal of the Cast and Hydrocolloid Flask Exterior Sleeve.



7.110.2. Using the appropriate spru e cutter (Figure 7.111), bore a main pouring channel through the hydrocolloid window to the height of the denture base area being processed. This channel will allow the liquid acrylic to be poured into the mold cavity. The pouring channel should be attached to the denture base area as high on its border as possible to enable air to escape the mold while pouring. Also bore a slightly smaller gauge auxiliary channel in the opposite side of the denture base to allow the liquid acrylic to completely fill the mold cavity without entrapping air.

Figure 7.111. Placement of Pouring Channels.



7.110.3. Rinse the entire mold cavity with a small amount of denatured alcohol to remove all surface contaminants from the hydrocolloid and allow to dry.

7.110.4. Apply a separator to the stone cast (paragraph 7.109.4).

7.110.5. Carefully inspect and remove any residual wax on the denture teeth. Prepare the denture teeth for processing by dabbing the ridgelap of the tooth with a monomer-soaked cotton tip applicator. Place the tooth in the hydrocolloid mold in its proper position. Carefully seat the cast with components (clasps and RPD frameworks) in to the flask being careful not to tear the hydrocolloid or dislodge the denture teeth. Reassemble the flask and ensure the flask clamps are not placed over the pouring channels.

7.110.6. The flask is now ready for mixing and pouring of acrylic resin (paragraph 7.123).

Section 7T—Characterizing Denture Base Resins

7.111. Overview. Characterization is done after the wax denture is boiled out, but before the mold is filled. Characterization of the denture base imparts the desired natural appearance to the denture.

7.112. Selecting a Primary Denture Base Color and Performing Supplemental Tinting:

7.112.1. Fine, superficial blood vessel complexes are visible on natural mucosal tissues, and most good denture base resins come with red nylon fibers that simulate those blood vessels.

7.112.2. Oral mucosal color differs from person to person and is primarily related to the degree of pigmentation contained with the tissue. In light skinned people, the free gingival areas are pale pink, the attached gingival is light red, and the alveolar mucosa and frenum attachments are dark red. Pigments such as brown, purple, black, and yellow may occur in persons of any race, but they happen more frequently in darker skinned people.

7.112.3. Acrylic resin denture base material is available in several different shades. It can be blended to match the basic color of almost any oral tissue. Some manufacturers provide a shade guide for the denture base resins they produce. However, many dentists and technicians assemble their own shade guides for a convenient reference. Tinting a denture base resin is accomplished with various colored acrylic polymer powders.

7.112.4. Each of the following colored polymer powders is used in a specific area of the mold cavity surrounding the denture teeth (Kayon® Denture Stains):

7.112.4.1. "F" (light red) for light foundation color.

7.112.4.2. "B" (brown) for dark foundation color.

7.112.4.3. "A" (medium red) for interdental papillae and sulci.

7.112.4.4. "H" (near white) for neck and eminence color.

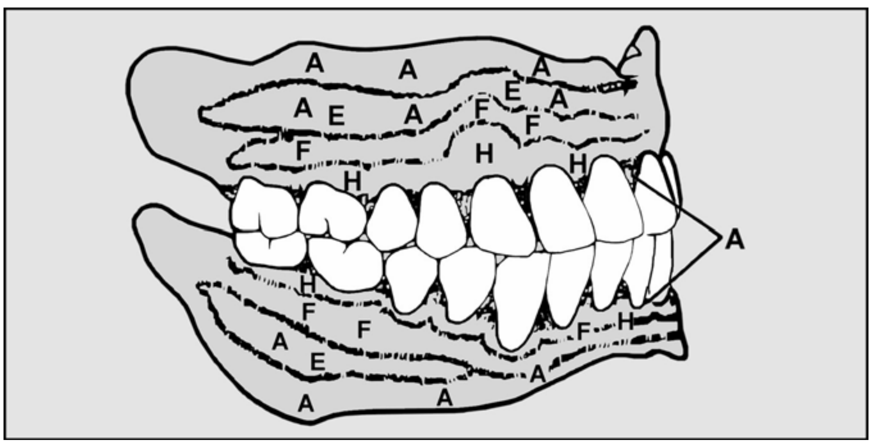
7.112.4.5. No. 4 (dark red) for frenums and sulci adjacent to them.

7.113. Application of Tinted Resin:

7.113.1. The depth of the tinted veneer varies from 1 to 2 mm, depending on the color effect desired. The stains are sifted and blended around groups of three to four teeth at a time. Add drops of monomer after sprinkling enough loose polymer to warrant holding it in position. It is best to add the monomer drop by drop from a 2-cc hypodermic syringe, using a blunted 27-gauge needle. Apply the monomer so it seeps into the polymer from the peripheral edge of the stains and the wetting travels toward the teeth. Flooding the stains with monomer causes the various colors to mix and lose their individuality.

7.113.2. Denture base tinting for light skinned people is shown in Figure 7.112 and as follows:

Figure 7.112. Denture Base Tinting for Light Skinned People.



7.113.2.1. Use "H" (near white) over labial and buccal surfaces (plus monomer). Apply the powder as a thin flashing that is barely visible (Figure 7.113).

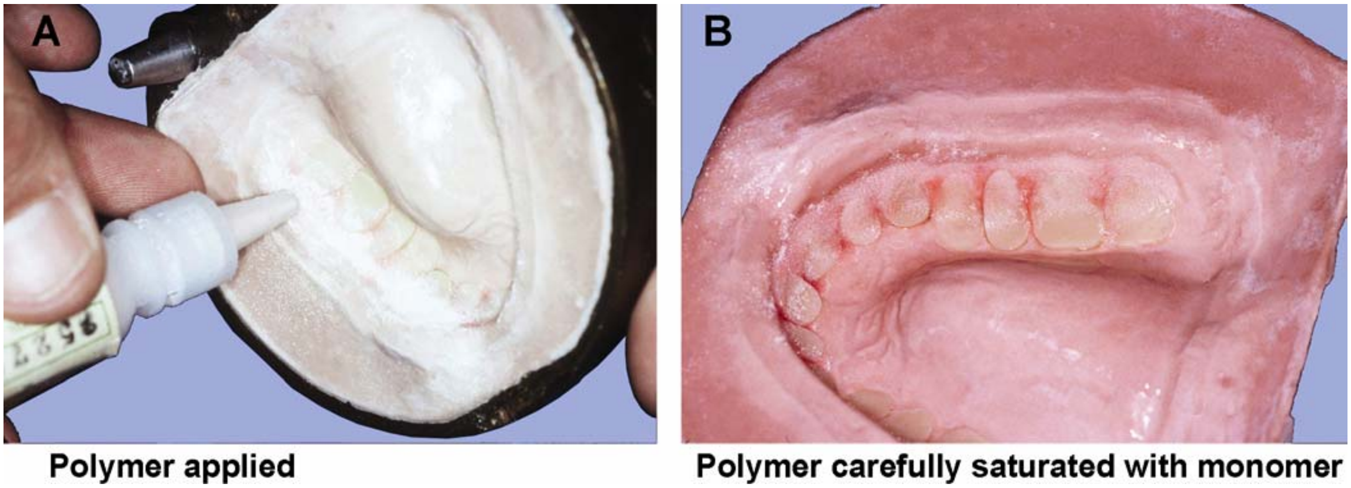
7.113.2.2. Use "F" (light red) all over the "H" (plus monomer). The "F" (light red) showing through the "H" gives depth to the coloring.

7.113.2.3. Use "A" (medium red) in the interseptal areas (plus monomer).

7.113.2.4. Use "H" for root eminences. Make the layer heavier near the necks of the teeth and fade it out a few millimeters apically (plus monomer).

7.113.2.5. Perform the bulk of the tinting by covering the open surfaces and completed areas almost to the borders with stain "F" (plus monomer). Create thicknesses that range from 1 to 2 mm. Dust short red fibers into this layer from the approximate middle of the attached gingiva into the sulci.

Figure 7.113. Applying Denture Base Stains.



7.113.2.6. Use “A” (plus monomer) for alveolar mucosa and border areas and sprinkle in a little No. 4 to accentuate frenums.

7.113.2.7. Put the tinted mold in a covered container along with a monomer-moistened cotton roll. Let the tinting set for 20 minutes before proceeding with the packing phase.

7.113.3. Denture base tinting for dark-skinned people is shown in Figure 7.114 and as follows:

Figure 7.114. Denture Base Tinting for Dark Skinned People.

7.113.3.1. Placing varied amounts of stain “B” (brown) satisfies most requirements. Follow the directions given for light skinned people (paragraph 7.113.2), but use stain “B” in place of stain “F,” either entirely or in part. For darker effects, black and blue stains are also available.

7.113.3.2. The most important effect is accomplished by selecting the most appropriate denture base material that which will provide the background shade. The use of acrylic stains only accents features found on the mucosa and will not compensate for a poorly selected denture base shade. The use of denture base stains alone when trying to duplicate heavily pigmented tissue is not recommended.

7.113.3.3. If a silicone coating material was used to invest the case, it is possible to practice tinting the flanges. The silicone material allows the tinting veneer to be removed from the mold for immediate evaluation. It is a good idea to study and practice different staining effects.

Section 7U—Compression-Molded, Heat-Cured Denture Resin

7.114. Principal Kind of Resin. The principal kind of resin used for denture bases at the present time is *polymethyl methacrylate.* It is supplied as a monomer (liquid) and polymer (powder) which are mixed together in accordance with manufacturer's instructions. The result is a dough-like mass that can be easily shaped to fit a mold space. After the two halves of the mold are closed, the chemical reaction between the monomer and polymer continues to completion. What was originally a pliable dough changes into solid plastic.

7.115. Chemically Activated Resins:

7.115.1. The chemical reaction that takes place when acrylic resin dough is converted into solid, acrylic resin plastic is called *polymerization.* There are two classes of acrylic resin; heat-curing and chemically activated. The division is based on how the monomer-polymer dough is changed into solid plastic.

7.11.5.2. With heat-curing acrylic resins, polymerization takes place by a process of controlled heating. The monomer-polymer contained in the mold is raised to a temperature specified by the manufacturer for a specific period of time to create a hard, dense, processed acrylic resin. The method of applying heat can be in the form of water as the principal means of conducting heat or the use of microwave energy.

7.11.5.3. Chemically activated acrylic resins are identified by other names like *self-curing, cold-curing,* or *autopolymerizing resin.* In this case, polymerization takes place without the external application of heat. The monomer portion of a chemically activated resin contains an additional substance (*dimethyl paratoluidine*). This substance causes the monomer and polymer to polymerize without the need for heat to be applied to the acrylic resin.

7.115.4. Heat-curing resin is most commonly used for processing complete dentures in the dental laboratory. Autopolymerizing resins have more advantages (for example, less dimensional change) than heat-curing resins, and heating equipment is not required for polymerization. Heat-curing acrylic resins also have their own distinct advantages--greater color stability, greater strength, more resistance to staining, and less absorption of oral fluids than autopolymerizing resins.

7.116. Mixing Heat-Curing Acrylic Resin. Meticulous cleanliness must be observed while mixing and packing acrylic resin to avoid introducing foreign materials into the dough.

7.116.1. The equipment needed for mixing the acrylic resin includes monomer impermeable gloves, a glass mixing jar with lid, a stainless steel mixing spatula, and two graduated cylinders. Maintain one cylinder for monomer measurement and the other for powder. Do not switch the two and do not use a plastic graduated cylinder for the monomer.

7.116.2. In the absence of manufacturer's instructions, use one part monomer to three parts polymer. By volume, 10 cc of monomer to 30 cc of polymer represents the average unit measure for packing and processing one denture.

CAUTION: The use of manufacturer's instructions is critical when selecting the curing method for the denture base material. Microwave curing of a denture base material not specifically designed for that application can lead to porosity, warpage, and incomplete curing. Each manufacturer provides specific instructions and curing directions.

7.116.3. From this point on, use disposable gloves or plastic sheets when physically handling the resin. Using gloves protects the hands from the possible health effects of handling uncured monomer, while protecting the resin from dirt and skin oils.

7.116.4. Pour the monomer liquid into the jar. Sift most of the powder into the liquid. (Always add the powder to the liquid to reduce the amount of entrapped air in the mix.) Tap the jar on the bench top several times to bring the liquid to the surface. Add the remainder of the powder. Stir, but do not whip the mixture. Whipping the mixture increases the likelihood of trapping air in the acrylic resin during the mixing process, which could cause difficulty in later fabrication steps. Place the lid on the mixing jar to prevent monomer evaporation during the time it takes for the mix to reach packing consistency.

7.116.5. Expect the mix to go through a series of stages or changes in consistency. After allowing the mixture to stand for the approximate length of time recommended by the manufacturer, open the jar and test the material with a spatula. When the mixture is no longer sticky and does not adhere to the walls of the mixing jar, it is in the dough stage and ready to pack into the mold. There are many brands of heat-cured acrylic resins, and manufacturer's directions sometimes recommend some other indicator of packing consistency that is desirable for their product. Therefore, it is important to read the directions and become thoroughly familiar with the material's characteristics and behavior.

7.116.6. If acrylic resin is packed at the sandy or stringy stage, the material does not have enough body to pack well and will flow too readily from the mold. Packing at too early a stage can result in a porous denture base. Packing the material at a very stiff stage does not allow it to flow under the pressure the press generates. Delayed packing results in a loss of denture base detail, possible movement of the teeth, and probable opening of the occlusal vertical dimension.

7.117. Procedures for Packing Heat-Curing Resin. The resin dough is handled with disposable gloves. The packing procedure is done confidently and without interruption. To ensure success, arrange the equipment and materials in the order of use and follow these procedures:

7.117.1. Use the following equipment and materials: bench press, carrier press, wrench and handle, plastic sheets and gloves, and a tinfoil substitute and brush.

7.117.2. Roll the resin dough into a 1-inch diameter sausage shape (roll) to align the fibers. Place the roll between two packing sheets and flatten it into a 3 mm thick slab.

7.117.3. Cut the material into appropriate shapes for the labial flange, buccal flange, and palatal areas of the maxillary mold cavity. Do the same for the labial, buccal, and lingual flanges of the mandibular mold. Fiber alignment is important when the pieces are cut. Fibers in the labial, buccal, and lingual flange pieces run parallel to the long axes of the teeth. Fibers in a palatal section run anterioposteriorly. After placing the pieces in the mold, there should be an excess of material (Figure 7.115-A).

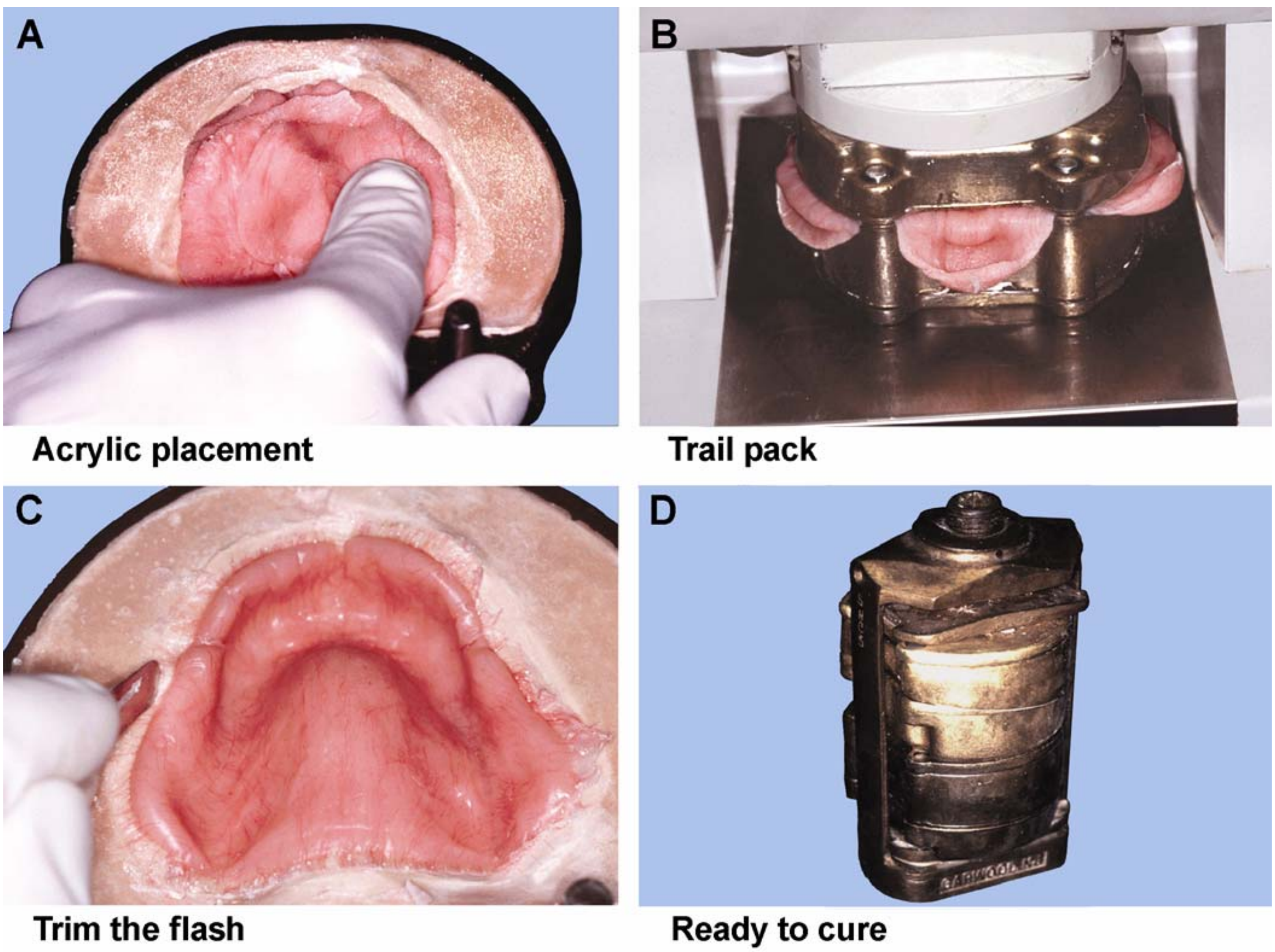
7.117.4. The objective of the packing procedure is to simultaneously have a densely filled mold and metal-to-metal contact between the flask halves. The steps leading to this goal are called *trial packs* (Figure 7.115-B). Most heat-curing, denture base resins require at least three trial packs before processing. In the first trial pack, a plastic sheet is placed between the halves of the flask. The flask is put together and hand pressure is applied to achieve initial closure. The flask is centered in a bench press, and the press is closed slowly (about a quarter turn every 10 seconds on a manual bench press). Slow closing allows the resin to flow and excess resin to escape between the flask halves. Slow closing also creates less likelihood that the mold or denture teeth may be fractured or dislodged.

7.117.5. Bring the halves of the flask to within 3 mm of metal-to-metal contact. Remove the flask from the press and carefully separated it. Remove the plastic sheet and trim the excess acrylic resin (flash) from the border of the mold (Figure 7.115-C). Place a fresh plastic sheet over the acrylic resin and put the two halves of the flask together. Again place the flask in the bench press and apply pressure. (The halves of the flask will come closer together than the 3 mm of the initial trial pack.)

7.117.6. Reopen the flask, remove the plastic sheet, and trim the flash away as before. Continue this trial closing procedure until the mold is densely packed (significant anatomical detail should be replicated in the acrylic resin from the dental cast), all excess material is removed, and the edges of the flask halves are in uniform, metal-to-metal contact.

7.117.7. Do not use plastic sheets during the final closure. Inspect the cast to determine if the application of another layer of tinfoil substitute is required. If it is, paint the cast surface with tinfoil substitute and let it dry. Place a sheet of plastic over the denture base resin to minimize monomer evaporation. Carefully bring the halves of the flask together by hand. Replace the flask into the bench press and achieve metal-to-metal contact. Transfer the flask to the flask carrier press (Figure 7.115-D).

Figure 7.115. Packing Acrylic Resin.



7.117.8. Using the handle and wrench, close the press until the springs are completely compressed and then back off a quarter turn. This allows for the expansion of the carrier press during the curing procedure. When using the microwaveable flask, the manufacturer normally encloses plastic nuts, bolts, and wrench to perform in the place of the flask carrier. Do not apply excessive force when tightening; it can cause stripping of the bolt.

7.117.9. Most dental laboratories have hydraulic or pneumatic flask presses to make packing acrylic resin easier and quicker. The operation of this equipment is simple, requiring little more than a quick review of the operating instructions. However, it is important to mention the pounds per square inch (psi) of pressure required to sufficiently close a properly packed flask. The hydraulic flask press requires the operator to pump the pressure handle until the pressure gauge reads between 1,000 and 1,500 psi for trial packs. A pressure of 2,500 psi is required for final closure. Be sure not to exceed 3,000 psi. On the other hand, the pneumatic press is automated. It has preset packing pressures of 1,500 psi for trial pack and 3,000 psi for final closure.

7.117.10. Failure to adhere to the above guidelines could result in mold distortion. Remember, the power presses can close quickly and easily fracture casts or teeth if the flasks are not positioned properly. Some dentures with severe soft tissue undercuts cannot be safely packed with a power press.

7.118. Incorporating a Soft Liner Into the Heat-Curing Denture Base Resin:

7.118.1. Flask and boil out the denture following the guidelines in paragraphs 7.104 and 7.107. Apply tinfoil substitute to the upper half flasking.

7.118.2. To control the thickness of the soft liner material, a spacer duplicating the desired thickness of the finished soft liner is required. This can be done by one of the following methods:

7.118.2.1. Mix silicone putty material and adapt it onto the master cast to a uniform thickness of approximately 2 mm. After the material is set, remove the spacer from the master cast and trim excess with scissors or a bur. The finished spacer should include all peripheral borders and be uniform in thickness.

7.118.2.2. After boilout, wait until the flask has cooled and then adapt two thicknesses of baseplate wax to the master cast to act as the spacer. Be sure there are no voids or spaces between the wax and the cast.

7.118.3. Apply tinfoil substitute to the lower half flasking and allow it to dry. With the spacer in place, pack the heat-curing resin into the mold. Place plastic over the spacer and trial pack the denture at least three times to ensure the mold is full.

7.118.4. Bench set the denture base while under pressure until the material becomes firm. This should take approximately 60 minutes depending on the type of denture base material.

7.118.5. Remove the wax or silicone shim and pack the soft liner material in its place. It is better to underpack during the first trial pack and have to *add* more material than to overpack initially and have to *remove* the denture base resin already in place. After the mold is fully packed, cure for 1 1/2 hours at 163 ^{o}F and then raise the temperature to 212 ^{o}F for 2 1/2 hours. Let the flask bench cool following curing.

7.119. Processing (Polymerizing) Heat-Curing Resin Denture Base:

7.119.1. **Overview.** Heat-curing acrylic resins must be heated to at least 158 ^{o}F before polymerization begins. Heat can be applied to the flasks by using a Hanau Curing Unit (Figure

7.116) or a microwave oven with approved microwave acrylic resin. Using resin not specifically designed for microwave processing will yield acrylic that is porous in the thickest areas of the denture base. Using either of these methods will generate additional heat during polymerization. If the monomer-polymer dough is heated to curing temperature too quickly, polymerization takes place faster. The heat of reaction can drive the internal flask temperature over 300 °F. Monomer boils at 212 °F, forms bubbles in the polymerizing dough, and creates unacceptable porosity in the processed denture base.

Figure 7.116. Hanau Model 2 Curing Unit.

7.119.2. **Methods of Polymerization.** Heat-curing dentures are polymerized by the following methods and processes:

7.119.2.1. **Long Cure Method:**

7.119.2.1.1. Place the carrier press containing the flasks in a room temperature water bath. Heat the water slowly to 160 °F and maintain it at this temperature for 8 hours. In the water bath in which it was processed, let the flask assembly cool to room temperature.

7.119.2.1.2. To set the Hanau Model 2 curing unit (Figure 7.116) for a long cure, using the Stage 2 controls only. Set the temperature control at 160 °F and the timer for 8 hours and 45 minutes (45 minutes preheating compensation).

7.119.2.2. **Short-Cure Method:**

7.119.2.2.1. Place the carrier press and flask in a room temperature water bath. Heat the water slowly to 160 °F and maintain at that temperature for 1 1/2 hours. Then, heat the water to 212 °F and maintain it at that temperature for 30 minutes to complete the polymerization. After polymerization, remove the flask assembly from the water bath. Bench cool the flask assembly for 30 minutes and then cool it under running water for 20 minutes.

7.119.2.2.2. To set the Hanau Model 2 curing unit for a short-cure method, set the first stage temperature control at 160 °F and the timer for 2 hours and 15 minutes. (Forty-five minutes for preheating *plus* 1 1/2 hours at 160 °F *equals* 2 hours and 15 minutes.) Set the second stage temperature control for 3 hours and 10 minutes to complete the polymerization. (Forty-five minutes preheating between 75 °F and 160 °F *plus* 1 1/2 hours at 160 °F *plus* 25 minutes preheating between 160 °F and 22 °F *plus* 30 minutes at 212 °F *equals* 3 hours and 10 minutes.)

7.119.2.3. **Hanau Model 2 Curing Unit.** The Hanau Model 2 curing unit is almost universally used in the dental laboratory service (Figure 7.116). It provides a positive means of controlling the rate of heating. The large volume of water in the unit acts as a heat sink to dissipate the extra heat generated by the chemical reaction between the monomer and the polymer. The temperature in the flask must stay below 212 ^{o}F to prevent the monomer from boiling. If the monomer boils, porosity of the cured acrylic would result. Under normal conditions, the water temperature in a Hanau curing unit rises about 2 ^{o}F per minute. If the presses and flask are placed in 75 ^{o}F (room temperature) water, the temperature reaches 160 ^{o}F in about 45 minutes.

7.119.2.4. **Microwave Processing.** Mirowave processing is becoming more widely accepted. However, it is important to process only denture base materials specially formulated for microwave processing. Using a material not designed for microwave processing will result in a porous denture base. The directions for processing dentures using the microwave are quite simple. Place the flask in the 500-watt microwave being sure to center the flask and irradiate for 3 minutes. This will sufficiently cure the denture base material.

7.119.2.5. **Flask Cooling.** It is highly recommended that the flasks be cooled slowly because dimensional change in the processed denture is smaller. When using the Hanau curing unit, the best way to cool flasks is to let the flask assembly reach room temperature in the water in which it was processed. A less acceptable method is to bench cool the flask assembly for 30 minutes and then place the assembly under lukewarm running water for 20 minutes.

7.120. Mixing Injection Molded Acrylic Resin:

7.120.1. This technique uses several items specifically designed to accomplish injection of polymethyl methacrylate. They are flask, insulating sleeve, injection funnel, precapsulated acrylic resin (paragraph 7.121), acrylic mixer and vibrator, capsule plunger, clamping frame, hydraulic press, injector press, and polymerization bath. The acrylic resin is supplied in premeasured capsules containing exact amounts of monomer and polymer. The use of precapsulated acrylic resin eliminates the need for technicians to handle unpolymerized acrylic resin while filling the mold--a distinct advantage over traditional compression molded mixing techniques (paragraph 7.116).

7.120.2. During polymerization, the acrylic resin is under constant pressure feeding the material into the mold as it polymerizes. This process of slowly feeding resin into the mold during polymerization eliminates dimensional warpage due to shrinkage.

7.121. Mixing Precapsulated Acrylic Resin:

7.121.1. Remove the monomer container from the end of the acrylic injection capsule and open it by twisting off the sealed lid (Figure 7.117-A).

7.121.2. Open the capsule containing the polymer, pour the entire amount of monomer into the injection capsule, and replace the cap. Return the monomer container in the end of the injection capsule. The acrylic resin must be mixed and activated immediately after the monomer and polymer are incorporated together.

7.121.3. Mount the injection capsule to the acrylic mixer or vibrator by attaching the rubber securing thong. Mix the material for 5 minutes (Figure 7.117-B).

7.121.4. When mixing time is reached, carefully inspect the acrylic resin. When observing the material, look for the acrylic resin to be in a ball and have no dry areas of polymer. If these conditions are not met, continue mixing the material until it reaches the correct consistency.

Figure 7.117. Mixing and Injecting Precapsulated Acrylic Resin.

7.121.5. After the material is mixed, remove the empty monomer container and place the capsule on the capsule plunger. The capsule plunger is designed to help the technician remove all air from the injection capsule (Figure 7.117- C). It is important that no air be contained in the injection capsule. Failure to remove all of the air can result in voids in the processed denture base. Start by pressing the capsule onto the plunger, using a slight rocking motion. As the material moves to the end of the injection capsule, allow the air to escape by removing the cap.

7.122. Injecting Injection Molded Acrylic Resin:

7.122.1. Prepare the flask for processing. Reassemble the two halves of the flask with the injection funnel and insulating sleeve positioned in the end of the flask. Place the entire assembly into the clamping frame (Figure 7.117-D).

7.122.2. Place the flask and clamping frame into the hydraulic press. The clamping ratchet should be in the upright position in the press (Figure 7.117-E).

7.122.3. Push the clamp lever to the right while applying pressure to the flask and clamping frame until 80 bars of pressure is indicated on the pressure gauge. As pressure is applied, the ratchet will engage the locking mechanism and maintain the desired pressure. The ratchet must engage the locking mechanism to guarantee the 80-bar pressure reading from the hydraulic press is maintained during processing.

7.122.4. Remove the plug from the end of the injection capsule containing the mixed acrylic resin. Push the capsule into the insulating sleeve located in the end of the flask until it engages the injection funnel (Figure 7.117-F).

7.122.5. Mount the pressure apparatus on the neck of the flask and move the locking ring down to secure the apparatus to the flask. The pressure apparatus is designed to maintain constant pressure of fluid resin during polymerization and will require an air pressure source. Ensure the plunger from the pressure apparatus properly engages the injection capsule (Figure 7.117-G).

7.122.6. Start the injection of resin and polymerization by applying 6 bars of pressure to the injection capsule. This can be accurately measured by observing the pressure gauge located on the end of the pressure apparatus (Figure 7.117-H). Allow the case to bench set under pressure for 5 minutes. ***NOTE:*** Acrylic resin that has been in a mixed state for several hours will require a 10-minute injection time. Acrylic resin left over from previous processings can be reused for cases processed later, thereby reducing wasted material.

7.122.7. Place the clamping frame into the preheated 212 ^{o}F polymerization bath (Figure7.117-I). The water level in the polymerization bath must reach the line located on the exterior of the clamping frame. The specified water level provides for a more controlled polymerization of the acrylic resin within the flask. When placing the clamping frame into the bath, be careful not to trap and submerge any plastic floats. The plastic floats are used as heat insulators for the polymerization bath. If trapped between the clamping frame and bottom of the tank, they could melt.

7.122.8. The water level must reach the line indicated on the clamping frame and remain at 212 ^{o}F for the entire processing period of 35 minutes. Never interrupt the boiling or polymerization procedure by introducing other flasks into the polymerization bath. The proper processing time must be observed and the flask must not stay in the processing bath longer than the prescribed 35 minutes. If flasks are processed longer than the designated time, excess resin in the injection capsule could polymerize.

7.122.9. The final step in the polymerization process is controlled cooling of the acrylic resin to suspend further polymerization of the excess resin in the injection cylinder. Using the air pressure shutoff valve located at the top of the pressure apparatus, move the valve to the closed position. It is now possible to disconnect the air supply line from the apparatus and move the entire assembly to the cooling bath while maintaining 6 bars of pressure on the cooling acrylic resin. During the first 20 minutes of the cooling phase, the 6 bars of pressure must be maintained to continue feeding resin to the cooling acrylic resin. After the initial 20 minutes of pressurized cooling time, the air valve may be opened to release the pressure and the apparatus may be removed for the final 10 minutes of cooling time. The total cooling time is 30 minutes.

7.123. Mixing and Pouring Acrylic Resin:

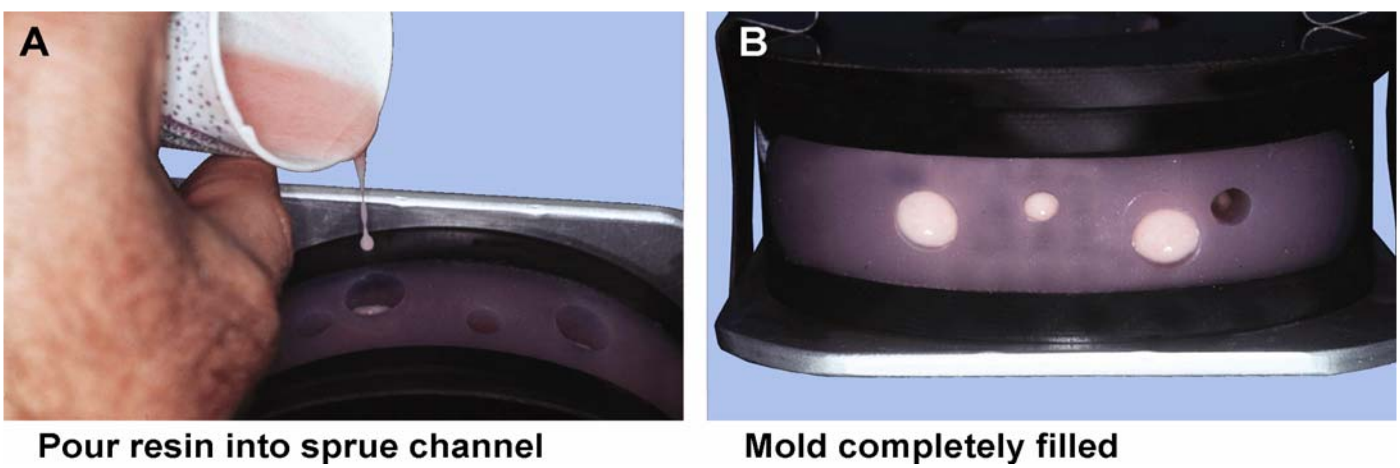
7.123.1. To properly mix the acrylic resin, you will need monomer and polymer measuring cylinders that are only used for liquid pour resin material, an acrylic mixing jar, and an acrylic mixing spatula.

7.123.2. The mixing ratio is 2.5 cc polymer to 1 cc monomer. When mixing the monomer and polymer, proper mixing ratios must be observed because excessive shrinkage could result during curing from excess monomer.

7.123.3. Place the appropriate amount of monomer in an acrylic mixing jar and slowly sift in the polymer (30 cc polymer to 12 cc monomer for a complete denture) and mix for 8 to 10 seconds. The acrylic resin must be poured into the mold within 3 minutes. When pouring RPDs, take care not to pour resin into the vent sprues.

7.123.4. Pour acrylic resin into the pouring sprue (Figure 7.118-A). When pouring, observe the vent sprues and watch for the presence of resin. As the resin fills the mold, it will drive air from the mold out the vent sprue. When the vent sprues become filled, stop filling the mold and slightly rock the flask from side to side to help dislodge any air remaining in the flask (Figure 7.118-B). ***NOTE*:** Take care not to tap the flask on the bench top or rock the flask more than 90 degrees. Failure to observe these precautions could result in denture tooth dislodgment.

Figure 7.118. Pouring and Processing Acrylic Resin.



7.124. Processing and Pouring Acrylic Resin:

7.124.1. Bench set the case sprue holes up for 3 to 5 minutes. Before processing the case in the pressure pot, the acrylic resin must be allowed to reach its optimum processing consistency. When the sprues have lost their gloss or sheen, the cast is ready to be processed.

7.124.2. Place one inch of 100 to 120 ^{o}F water in the pressure pot.

7.124.3. Position the flask in the pressure pot sprue holes up and ensure the flask is not located under the air inlet. ***NOTE:*** Placement of the flask under the air inlet may cause acrylic displacement within the flask as the pressure pot is charged with air.

7.124.4. Apply 20 pounds of air pressure and allow to set for 30 minutes to complete processing of the acrylic resin.

7.125. Removable Prosthesis Identification:

7.125.1. **Requirements:**

7.125.1.1. In relation to dentistry, the subject of forensics is increasing in importance. Many shortcomings in personnel identification have surfaced as a result of findings during mass casualty identifications. There are fewer problems when removable dentures have the wearer's identification.

7.125.1.2. *Every* completed removable prosthodontic appliance must carry the social security number (SSN) of the patient. The only exception to using the full number is when physiologic, esthetic, or space considerations limit its use. In that case, use as many terminal digits as possible. To be useful, the identification must be legible. In all instances, the identification procedure should be done at the local level where the proper SSN of the patient is easily verified. ***NOTE:*** An all-metal partial denture must have the patient's SSN carefully engraved in metal in an appropriate area.

7.125.2. **Paper Strip Technique:**

7.125.2.1. Use this technique only during resin packing procedures.

7.125.2.2. Type the patient's SSN on a piece of absorbent paper sheet (for example, onion skin paper).

7.125.2.3. Before the last trial pack and using an instrument, displace the acrylic resin in an area where subsequent denture base adjustments are unlikely. The prepared area should be approximately 1.5 mm deep and long enough to accommodate the prepared SSN identification.

7.125.2.4. Trim off the excess paper around the patient's SSN and place the paper strip in the prepared area. Wet the strip with monomer.

7.125.2.5. Mix clear orthodontic polymer or Class A monomer in a small dappen dish, cover with plastic sheet, and allow to reach packing consistency. Apply the prepared orthodontic resin and accomplish the final trial pack procedure. Be sure to inspect the SSN prior to final closure of the flask.

7.125.2.6. Proceed with the final closure. ***NOTE:*** If a reducing copy machine is available, reduce the patient's SSN so the label can be used in a limited area.

7.125.3. **Shrinking Plastic Technique.** Many dentists and technicians prefer to use a shrinking plastic sheet (for example, Shrinky Dinks® by Color Forms, Ramsey, NJ) for removable prosthesis identification. The material shrinks to one-third of the original size, yet increases in thickness nine times, making it ideal when space is limited. The shrinking plastic technique is not limited to preprocessing use, but may be used for post-processing as well. Because RPDs are packed differently from complete dentures, the only chance to perform the prosthesis identification is after the RPD is finished. Pre-processing procedures using the shrinking plastic material are very similar to those described in the paper strip technique; therefore, only the post-processing procedures are detailed (as follows):

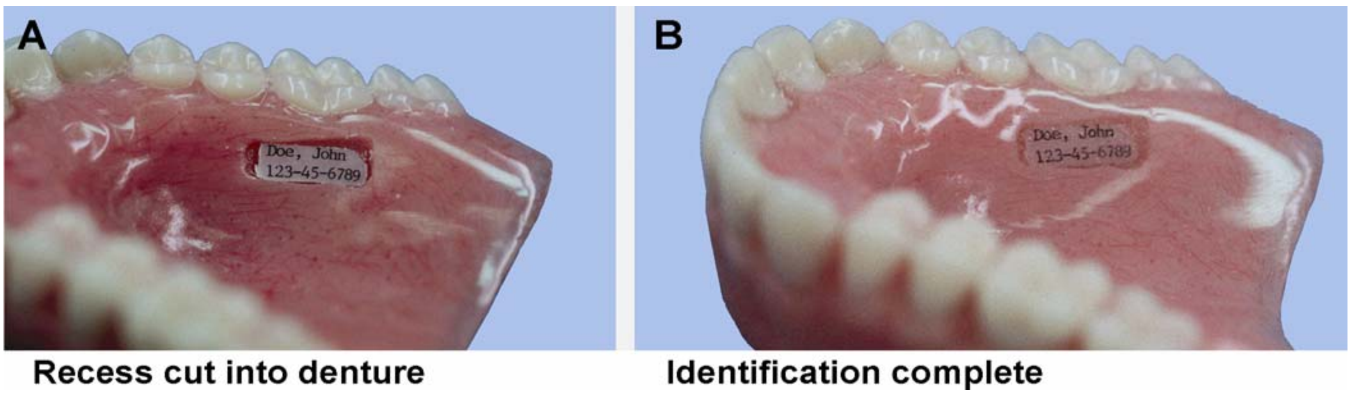
7.125.3.1. Lightly shell or microblast the surface of the material that will be typed on, which increases the retention of the ink.

7.125.3.2. Type the patient's SSN on a piece of the shrinking plastic sheet and trim the excess plastic away from around the SSN.

7.125.3.3. Using a pair of hemostats, lightly pass the material over a bunsen burner flame until the material undergoes its shrinking process.

7.125.3.4. In an appropriate area of the denture base, cut a shallow recess that is deep enough to recess the identification label (Figure 7.119-A). Grind the back of it to reduce the thickness of the label.

Figure 7.119. Removable Prosthesis Identification.



7.125.3.5. Use the brush technique of adding *autopolymerizing* acrylic because it works best with this type procedure. In one dappen dish, place a small amount of monomer; place a small portion of clear polymer in another. Place the identification label in the recess. Dip the tip of an investment painting brush into the monomer and wet the recessed area and label. Dip the brush again in monomer and then dip the wet brush in the center of the powder in the dappen dish. Do not let the brush touch the side of the dish because monomer may leak down the side and cause the rest of the powder to be unusable.

7.125.3.6. Pick up a small amount of polymer on the brush tip and apply it to the label. Continue to repeat this step until the clear overlayer is slightly raised.

7.125.3.7. Place the prosthesis, in a pressure pot filled with 115 ^{o}F water at 20 psi for 30 minutes. Recover the prosthesis, carefully recontour the repaired area, and lightly smooth the area with a rubber point (Figure 7.119-B).

Section 7V—Deflasking Complete Dentures

7.126. Overview. The objective of the deflasking procedure is to remove the denture from the investment material without breaking the denture or dislodging the denture from the cast. Ensure the denture flask and its contents have reached room temperature before deflasking. Equipment needed includes a plaster knife, two chisels, flask ejector unit, and plaster saw.

7.127. Removing the Investment Mold and Denture From the Flask:

7.127.1. Make sure the flask is cool. Remove the lid of the flask with a plaster knife (Figure 7.120-A). Place the flask in the ejector unit with the knockout plate up. Close the unit and pass the chisels through the holes in the sides of the ejector into the slots between the two halves of the flask. Using inward and downward pressure, apply force until the halves of the flask come apart

(Figure 7.120-B). The chisels act as levers, and the sides of the ejector unit are the fulcrums. Pull the handles of the chisels up in the other direction to separate the mold from the flask.

7.127.2. When using the hydrocolloid investment technique, it is as simple as cutting away the solidified hydrocolloid after final polymerization. When using the injection flask, place the clamping frame on the hydraulic press to allow release of the ratchet. When the ratchet has been released, the flask should slide easily from the clamping frame. Remove the plastic top and bottom caps and deflask the denture using the hydraulic press (Figure 7.120-C). Use the steps in paragraph 7.128 to remove the stone surrounding the processed dentures.

7.128. Removing the Denture and Cast From the Investment Mold:

7.128.1. Pry off the occlusion cap to expose the cusp tips and incisal edges of the denture teeth (Figure 7.120-D). In the right and left canine areas and at the right and left distal ends, cut the outer walls of the stone mold with a plaster saw from top to bottom. Do not saw into the denture.

7.128.2. Pry the sectioned stone mold away from the facial surfaces of the denture with a plaster knife (Figure 7.120-E and -F). Before trying to remove the investing stone from the maxillary palatal area or mandibular tongue space, trim the stone away from the lingual surfaces of the teeth (Figure 7.120-G). This trimming helps reduce the possibility of the denture lifting off the cast when the inner portion of the mold is removed and also guards against fracturing the denture teeth.

7.128.3. Take out the inner section of the maxillary or mandibular mold in a way that does not dislodge the denture from the cast (Figure 7.120-H). Remove the thin shell of stone covering the base of the cast and indexing grooves. Remove *all debris* from the grooves. Clean away any remaining plastic bubbles or dental stone residue from around the denture teeth (Figure 7.120-I).

7.128.4. After deflasking, leave the denture firmly seated on its cast. If there is the slightest trace of wobble or other evidence that the denture has come loose from the cast, the dentist must decide if the case can be transferred to the articulator for remount. Do not shellblast a denture on a cast during the deflasking procedure. The high pressure air blast lifts the denture off the cast. Shells wedged between the denture and the cast prevents the denture from ever going back to its original position. Accurate remounting is impossible under these conditions.

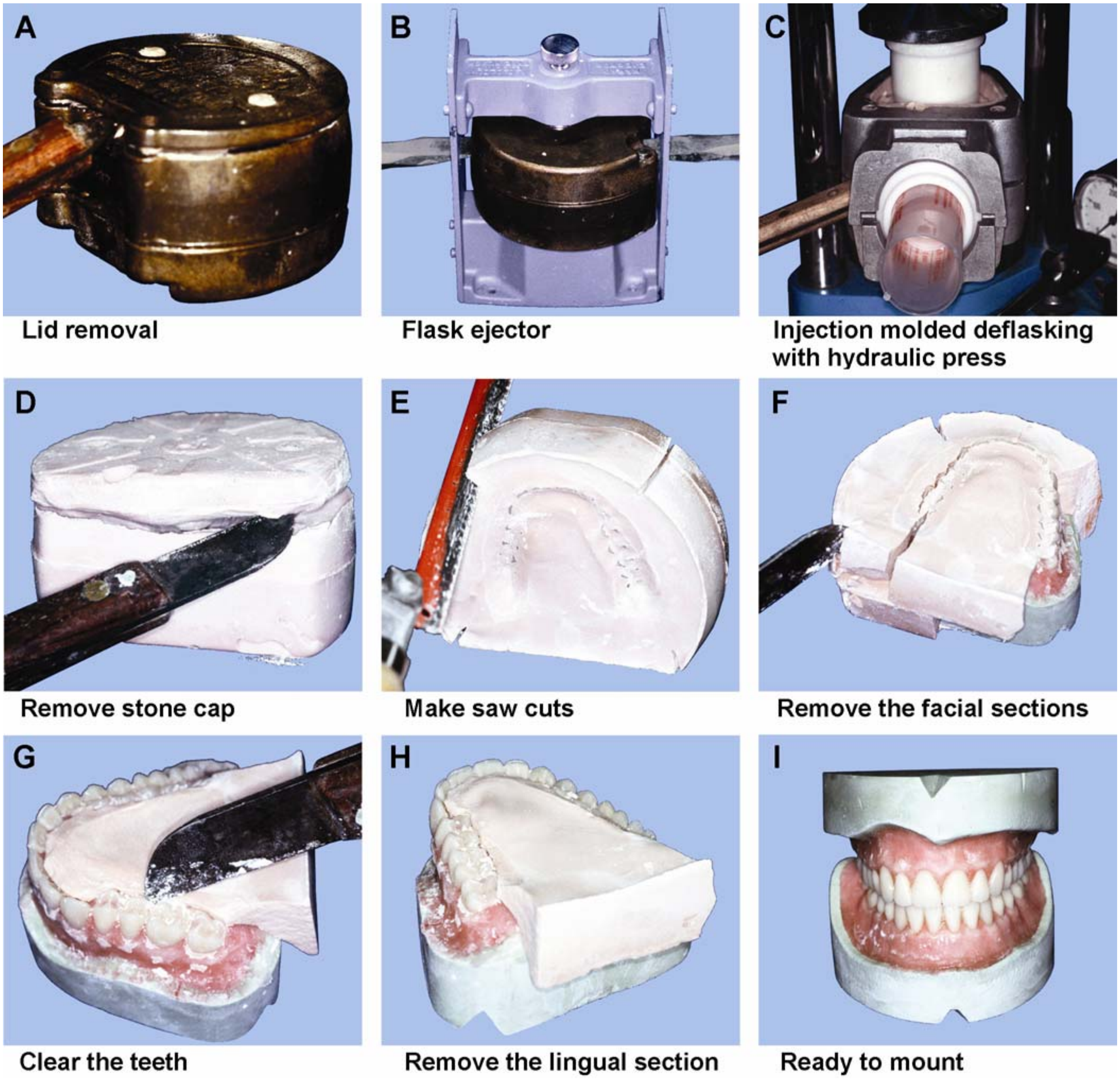
Section 7W—Correcting Changes Between Occlusal Surfaces and Incisal Edges

7.129. Overview. Remounting complete dentures (Section 7X), with subsequent occlusal grinding (Sections 7Y and 7Z), corrects any changes in the contact relation of the occlusal surfaces and incisal edges of the teeth that might have occurred during the final waxing, investing, packing, and polymerization of the denture base.

7.129.1. The change that is most typical of compression molded, heat-cured dentures is an increase in the occlusal vertical dimension. Increases of more than 0.25 - 0.50 mm per single denture are not acceptable and are not indicative of good packing and processing techniques. Another processing change occurs if the denture teeth shift position in relation to each other.

7.129.2. Changes can happen for many reasons. All baseplate waxes are somewhat unstable and denture teeth drift in a wax trial denture. Setting expansion of the stone used to flask the wax denture contributes to tooth movement. Resin packing pressures cause mold distortion, and it is very difficult to eliminate all resin flash in the packing step. As the resin dough reaches polymerization temperature, the mass expands and generates very high pressures inside the mold. Later, in the polymerization reaction, the resin contracts. The acrylic resin also contracts when it cools down to room temperature.

Figure 7.120. Deflasking Complete Dentures.



Section 7X—Remounting Complete Dentures

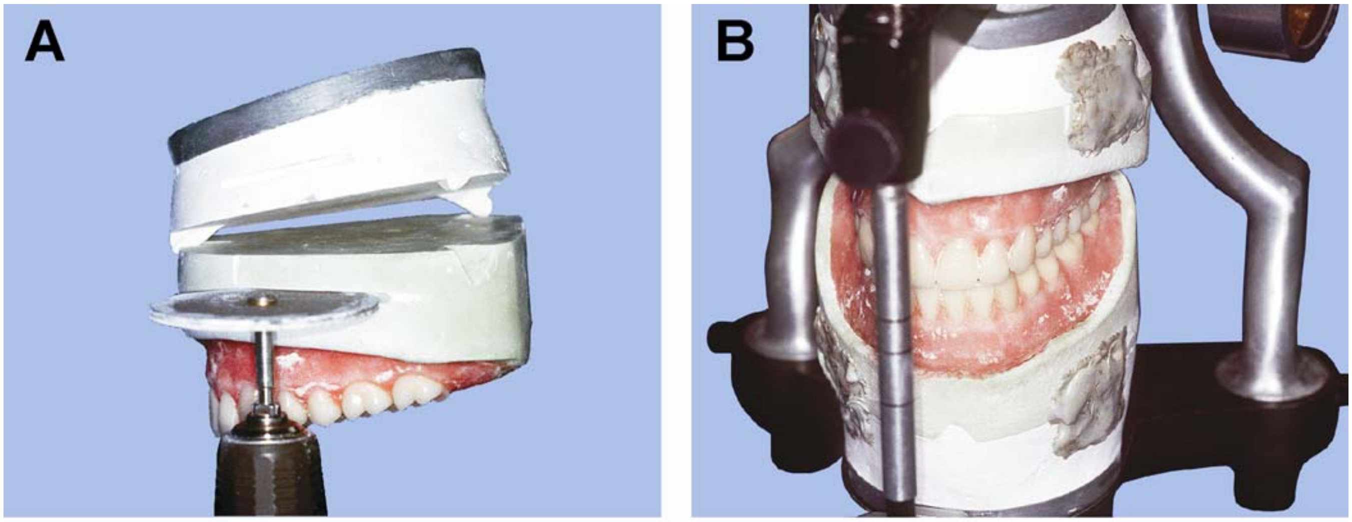
7.130. Steps To Remounting the Cast:

7.130.1. Use a large "cutoff" disc to make retention cuts in the cast and immediately above the cast cuts in the mounting (Figure 7.121-A). Place these pairs of cuts in four areas: right buccal, left buccal, anterior, and posterior. Make sure the bottom of the cast and all index keys are perfectly clean.

7.130.2. Ensure there is total contact between the bottom of the cast and the mounting. Hold the cast and mounting together in complete contact. Use dripping hot green or red modeling plastic to attach the cast to the mounting in the areas where the retention cuts are located.

7.130.3. Do not cover the entire junction line (Figure 7.121-B). Leave some of the junction exposed to detect if the cast separates from the mounting.

Figure 7.121. Remounting Complete Dentures After Processing.



Undercuts in cast and mounting

Casts attached with compound

Section 7Y—Selective Grinding of Opposing, Balanced Complete Dentures

7.131. Objective of Selective Grinding:

7.131.1. The objective of selectively grinding complete dentures for balance is to eliminate premature tooth contacts (interferences) that prevent multiple, well-distributed points of contact between upper and lower teeth in anterior and posterior areas on the right and left during working, balancing, and protrusive occlusions.

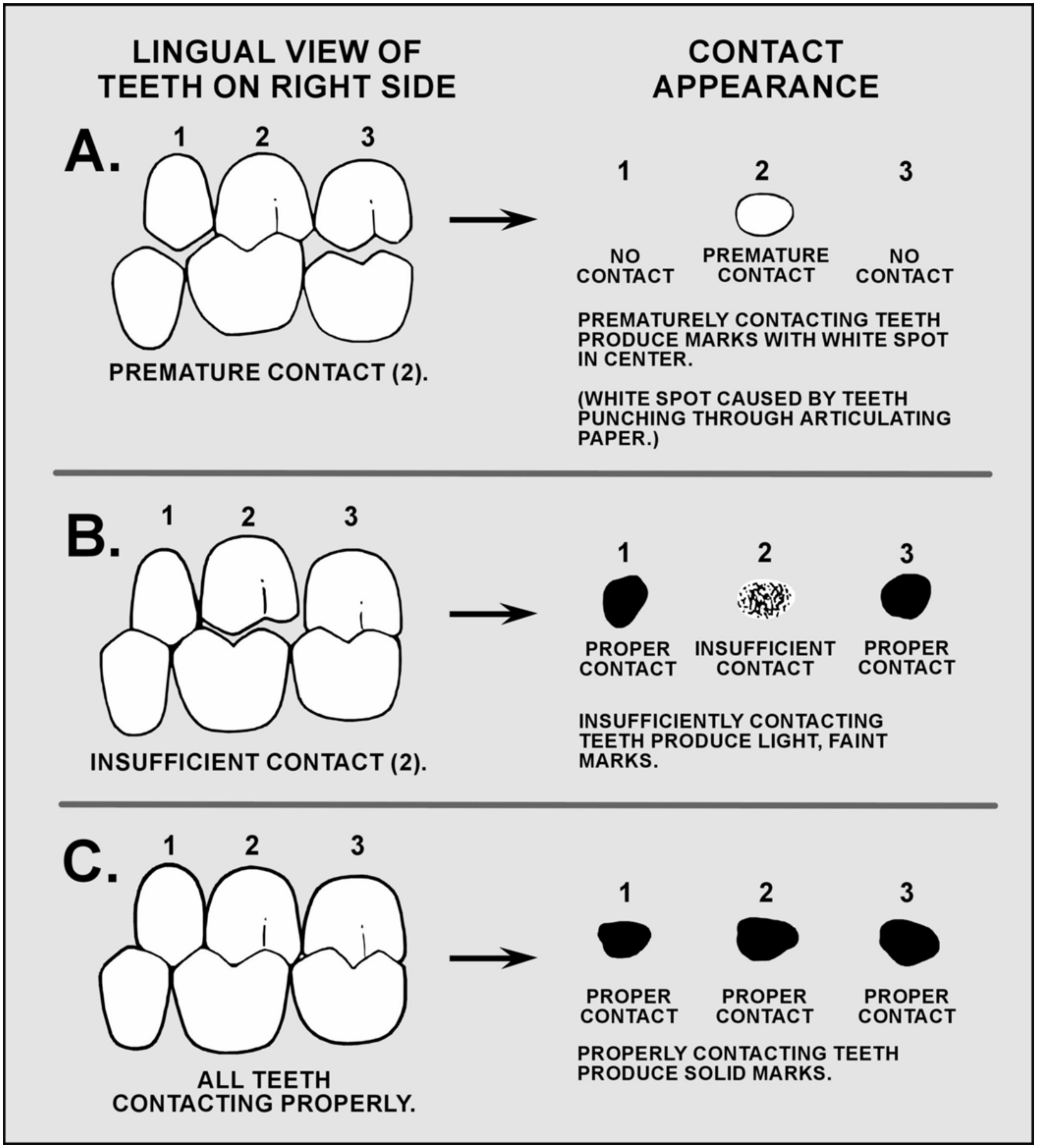
7.131.2. To eliminate interferences (high spots, deflective contacts, or prematurities), they first have to be found. The selective grinding process has strict rules. Those rules represent a precise, orderly way of using articulating paper to identify prematurities and eliminate them. The really gross interferences are seen as white spots surrounded by carbon rings (Figure 7.122-A). This kind of mark shows a contact so heavy that the cusp has cut through the articulating paper.

7.131.3. As a few more contacts begin to develop, the prematurities take the appearance of isolated, solid dark spots or tracks. Opposing surfaces that are close to contacting reveal themselves as faint smudges (Figure 7.122-B). When the full pattern of multiple tooth contact characteristic of balance becomes established, all of the marks should show up as relatively dark spots or tracks (Figure 7.122-C).

7.132. Equipment and Material. These include black and red double sided articulating paper or ribbon (the thinnest available), an engine and handpiece, mounted stones and diamonds for the straight handpiece, and milling paste.

7.133. Major Steps. The major steps are to correct the vertical processing error and restore the centric occlusion (paragraph 7.134), correct the working and balancing occlusion (paragraph 7.135), correct the protrusive occlusion (paragraph 7.136), polish the selectively ground denture teeth (paragraph 7.137), and mill-in the dentures (paragraph 7.138).

Figure 7.122. Appearance of Marks Produced by Articulating Paper.



7.134. Correcting the Vertical Processing Error and Restoring the Centric Occlusion:

7.134.1. First, check the articulator settings. Ensure the readings on the articulator are the same as when the denture teeth were set in wax. Also, ensure the condylar elements of the articulator are locked against the centric stops and the incisal guide pin is at the same setting as when the case was final waxed.

7.134.2. Evaluate the compensating curve. All cusp tips of the processed denture *should be* on the compensating curve established in the wax denture. Packing and processing forces can move individual denture teeth grossly out of position. If a maxillary cusp tip is obviously protruding below the curve or a mandibular cusp tip is significantly above the curve, grind those cups tips carefully to conform to the curve. ***NOTE:*** Do not use this step to reorient or "touch up " an entire compensating curve; use it only on an *isolated* tooth that has clearly migrated out of line.

7.134.3. Check the amount of opening between the incisal guide pin and the guide table (Figure 7.123). In a set of opposing complete dentures, a pin opening of 1 mm is the limit of reasonable acceptability. Beyond that point, every bit of opening requires that much more selective grinding with consequent destruction of denture tooth anatomy. If 2 mm pin opening is present and isolated migration of a tooth is not responsible for it, do not do anything more to the case without consulting the dentist.

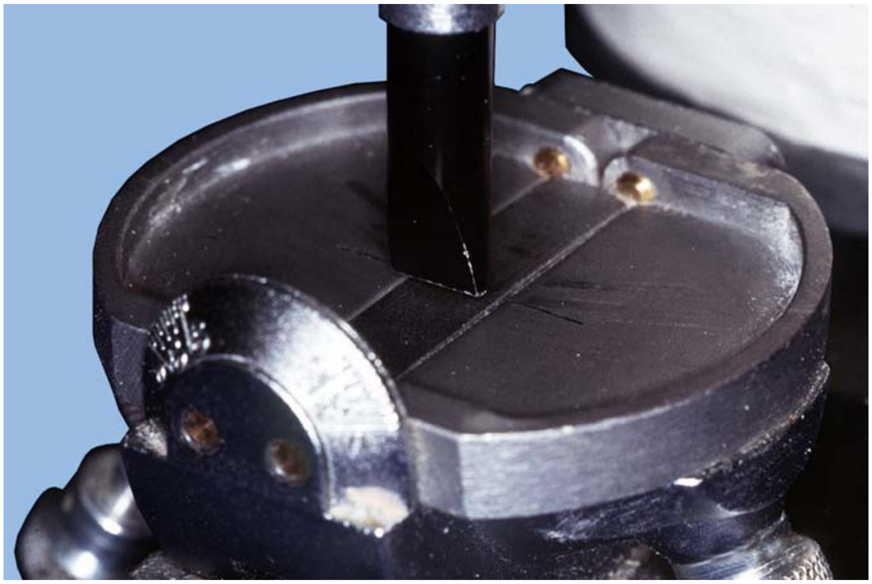
7.134.4. Deepen surfaces marked by articulating paper opposite stamp cusps. Place the double-sided (red and black) articulating paper (commercially available in arch form) on the occlusal table, ensure the paper covers the denture teeth, and tap the denture teeth together. Open the articulator and remove the paper. Notice that the articulating paper will mark the maxillary and mandibular denture teeth with each respective color. Close the articulator and only points of contact between the denture teeth will transcribe marks from one arch to the other. This technique will very accurately show the areas of true contact.

7.134.5. Technicians are often misguided by faulty occlusal markings. For example, if the maxillary denture was designated with red and the mandibular with black, then any contacts of the opposite color located on the arch would be points of true contact. Make corrections by grinding fossae, proximal marginal ridges, and cusp inclines marked by articulating paper. *Do not grind cusp tips during this step.* Repeat this procedure until the incisal guide pin touches the incisal guide table (Figure 7.124).

7.134.6. For the next step, remove the articulator paper markings with a cotton tip applicator moistened with monomer. Place black articulating paper on the right and left sides and tap the denture teeth together. With the pin touching the table, there should be multiple, evenly distributed points of contact between maxillary and mandibular teeth (Figure 7.125). This figure shows all fossae and embrasures where stamp cusps hit. When correcting a vertical processing error (the pin is off the table), grind all marks that appear in these places. Figure 7.125 also represents the ideal pattern of centric occlusion contacts that should be present when the incisal pin touches the guide table.

7.134.7. Occasionally, contacts between opposing anterior teeth develop during correction of vertical processing error. The usual practice is to reduce the facioincisal surfaces of the mandibular anterior teeth that are in premature anterior centric occlusion contact.

Figure 7.123. Pin Opening.



7.135. Correcting the Working and Balancing Occlusion:

7.135.1. Two paths of travel are possible when newly remounted dentures are moved into working and balancing relations. One is a path which the upper and lower teeth mesh best; the second is a path governed by the way articulator settings guide the upper member through lateral movements. (The teeth may or may not mesh well.) After waxing the dentures and subsequent processing, the two paths should be the same.

7.135.2. An assumption in the selective grinding procedure is that processing the denture base shifted the teeth into slightly incorrect positions. After remount, there may be a path where the teeth mesh together rather well, but this "tooth-guided" path is totally unreliable for correcting interferences between denture teeth along that path. Instead, depend on the path dictated by the articulator settings as the standard.

7.135.3. When correcting working and balancing occlusion, the objective is to once again make the tooth guided lateral paths and the articulator guided lateral paths coincide. The way in which the articulator is manipulated is crucial to success. Every bit of sideshift at a given lateral condylar guidance setting must be incorporated into each lateral movement. (See paragraph 6.21 for a description of the proper way to produce a lateral movement in a Hanau H2 articulator.) To correct the occlusion in eccentric positions:

7.135.3.1. Lock down the working side condyle and release the balancing side condyle. Place *red* articulating paper on the right and left sides and move the articulator into a lateral excursion, being sure to incorporate sideshift. Do not let the denture teeth guide the movement. ***NOTE:*** Use red articulating paper this time to distinguish between the centric contact points and the eccentric ones. Do not grind on the black centric contact points when correcting working, balancing, and protrusive occlusions.

Figure 7.124. Correction of Vertical Processing Error.

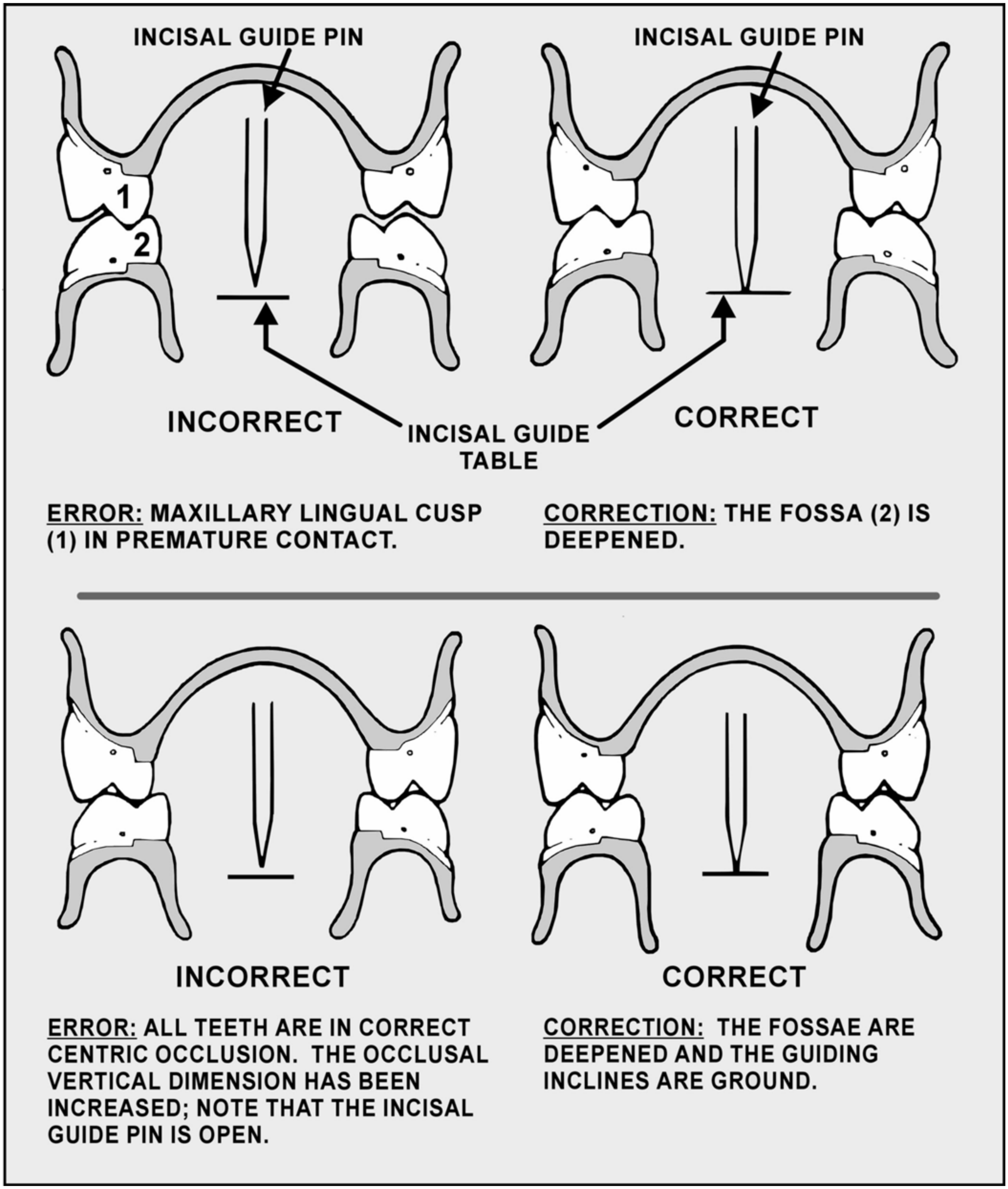
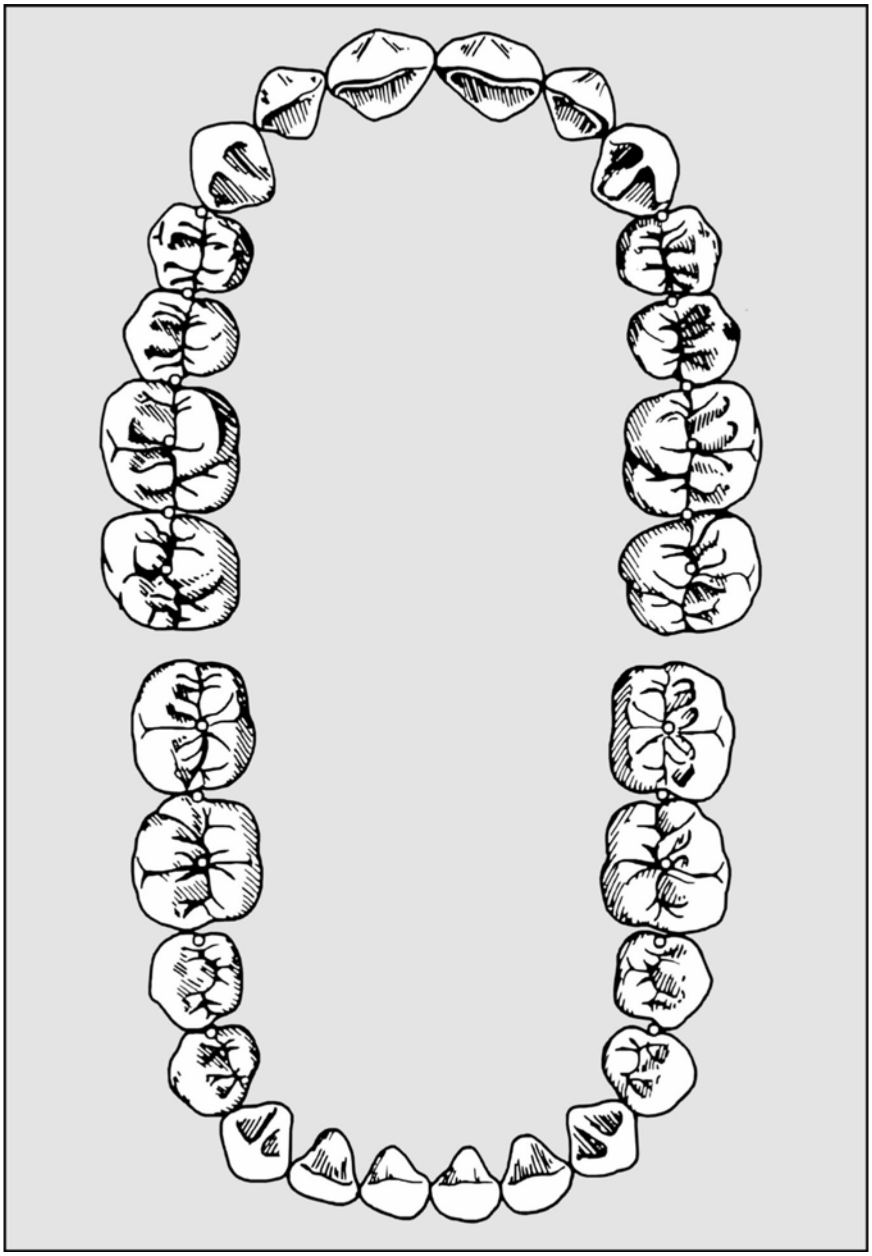


Figure 7.125. Stamp Cusp Centric Occlusion Contacts.



7.135.3.2. On the working side, check for working side collisions between maxillary and mandibular anterior teeth that prevent posterior teeth from contacting. If such anterior interference exists, grind the facioincisal surface of the offending lower anterior or the lingual surface of the maxillary anterior teeth. Next, follow the buccal of the upper and lingual of the lower (BULL) rule on the working side. Grind red articulating paper marks found on the inclines or cusp tips associated with the buccal cusps of maxillary posterior teeth and lingual cusps of the mandibular posteriors. ***NOTE:*** The BULL rule only applies to the working side. Do not grind any other marks on the working side that are not a part of the rule.

7.135.3.3. On the balancing side, note that the only contacts possible occur between the buccal inclines of lingual cusps on maxillary teeth and the lingual inclines of buccal cusps of mandibular teeth. The rule on the balancing side is to grind articulating paper marks found on inclines and cusp tips associated with the buccal cusps of the mandibular teeth. Disregard all other marks on the balancing side.

7.135.3.4. Perform working and balancing side corrections together. For example, place articulating paper between the maxillary and mandibular teeth on the right and left sides, move the upper member of the articulator into a lateral excursion, perform the indicated working and balancing side corrections, and repeat the previous three steps in sequence until numerous, well-distributed working and balancing side contacts develop. The practical limit of a lateral excursion test movement is cusp ridge contact.

7.135.3.5. Figures 7.126 and 7.127 show the possible patterns of marks for right and left lateral excursion. Use these figures as guides in the selective grinding procedure. Start with a right lateral excursion (Figure 7.126). Then follow these steps: (1) Lock down the right condylar element and release the left element; (2) Place red articulating paper between the maxillary and mandibular teeth on the right and left sides; (3) Move the articulator into a right lateral excursion--the right side becomes the working side; and (4) Grind premature spots and tracks using Figure 7.126 as a guide. (Notice that the figure conforms to the BULL and balancing side rules; that is, buccal of the upper and lingual of the lower on the working side and buccal of the lower on the balancing side.) Disregard all other marks.

7.135.3.6. Continually repeat steps 2 through 4 above until a general contact pattern that resembles the figure develops on the working and balancing sides. After selective grinding has been performed for a right lateral excursion, perform the procedure for a left lateral excursion, using Figure 7.127 as a guide.

7.136. Correcting the Protrusive Occlusion. To correct protrusive interferences, grind the appropriate inclines, but do not reduce the heights of any of the cusps. Also, the practical limit of a protrusive excursion is when the incisors are edge to edge and the posteriors are just short of a cusp to cusp tip relationship. When correcting protrusive occlusion, the following two conditions are possible:

7.136.1. Contact between the upper and lower anteriors with no posterior contact. Grind the facioincisal surfaces of the mandibular anterior. As a last resort, modify the lingual surfaces and incisal edges of maxillary anterior teeth.

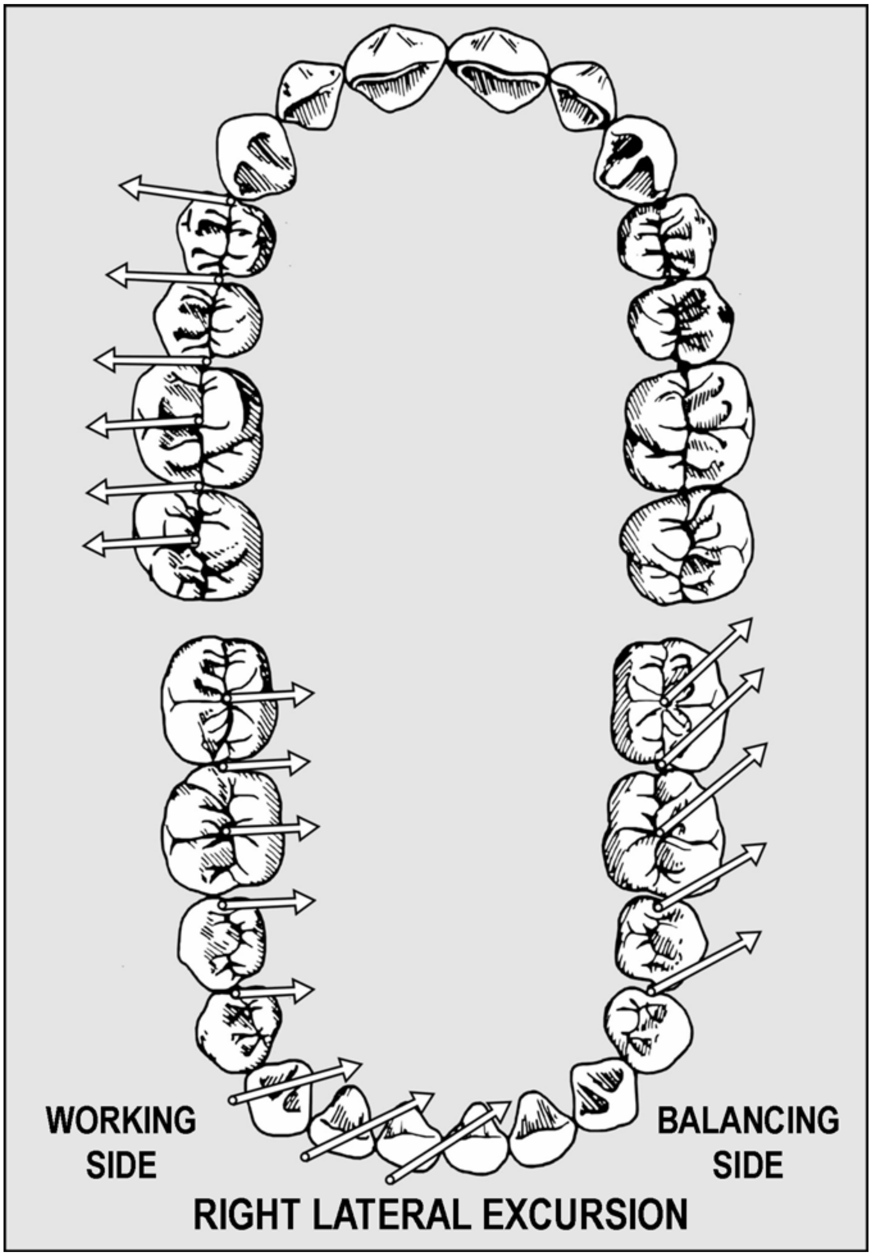
7.136.2. Contact between the upper and lower posterior teeth with no anterior contact. Grind the distal inclines of interfering maxillary buccal cusps and premature mesial inclines on mandibular lingual cusps.

7.137. Polishing Selectively Ground Denture Teeth. Use rubber points impregnated with carborundum grit to smooth over cusp and fossa irregularities. To get a high polish on denture teeth, use flour of pumice and a fine abrasive commercial agent (for example, Tru-Polish® #3 by Dentsply, Inc). When polishing selectively ground denture teeth, do not destroy the details of the occlusal surfaces. Recheck the occlusal contacts prior to proceeding with the steps in paragraph 7.138. Be particularly careful with plastic teeth.

7.138. Milling-In the Occlusion. This is the process of covering the occlusal surfaces of the teeth with abrasive paste and, with the teeth in contact, rubbing off any remaining, small interferences. For mill-in procedures, perform the following steps sequentially:

7.138.1. Raise the incisal guide pin above the incisal guide table. Release the centric locks so the upper member of the articulator moves freely.

Figure 7.126. Selective Grinding--Right Lateral Excursion.



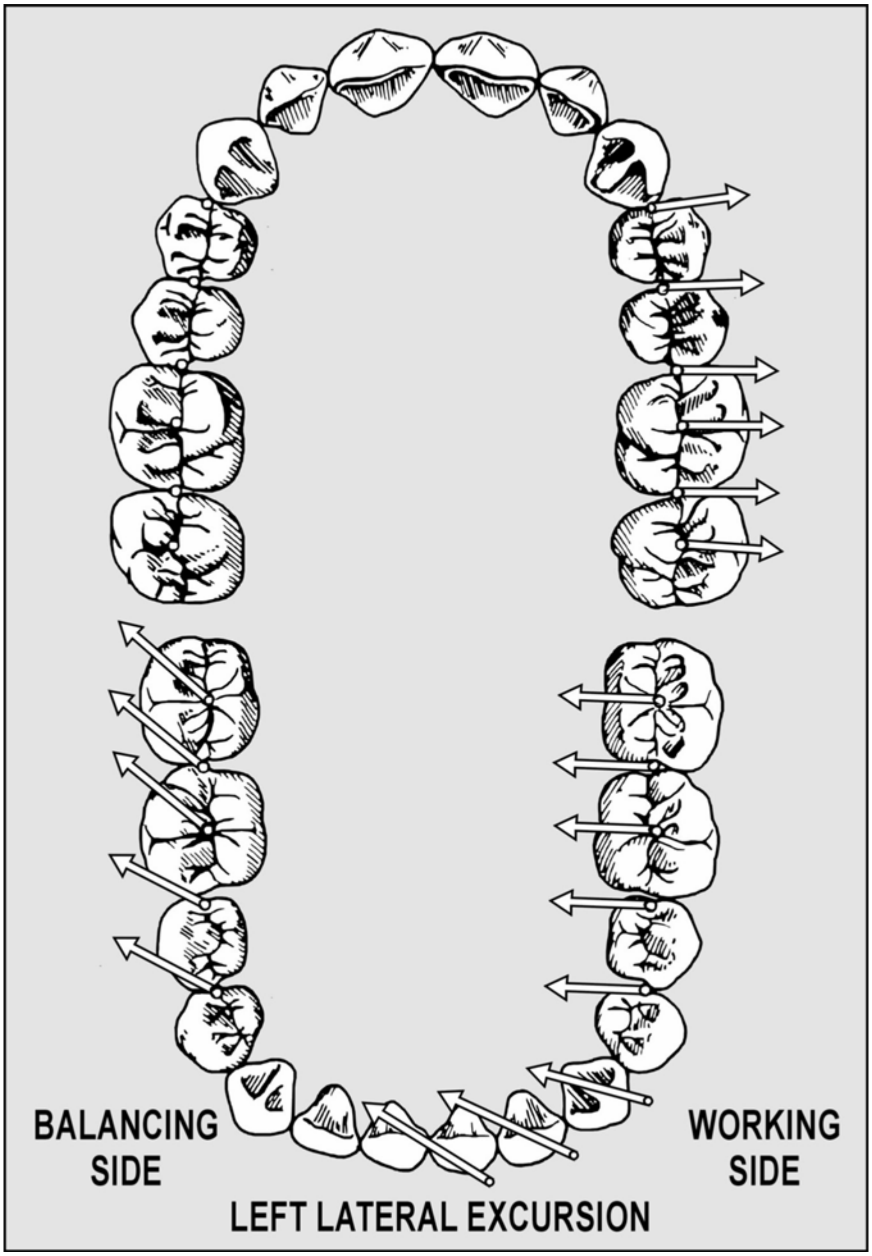
7.138.2. Place abrasive paste on the occlusal surfaces of the teeth.

7.138.3. Slide the articulator from the centric occlusion to the right lateral position and back about five times. Perform the same movements to the left.

7.138.4. Move the dentures from the centric occlusion into the protrusive position and back about five times.

7.138.5. Perform the above steps in sequence about three or four times.

Figure 7.127. Selective Grinding--Left Lateral Excursion.



Section 7Z—Selective Grinding of Monoplane Complete Dentures

7.139. Procedures:

7.139.1. The objective in setting 0 degree teeth on a monoplane is to make the monoplane as flat as possible. That goal may be achieved in the wax-up, but processing changes require touching up irregularities that inevitably develop.

7.139.2. The rule in selectively grinding monoplane denture occlusions is to flatten the occlusal plane of one arch and then adjust the teeth in the other arch against that standard. After remounting the case, check the amount of the pin opening. If it is more than 2 mm, consult with the dentist.

7.139.3. Because the mandibular teeth are almost set on a flat plane, pick the mandibular arch as the first arch to adjust. A flat aluminum plate helps detect teeth that do not conform to the monoplane.

7.139.4. When the plate is rubbed across the entire arch form, aluminum oxide transfers to the tooth surfaces and marks the high spots. Reduce the high spots with the flat edge of an abrasive wheel mounted in a straight handpiece. (A handpiece gives infinitely more control than a lathe.) When the occlusal plane of the mandibular arch is flat, do not touch it again. Lock the condylar elements against the centric stops.

7.139.5. Another technique requires removing the mandibular cast from the articulator and sanding the occlusal surfaces of acrylic teeth against a sheet of 320-grit wet or dry sandpaper held flat against a glass slab. Perform all remaining corrections on the maxillary teeth. Always use two pieces of articulating paper, one on the right and the other on the left to find the high spots.

7.139.6. Continue to grind until the incisal guide pin meets the table. Be sure to maintain a generally flat plane among all maxillary posteriors. ***NOTE:*** When grinding a high spot, do not just zero in on that place. If ditching and creation of posterior vertical overlap are to be avoided, grind the immediate area around the high spot.

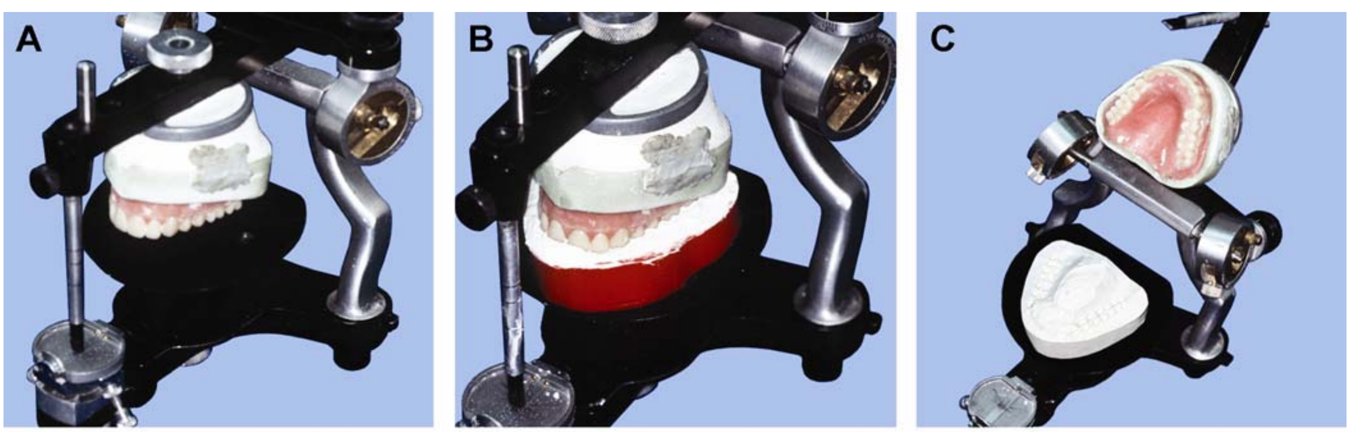
Section 7AA—Remounting Index

7.140. Constructing a Remounting Index:

7.140.1. When a dentist has the maxillary cast mounted with a facebow transfer, he or she will probably request a remounting index. The index is a permanent record of the facebow transfer. Using this index, a finished maxillary complete denture that has been separated from its original mounting can be remounted as if another facebow transfer has been made.

7.140.2. The usual reason for remounting a finished denture is a need for additional occlusal correction after the denture has been checked in the patient's mouth. Make a remounting index after completing all selective grinding corrections, but before separating the denture from its master cast and original mounting (Figure 7.128).

Figure 7.128. Fabricating a Remounting Index.



Remount jig in articulator | Denture teeth in a stone patty on a boxed remounted table | Completed remount index

7.141. Procedures for a Remounting Index:

7.141.1. Use a remounting jig or a cylinder of boxing wax shaped around a mounting plate on the lower member to support a mix of accelerated dental stone. Make the surface of the mix capture only the incisal edges of the anterior teeth and the occlusal surfaces and cusp tips of the posterior teeth of the maxillary teeth when the articulator is closed. Ensure the occlusal surfaces and incisal edges of the maxillary teeth are registered as *shallow* indentations in the soft stone. Take care not to lock the denture teeth in the index to prevent fracture of the teeth or destroying the accuracy of the index. After the dental stone sets, put the index aside for possible future use.

7.141.2. Recover the dentures from their master casts (paragraph 7.145) and perform routine finishing and polishing procedures (Section 7A B). To prevent the acrylic resin from drying and subsequently undergoing dimensional changes and warping, place the dentures into a moist denture bag prior to delivery to the dentist.

7.142. Use of a Remounting Index. Have the dentist place the completed dentures in the patient's mouth and evaluate them. If the teeth do not come together satisfactorily, the dentist will often ask for a denture remount with subsequent correction of the occlusion on the articulator. To do a remount without access to an index, the dentist must supply a new centric relation record and facebow transfer. If an index is available that duplicates a prior facebow transfer, there is no reason to do another transfer procedures. First, make *remounting casts.* Then remount the maxillary cast (using the previously prepared index) and mandibular cast (using the new record of centric relation) (Figure 7.129).

7.143. Fabricating a Remounting Cast:

7.143.1. Because master casts are destroyed during denture recovery, construction of a remounting cast should make the remount procedure easier. In a good remounting cast, the denture comes off the cast easily and seats on the cast with no trace of wobble.

7.143.2. To meet these goals, make a cast that accurately reproduces all of a denture's borders. Fill in all undercuts in the tissue surface of denture with wet paper towel material, polyvinylsiloxane putty, or a similar material (Figure 7.129-A). Invert the denture onto a mount of wet plaster, and make sure the border coverage is adequate but not excessive (Figure 7.129-B). After the stone sets, trim it into the form of a cast and key the base (Figure 7.129-C).

7.144. Remounting Dentures With an Index and a Remounting Cast:

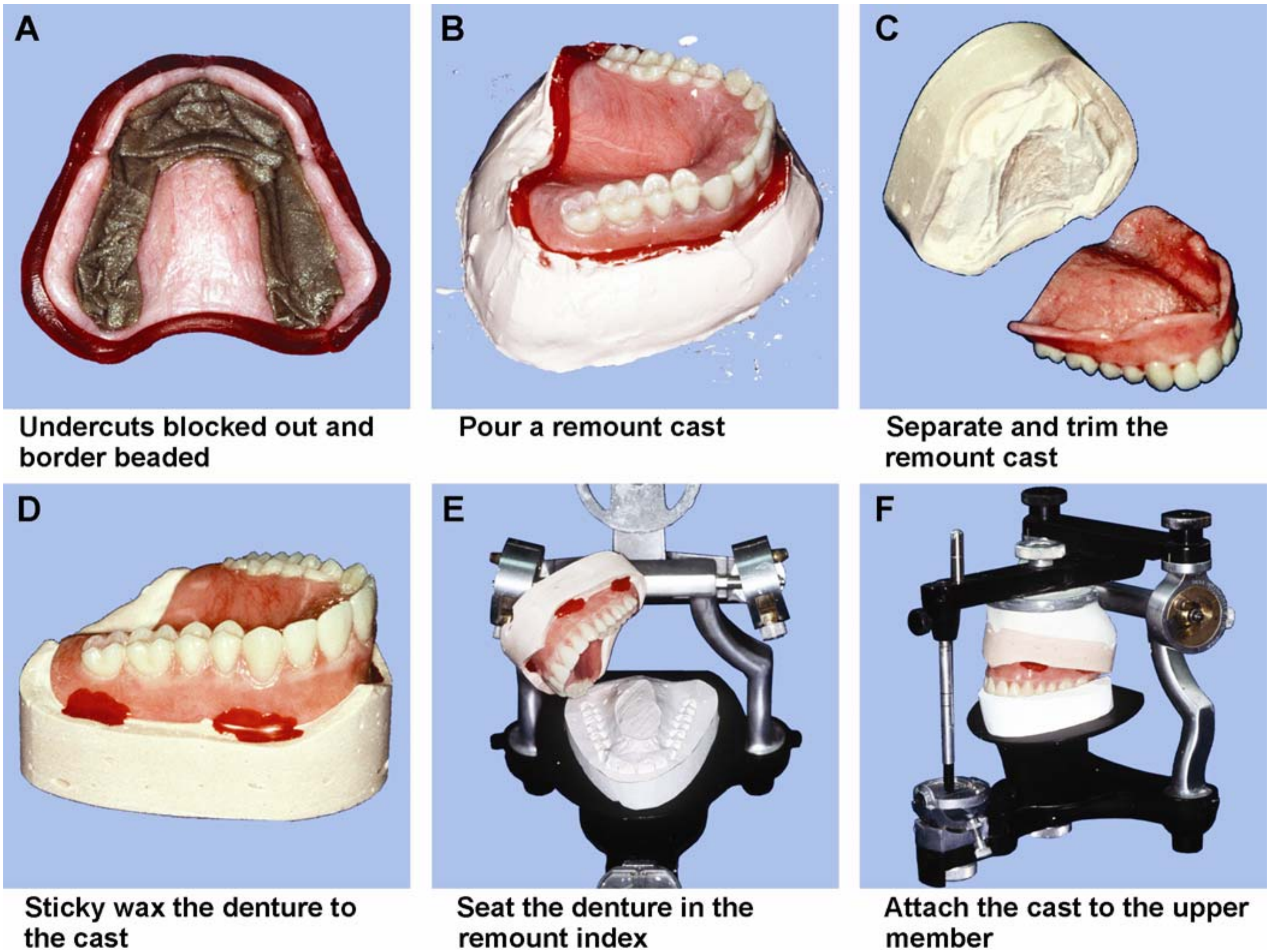
7.144.1. Use sticky wax to fasten the maxillary and mandibular dentures to their remounting casts (Figure 7.129-D). Place the index in position on the articulator's lower member. Firmly seat the maxillary denture teeth in the indentations and use a mix of accelerated stone to attach the cast to the upper member (Figure 7.129-E and -F).

7.144.2. After mounting the maxillary cast, remove the index and invert the articulator onto an inversion stand if necessary. Some articulators are manufactured to allow the lower mounting procedure to be accomplished without an inversion stand.

7.144.3. Fit the dentures into the centric relation record the dentist provides. Stabilize the entire assembly with pieces of coat hangar wire attached with compound to the proximal surfaces of the base of the cast. (Usually three rods are sufficient.) Do not use tongue blades, cotton swabs, or any other wood products when stabilizing the casts. When stone is added to the base of the cast, it may come into contact with the wood, causing the wood to expand and thereby altering the occlusal relation of the dentures to be mounted.

7.144.4. Open the incisal guide pin by an amount estimated to equal the thickness of the record. Attach the mandibular cast to the lower mounting plate. After the stone sets, loosen the guide pin and close the denture teeth into contact.

Figure 7.129. Remounting a Maxillary Denture With an Index.



Section 7AB—Recovering, Finishing, Polishing, and Caring for Complete Dentures

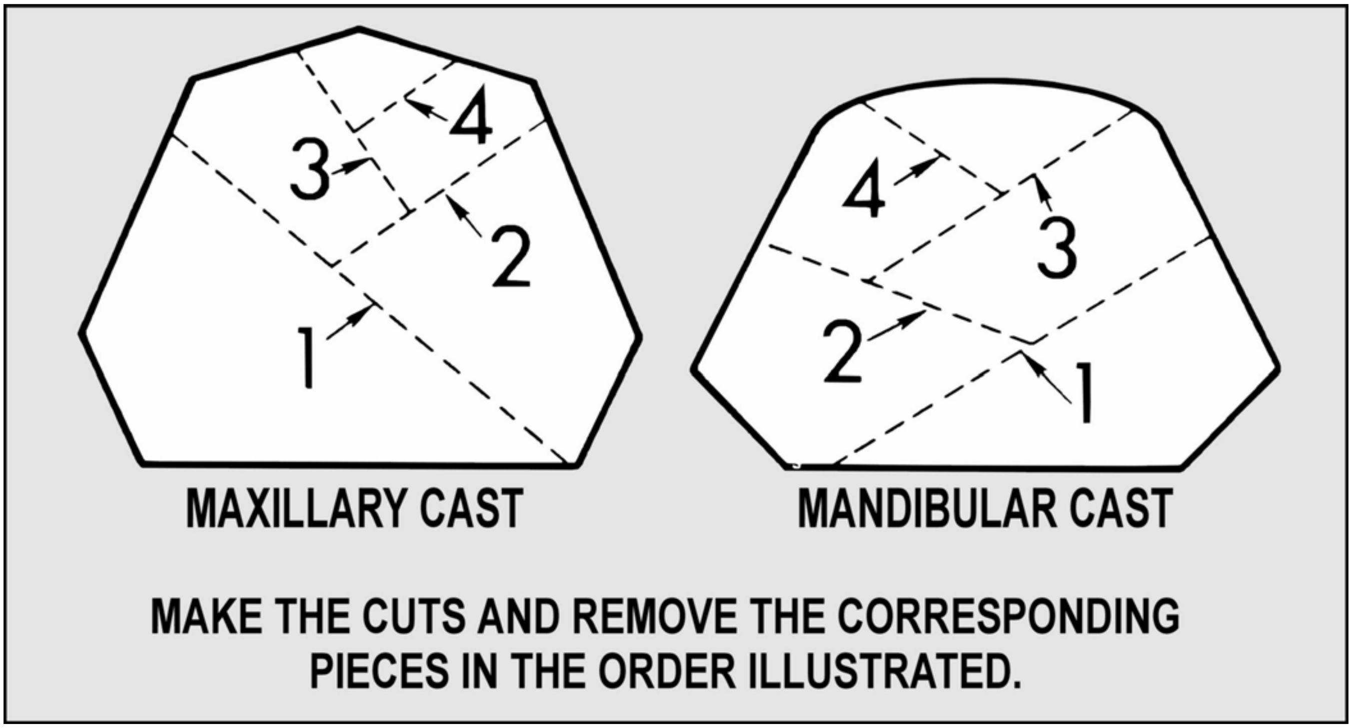
7.145. Recovering a Processed Denture From the Master Cast. Most dentures are undercut in varying amounts. Breakage or distortion of the denture is inevitable if an attempt is made to pry it off its processing (master) cast. Undercuts on the upper denture are most commonly found beneath the labial flanges, and less frequently in the tuberosity areas. Mandibular denture undercuts are most often located in the lingual flange regions bilaterally and under the labial flanges, anteriorly. Undercut casts must be sectioned with a saw to remove individual smaller pieces as careful as possible.

7.145.1. **Equipment and Materials.** Equipment and materials and their order of use are a plaster saw and blades, a pneumatic chisel, a shell blaster, and sodium citrate solution (or a commercially available stone remover).

7.145.2. **Denture Recovery Procedures:**

7.145.2.1. Recovering a denture from its processing cast requires considerable care in sawing and a practical sense of where and how to apply pressure in dislodging the pieces. Make the initial cuts with a plaster saw and remove the segments by gently wedging a knife blade in the cut. Figure 7.130 shows the sequence to follow when removing the different segments of maxillary and mandibular casts.

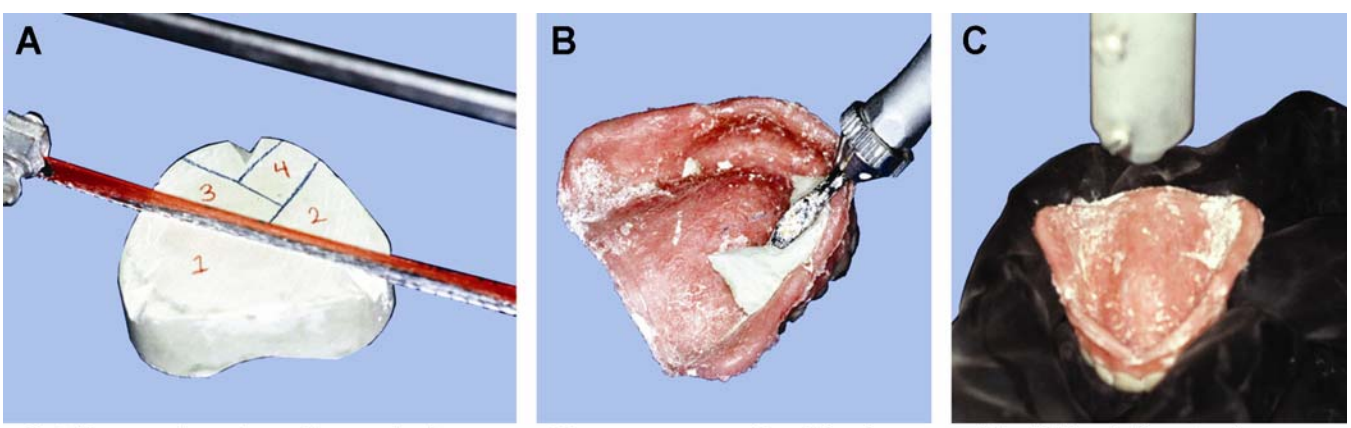
Figure 7.130. Denture Recovery--Suggested Sequence of Cuts and Fragment Removal.



7.145.2.2. When using a plaster saw, it is very easy to cut into the resin without being aware of it. One way to improve visibility is to saw the cast under a stream of water and flush the debris away as the cut deepens. Saw a short distance, remove the saw from the cut, and check for depth. Pay special attention to a maxillary denture with a high vault. Because the palate could be the same height or in some cases slightly higher than the peripheral borders of the denture, inattention could cause irreparable damage to the newly fabricated denture.

7.145.2.3. After removing the bulk of the base of the cast, *use* a small pneumatic chisel to cut out the pieces that remain in ridge areas (Figure 7.131). Do not let the pneumatic chisel come into contact with the newly processed denture base because chipping or even a fracture of the acrylic resin could result.

Figure 7.131. Denture Fragment Removal and Use of the Pneumatic Chisel.



Cut the cast and wedge out pieces | Use a pneumatic chisel on remaining cast | Shell blast the dentures

7.145.2.4. Use a shell blaster to clean away the last remaining particles of stone. (A shell blaster blows a high pressure jet of walnut shell particles, but it is not intended for removing large masses of stone.) To prevent warping or burning the denture resin, do not hold the denture closer than 4 inches from the blaster's nozzle. As an added precaution, keep the piece of work moving while it is under the shell stream.

7.145.2.5. Soak a recovered denture in sodium citrate or one of the commercially available stone remover solutions to dissolve away the last traces of stone that may have been missed with the blaster.

7.146. Finishing Complete Dentures. *Finishing* is the process of contouring the denture to the desired shape and thickness (Figure 7.132). Only a little finishing is required if the final wax-up was carefully waxed, packed, and polymerized.

7.146.1. Use abrasive materials to finish complete dentures, but never apply an abrasive to the tissue surfaces of a denture unless directed by the dentist to do so.

7.146.2. Remove all flash and sharp edges of resin from the peripheries of the denture using carbide denture burs and stones specially made for finishing acrylic resin (Figure 7.132-A). Do not alter the height or width of a peripheral roll during this procedure. It is often more effective for the cautious technician to use a red wax pencil to trace out the area to be trimmed. Often subtle changes in the peripheral contour can be missed and overtrimming can result. Take care to compensate for the following polishing steps, as required, and leave a very small amount for removal by pumice and polish:

7.146.2.1. Cut or carefully grind away resin bubbles from all surfaces (Figure 7.132-B). Check the interior of the denture carefully with a finger to locate any nodules of acrylic resin and consult the dentist if relief is required. Remove any flash from around the necks of the teeth with right and left denture-trimming chisels. The denture resin that represents the free gingival margin should be about 1 mm thick and rounded in all directions.

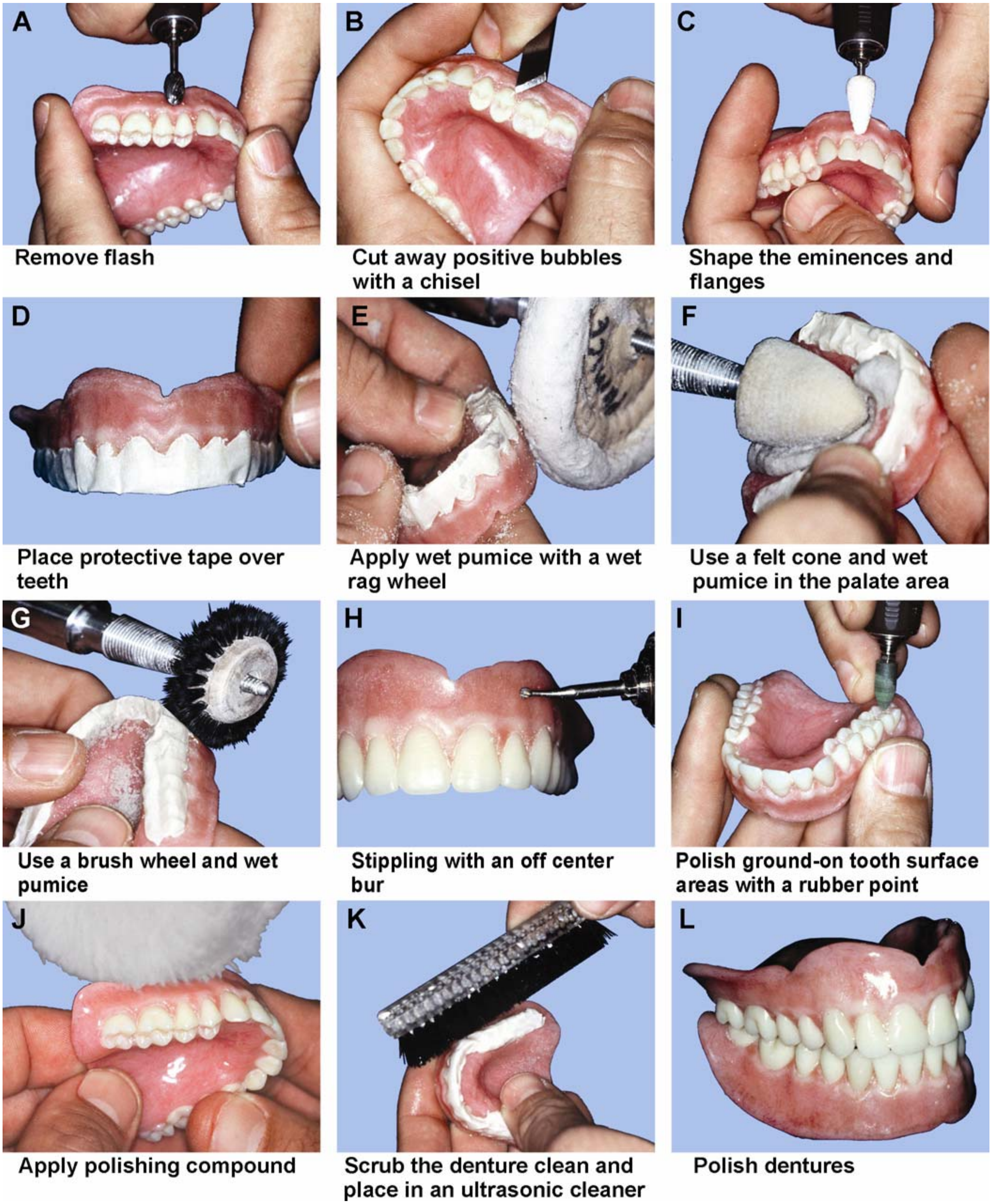
7.146.2.2. Smooth the eminence contours at the base of the denture teeth with the appropriate grade of finishing material (for example, acrylic bur, stone, or rubber point) (Figure 7.132-C). If necessary, continue shaping and smoothing the denture surfaces out to the facial and lingual borders. Remember, the time spent preparing the acrylic resin for polishing now means the anatomical detail placed in the denture base is less likely to be pumiced away.

7.147. Polishing Complete Dentures. The polishing procedure removes all scratches from the denture base and produces a generally glossy finish (Figure 7.132-D through -L). After polishing, the denture tends to accumulate less food debris, is easier to clean, and becomes more stain resistant. Polished surfaces feel better to a patient's tongue and are less likely to irritate other surrounding soft tissues.

7.147.1. A series of progressively finer abrasive agents will be used to produce the required denture base gloss. (A highly reflective, mirror-like appearance is not desirable.) Each of the wheels and brushes used to apply these agents is assigned for use with a specific agent. Do not mix brushes and wheels with different types of abrasives. During polishing, keep the denture base moving. Hold the denture firmly and do not press against a wheel too hard or the resin will get hot and scorch. Use adequate protective equipment. Always stay alert to potential hazards.

7.147.2. Protect the denture that has acrylic resin teeth from abrasive action. Cover the facial and lingual surfaces of the teeth with adhesive tape. Begin polishing the denture base with wet pumice applied to a course black brush wheel. Carefully smooth the interproximal areas and the gingival trim areas. Control the location of the brush wheel and be sure to keep it moving. If the wheel is allowed to remain in any one place for long periods of time, scorching of the resin could result.

Figure 7.132. Finishing and Polishing Complete Dentures.



7.147.3. Once satisfied with the smoothness of the gingival trimming, move on to the palatal section of the maxillary denture. The construction of the brush wheel allows it to flex and conform to the intricate contours of the palate. If an anatomical palate has been placed in the denture, care must be taken to prevent elimination of the contours.

7.147.4. After completion of the palate, proceed to the buccal surfaces of the maxillary, or mandibular dentures and the lingual flange sections of the mandibular denture. Begin by working from firm pressure to light pressure. A lot of pumicing should not be necessary if care was taken in the wax-up stage. Usually one pass over the eminences is sufficient.

7.147.5. Finish the bulk polishing of the denture base with a rag wheel running at low speed. Used properly, this wheel can reach all flat surfaces located at the peripheral borders, deep lingual flanges, and the termination point of the maxillary denture at the post palatal seal.

7.147.6. Rinse the pumice from the dentures and inspect them for scratches. If scratches are present, remove them with a rubber point and repeat the pumicing step in that area. When the smoothness of the resin is satisfactory, remove the tape and proceed with the final step in pumicing.

7.147.7. Often, denture teeth can be scratched or dulled as a result of shell blasting. To remove the fine abrasions use a soft white bristle brush wheel. *Lightly* pumice over the teeth and the entire denture, taking care not to polish away the surface anatomy of the teeth or the acrylic resin denture base.

7.147.8. Next, polish the denture with *tripoli* on a different set of wheels and brushes. At this stage, inspect the denture for scratches and irregularities not visible during the pumice stage and repeat earlier steps of pumicing and polish with tripoli until the desired smoothness is attained. Remember that the success of each polishing step is determined by the step before it, so attention to detail is critical for complete success.

7.147.9. Complete the final polishing of the denture base using a soft, dry rag wheel impregnated with commercial polishing compound and formulated for acrylic resin.

7.147.10. Use soap and water to scrub all polishing compound residue from the denture surfaces. Place the denture in a bag containing green soap and ammonia in an ultrasonic cleaning unit for 10 minutes.

7.148. Caring for Completed Dentures. To prevent the acrylic resin from drying and subsequently undergoing dimensional changes and warping, place the dentures into a moist denture bag prior to delivery to the dentist. If mailing the dentures to another clinic, ship them in a plastic bag that contains a sufficient amount of water to keep the dentures moist. Addition of a suitable antimicrobial agent will prevent growth of bacteria or mold during shipment.

7.149. Troubleshooting Processed Acrylic Resin. Occasionally, dentures show defects. Common errors and their causes are as follows:

7.149.1. **Excessive Denture Tooth Movement and Incisal Guide Openings.** For denture tooth movement and incisal guide pin openings in excess of acceptable limits, the following errors (and causes) can occur:

7.149.1.1. Failing to achieve complete metal-to-metal contact when a flask is closed.

7.149.1.2. Using excessive packing pressure.

7.149.1.3. Using plaster instead of dental stone in the flasking procedure.

7.149.1.4. Placing additional resin in the mold after trial packing and before final closure.

7.149.2. **Porosity.** For porosity, the following errors (and causes) can occur:

7.149.2.1. Using insufficient pressure in the mold.

7.149.2.2. Packing the resin dough before it is ready.

7.149.2.3. Improper temperature and time control during curing.

7.149.2.4. Excess or insufficient monomer in the mix.

7.149.2.5. Acrylic thickness too great (inadequate contouring of the denture base).

7.149.2.6. Underpacking.

7.149.3. **Fractured Teeth.** For fractured denture teeth, the following errors (and causes) can occur:

7.149.3.1. Using resin dough that was too stiff when it was packed.

7.149.3.2. Grinding porcelain denture teeth with a coarse stone wheel.

7.149.3.3. Applying packing pressure too rapidly.

7.149.3.4. Setting denture teeth in direct contact with the cast.

7.149.3.5. Inaccurate replacement of teeth that have become dislodged during the boilout procedure.

7.149.3.6. Careless deflasking.

7.149.4. **Grainy-Appearing Resin.** For grainy-appearing resin, the following errors (and causes) can occur:

7.149.4.1. Using insufficient monomer to wet all of the powder.

7.149.4.2. Letting a packed case stand for a long period before curing.

7.149.5. **Craze or Check Lines.** The probable cause of craze or check lines in the acrylic resin is allowing the plastic to come into contact with a highly volatile solvent such as acetone or chloroform.

7.149.6. **Denture Base Streaks.** For denture base streaks, the following errors (and causes) can occur:

7.149.6.1. Contamination with dirt and oils from bare hands.

7.149.6.2. Failure to stir the monomer-polymer mix thoroughly.

7.149.6.3. Using excess monomer.

7.149.6.4. Flaking of the tinfoil substitute.

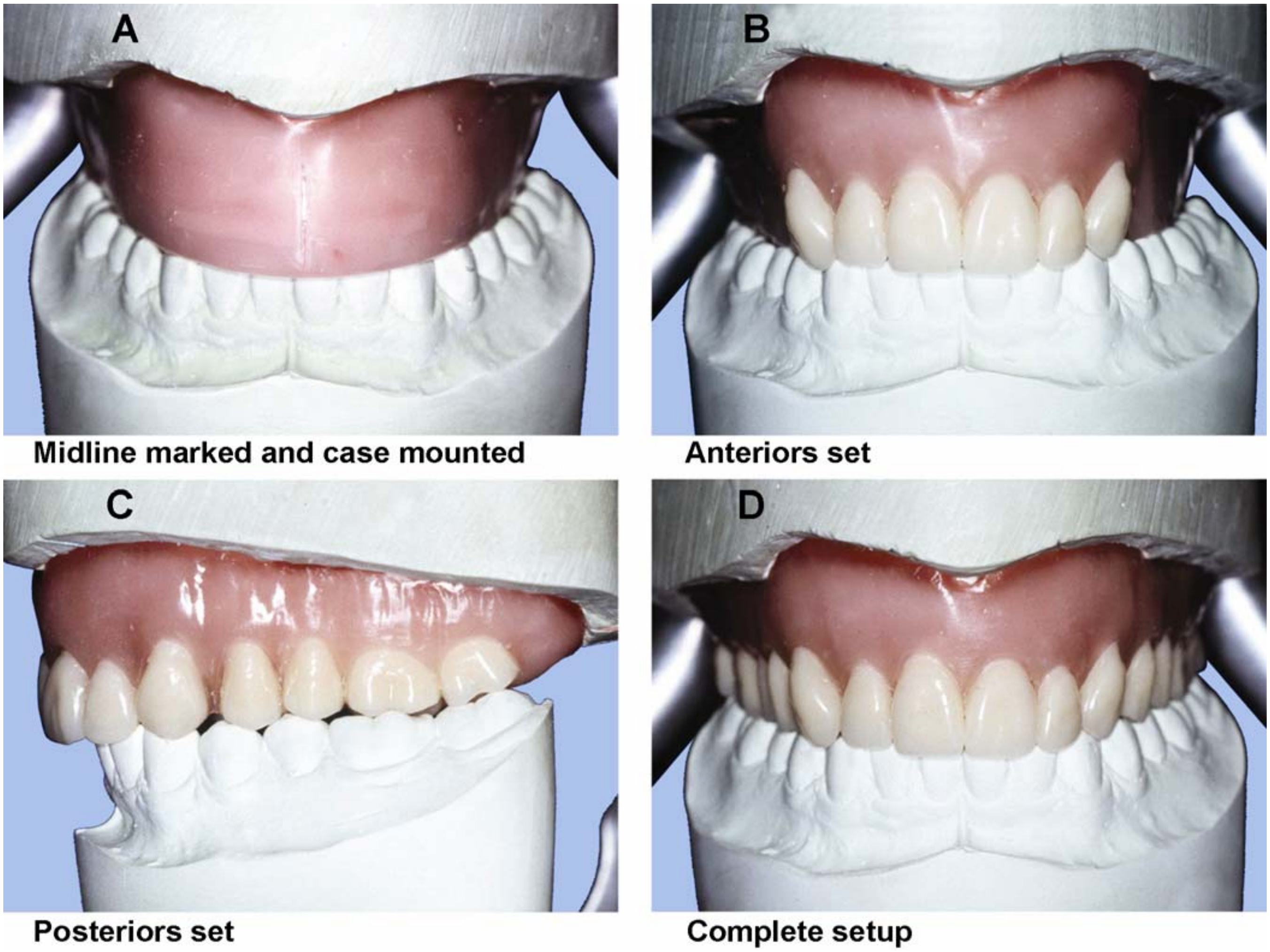
7.149.6.5. Dry crusts of resin somehow become incorporated into the mix.

7.149.6.6. Poor characterized denture base staining technique.

Section 7AC—Maxillary Complete Denture Opposing a Natural Dentition

7.150. Overview. A maxillary denture opposing natural teeth requires changes to standard procedures in denture fabrication (Figure 7.133). The objective of this section is to identify those changes.

Figure 7.133. Maxillary Complete Denture Opposing a Natural Dentition.



7.151. Casts. It is a good idea to pour the teeth on the mandibular cast in a low fusing metal to reduce wear and possible fracture of the cast's surface. If low fusing metal is not available, dental stone is adequate. (The use of a stone hardener is also an option if no low fusing metal is available.)

7.152. Mounting the Lower Cast. The dentist will provide a jaw relationship record with tooth indentations of cusp tips and incisal edges only. Trying to jam an opposing cast into a jaw relationship record that laps onto the facial and lingual surface of the teeth will lead to gross mounting inaccuracies. If a record shows a lot more than cusp tips and incisal edges, take a razor-sharp blade and carefully trim back the record until nothing but cusp tip and incisal edge indentations remain. When a cast of natural teeth is positioned against a jaw relationship record, it must be trimmed to see exactly where cusp tips and incisal edges are supposed to fit.

7.153. Denture Tooth Selection. Use plastic, cusped teeth to oppose natural teeth. Particularly in older individuals, natural teeth tend to be worn and have flattened occlusal surfaces. Teeth with lower cusp angles, such as 20-degree teeth, may articulate better with worn, natural teeth.

7.154. Denture Tooth Arrangement:

7.154.1. The occlusion scheme for dentures of this kind will be made with the mandatory multiple, well-distributed contacts in centric occlusion. Tooth contacts in lateral and protrusive excursions characteristic of a balanced denture are difficult to achieve. Therefore, dentist who wants more contacts should give specific directions.

7.154.2. Most dentists provide detailed instructions on how the anterior teeth are to be set. Arrange the teeth for maximum esthetic value. Incorporate an acceptable amount of vertical and horizontal overlap. Increasing the vertical overlap usually improves the appearance of an anterior tooth arrangement. It is also true that the chances for lateral and protrusive excursion balance tend to diminish as vertical overlap increases. An "acceptable" compromise needs to be drawn between these two considerations based on the dentist's decisions.

7.154.3. When a denture is made to function against existing natural teeth, minor natural tooth irregularities usually prevent development of the best possible centric occlusion. To compensate for inadequate or marginally adequate posterior tooth occlusion:

7.154.3.1. Open the occlusal vertical dimension about 1.0 mm on the articulator.

7.154.3.2. Set the posterior denture teeth in the best centric occlusion possible.

7.154.3.3. Surround the posterior teeth with enough wax to make them stable.

7.154.3.4. Clean any wax drippings from the occlusal surfaces.

7.154.3.5. Put the incisal guide pin back at its original setting. (This places the pin 1 mm off the guide table.)

7.154.3.6. Use a handpiece, tapered 203 stone, and #6 ball diamond to selectively grind the posterior teeth for the centric occlusion position until the pin meets the table.

Section 7AD—Immediate Dentures

7.155. Overview:

7.155.1. An immediate denture is constructed to completion before all of the natural teeth have been extracted. The denture is inserted "immediately" after the last extraction. Construction of an immediate denture can be started with any number of teeth present in an arch. More commonly, construction is begun with only anterior teeth remaining in the affected arch. The usual practice is to extract all of the posterior teeth first and wait about 6 weeks for healing. Generally speaking, if there are fewer teeth removed at the time of insertion, there are greater chances for success.

7.155.2. The principle behind immediate denture construction is that a cast of the patient's mouth with its natural teeth present is sculptured into a shape that represents the dentist's best guess of what the residual ridge will look like after the teeth are extracted. The immediate denture is made on this modified, sculptured cast.

7.156. Advantages of Immediate Dentures:

7.156.1. When making conventional complete dentures, it is best to wait at least 2 months after all the teeth have been removed before starting construction procedures. However, most patients are not willing to tolerate such an extended period of personal embarrassment. In the immediate denture treatment plan, the patient walks into a dental office with natural teeth that cannot be rehabilitated and walks out with a complete denture.

7.156.2. It is possible for the true occlusal vertical dimension to be reproduced exactly. However, when opposing natural teeth are not present at the start of a complete denture procedure, the occlusal vertical dimension has to be estimated.

7.156.3. From the standpoint of improved denture esthetics, a technician can refer to a cast of the patient's natural tooth arrangement for guidance.

7.156.4. When a denture base covers fresh extraction sites, patients seem to experience less postoperative pain and healing progresses at a faster rate.

7.157. Disadvantages of Immediate Dentures:

7.157.1. The cast on which an immediate denture is made is a sculptured estimate of how the ridge is supposed to look after the extractions. The denture fits as well as the dentist's guess.

7.157.2. The bone surrounding extraction sites can be expected to decrease in height and width (resorb). Resorption is usually the greatest in the first 2 months after the extractions have been performed. It slows down to a gradual rate of change after a year's time. An immediate denture will become unstable and require relining within 3 to 10 months.

7.158. Impressions and Casts:

7.158.1. To fabricate the preliminary impression and diagnostic cast, most dentists use alginate in a stock tray to make these impressions. The diagnostic cast is poured in the usual manner. The cast may be used to evaluate the patient's condition, fabricate a custom tray, and serve as a very valuable guide for selecting and arranging denture teeth. It is often advisable to pour the impression that will serve as the opposing cast during later fabrication steps in an improved dental stone. (The use of a commercially available stone hardener is also advisable.)

7.158.2. If the dentist is not comfortable with the first opposing cast made during the diagnostic impression appointment, then the opportunity to retake the impression will be available during the final impression appointment. This saves the patient unavoidable delays in delivery of the immediate denture.

7.158.3. For a final impression, some dentists use a stock tray in combination with an elastic impression material; others use a custom tray. The tooth and tissue undercuts must be blocked out on the diagnostic cast and the custom tray adapted over them. As a rough guide, it takes at least 6 mm of relief for a tray to satisfactorily accommodate an elastic impression material. In any event, the impressions described so far are made by the dentist in one step.

7.158.4. There is a very popular method of making immediate denture impressions that requires two steps. First, a specialized custom tray is constructed to match outlines on the diagnostic cast drawn by the dentist. A tray of this type usually takes in all of the edentulous areas. After the dentist makes the impression of the posterior edentulous areas, he or she trims the excess and returns the impression to the patient's mouth. Using a stock tray, the dentist makes an alginate impression over the entire custom tray. The anterior teeth and soft tissue areas are recorded in the second impression, and the custom tray is removed from the mouth embedded in the second impression. The result is a highly accurate combination impression of the dental arch.

7.158.5. To make a master cast, follow these guidelines: if the final impression can be boxed, box it; if the impression cannot be boxed, pour it in two stages.

7.159. Selecting Denture Teeth. The dentist will designate the shade and mold of the denture teeth. The mold can be selected by using the stone teeth on the cast as a guide. Often, more than one mold is required. For example, a central incisor might be taken from one mold and a lateral incisor from another. Within the mechanical requirements of the prosthesis, every effort should be made to copy the arrangement of the patient's own teeth. The dentist and the patient can decide on slight modifications to improve the appearance of the denture. Posterior teeth will be selected, using the considerations for conventional complete dentures (paragraph 7.60).

7.160. Record Bases, Occlusion Rims, and Articulator Mounting. The steps associated with making record bases and occlusion rims for immediate dentures are essentially the same as those used for making conventional dentures (Sections 7G and 7H). The only difference is that the portions of the record base occupied by the natural teeth are excluded (Figure 7.134-A). The upper cast is mounted according to anatomical averages or with a facebow transfer supplied by the dentist. The dentist will use record bases and occlusion rims to make a jaw relationship record, and the technician will use the record to mount the lower cast (Figures 7.134-B through -D).

7.161. Arranging Denture Teeth:

7.161.1. **Posterior Teeth.** Posterior teeth are set up on the record base, but anterior teeth are not (Figure 7.134-E). The posterior arrangement can be tested in the patient's mouth to check if important jaw relationships are correct. Most dentists do this routinely.

7.161.1.1. The dentist will choose the occlusion scheme. Some of the possibilities are predictable contact in centric occlusion only, balance in all excursions, or a monoplane occlusion scheme.

7.161.1.2. A maxillary immediate denture is usually opposed against natural lower teeth. This combination of circumstances is common. These cases are always constructed with cusped, plastic denture teeth. (For an occlusion scheme, see paragraph 7.154.) After the posterior teeth are set, perform a basic, uncharacterized wax-up. The case is ready for a posterior tooth try-in if the dentist desires.

7.161.2. **Anterior Teeth.** If the patient's natural anterior tooth arrangement is acceptable, try to copy it as closely as possible. The following steps provide guidance (Figure 7.134-F):

7.161.2.1. Mark the faciogingival and linguogingival junction between the tooth and the gum tissue with a pencil.

7.161.2.2. Draw a long axis line on each stone tooth. Extend this line onto the facial surface of the cast as far as the labial sulcus.

7.161.2.3. Consequentively number alternate teeth on the cast. For example, number the left central incisor "1," the right lateral incisor "2," the left canine "3," the right central incisor "4," the left lateral incisor "5," and the right canine "6."

7.161.2.4. With the incisal guide pin touching the table, draw a line on the labial surfaces of the mandibular anterior teeth that indicates the amount of maxillary incisor and canine vertical overlap.

7.161.2.5. Measure the distance between the labial surfaces of both canine with a Boley gauge. Record the measurement on the base of the cast.

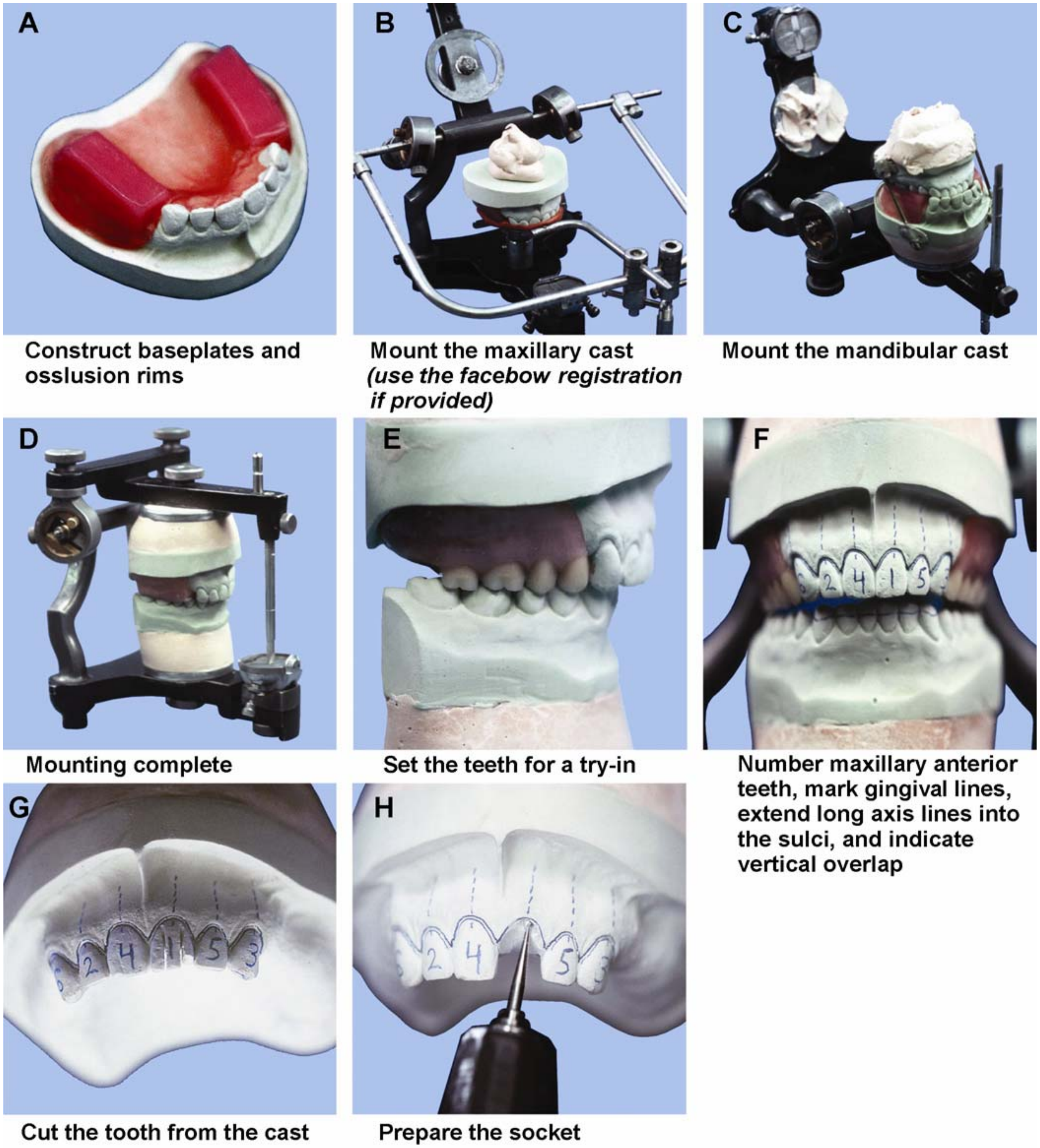
7.161.2.6. Following the alternating tooth sequence as follows:

7.161.2.6.1. Use a saw or bur to cut down the middle of the tooth to the gingival pencil lines (Figure 7.134-G).

7.161.2.6.2. Remove the entire tooth down to the gingival lines, using a sharp knife and taking care to preserve the contours of adjacent stone teeth (Figure 7.134-H).

7.161.2.6.3. Excavate the facial root portion of the cast to a depth barely sufficient to accommodate the collar of a denture tooth (1.5 mm maximum). Reduce the collar if it is longer than 1.5 mm. Use a #4 round bur in a straight handpiece for the excavation.

Figure 7.134. Immediate Denture Fabrication.



7.161.2.6.4. Cut the lingual root portion of the cast flush with the linguogingival pencil line (Figure 7.135).

7.161.2.7. After cutting away a stone tooth on the cast, position the corresponding tooth as shown in Figure 7.136-A and -B and as follows:

7.161.2.7.1. Use the contact areas and contours of the adjoining stone teeth to guide the mesiodistal and faciolingual placement of each denture tooth.

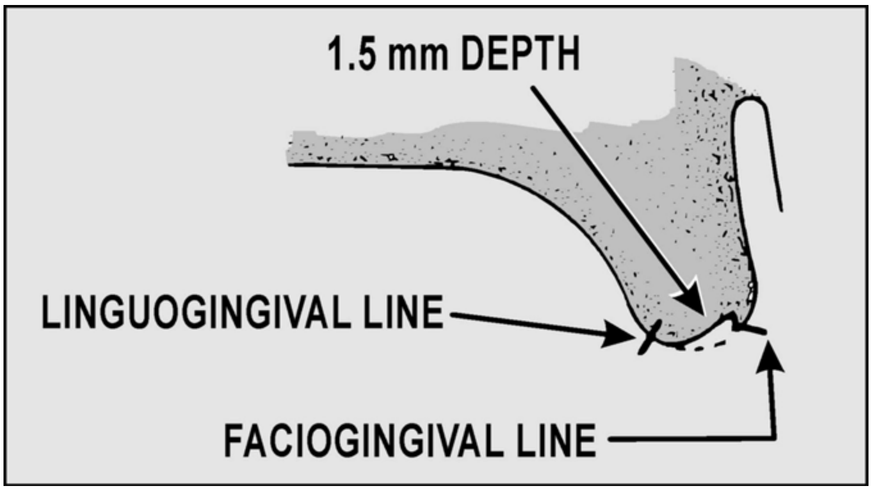
7.161.2.7.2. Use the line scribed on the facial surface of the lower anteriors as a check on the vertical overlap.

7.161.2.7.3. Use the pencil lines that extend into the labial sulci as aids in aligning the long axes of the replacement teeth.

7.161.2.7.4. Have a separate cast of the patient's natural tooth arrangement available for periodic reference. Use the diagnostic cast or make a duplicate of the master cast.

7.161.2.7.5. After the canine teeth are set, check to see that the distance between their labial surfaces is the same as the original distance between the stone canines.

Figure 7.135. Excavation for Seating Denture Tooth in Immediate Denture Cases.



7.162. Performing a Final Wax-Up. The final waxing and contouring of an immediate denture differs from a conventional denture in the following respects (Figure 7.136-C):

7.162.1. The palatal portion of the record base is not sawed out in a maxillary immediate denture final waxing procedure. Ensure the baseplate used for the posterior teeth try-in is no thicker than 2 to 3 mm.

7.162.2. The labial flange areas of an immediate denture require special attention. If thick, bulky flanges are made to cover bony areas where virtually no resorption has occurred, the patient's lips will appear ballooned and distorted. If the resin is too thin, the flanges will fracture. Follow these suggestions for the labial flange areas of an immediate denture:

7.162.2.1. Fill the sulcus rolls with wax and contour the wax at the necks of the teeth in the usual manner.

7.162.2.2. Make the depth of wax between the sulcus rolls and the gingival contouring equal to one thickness of 28-gauge wax plus one thickness of baseplate wax.

7.162.2.3. Do not try to produce deep festooning. Instead, be content with surface irregularities resulting from the sheet wax following natural curvatures.

7.162.2.4. Stippling of the denture base for immediate dentures is not recommended. However, if stippling is used, be sure it is the positive, blow-on variety.

7.162.3. Be certain the teeth are in good centric occlusion and the incisal guide pin is touching the incisal guide table.

7.163. Flasking, Wax Elimination, Packing, Processing, and Finishing. Follow ordinary flasking and boilout practices. After the wax is eliminated, perform all of the following procedures that apply:

7.163.1. If the posterior palatal seal has not been cut into the cast, do it now (paragraph 7.101.1.2).

7.163.2. Imagine how the residual ridge will look after the natural teeth are extracted. After the wax is eliminated, wait until the flask is cool enough to handle (Figure 7.136-D). At this time, the dentist will trim off the faciogingival stone ledges and otherwise modify the cast according to an estimate of alveolar bone contours after the remaining natural teeth are removed. To do this, the dentist will usually draw a line on the cast, attempting to represent where the depth of the gingival sulcus can be found around each natural tooth. After cutting off the stone ledges, the dentist blends the contours of the cast into the pencil line (Figures 7.136-E and 7.137).

Figure 7.136. Immediate Denture Fabrication (Denture Tooth Setup and Preprocessing Cast Corrections).

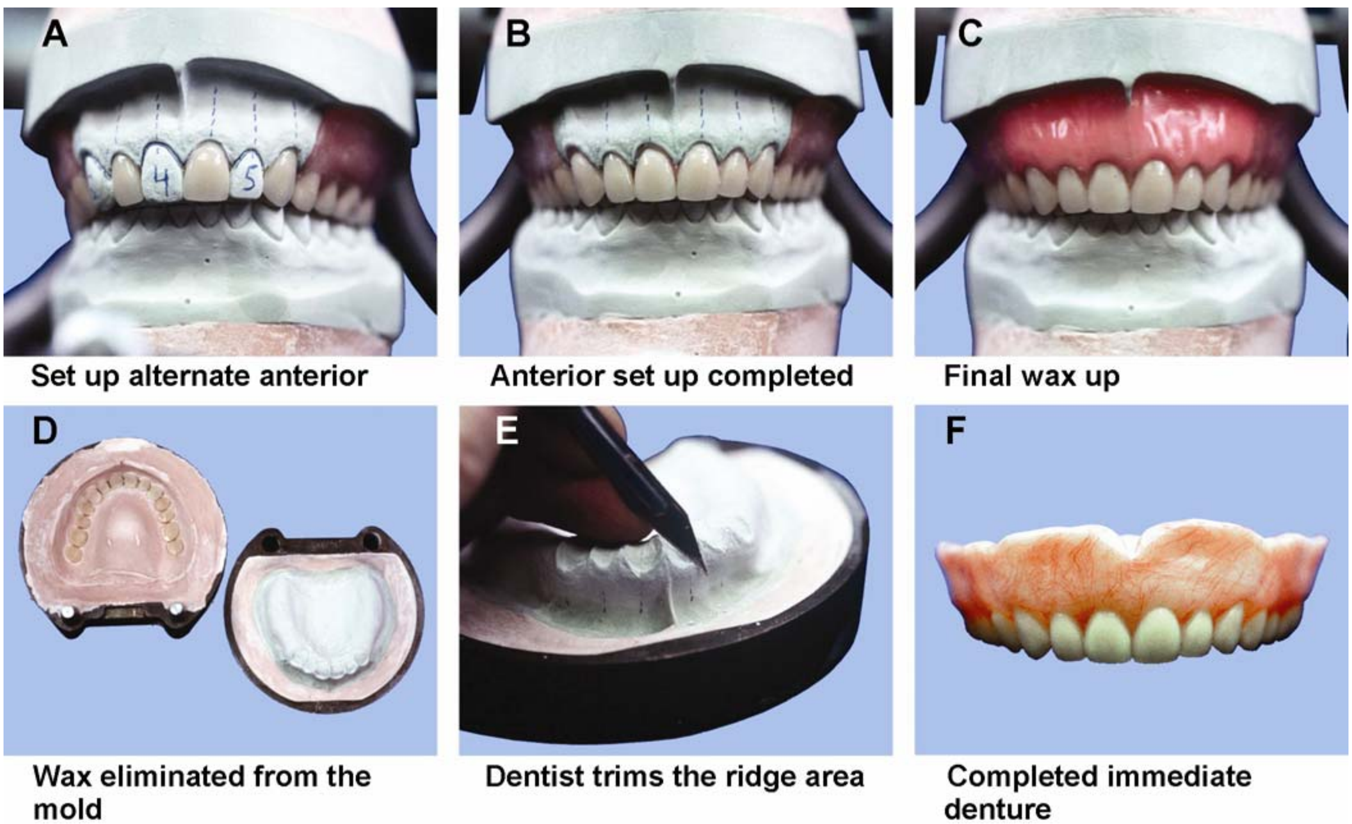
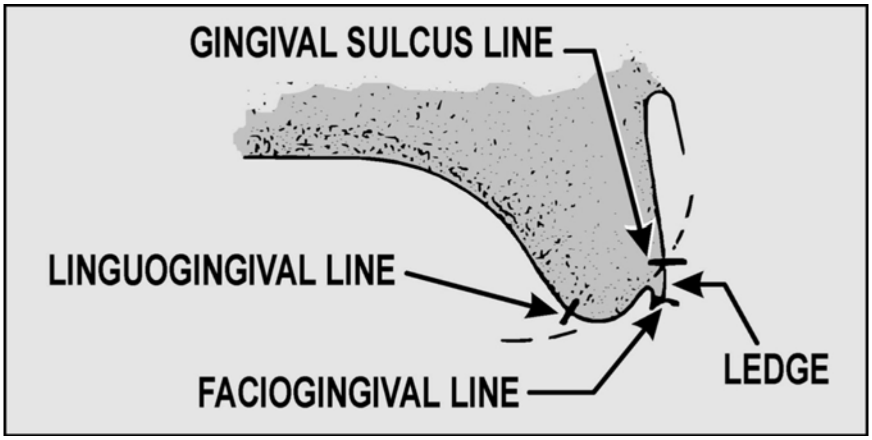


Figure 7.137. Trimming the Cast After Boilout.



7.163.3. After the dentist finishes trimming the case, he or she may order a transparent surgical template. This template may be accomplished by two methods:

7.163.3.1. **Vacuum Formed (Omnivac®) Method.** Take a sheet of clear plastic tray material and suck it down over the cast and the half flask. Cut away the excess plastic tray material.

7.163.3.2. **Compression-Molded Method:**

7.163.3.2.1. After the dentist trims the cast, make an alginate impression of the cast using a rim-lock tray. Pour a stone cast from this impression. Adapt two layers of pink baseplate wax to the duplicate cast for constructing a clear, surgical template.

7.163.3.2.2. Flask this cast in the usual manner. Eliminate the wax. Apply tinfoil substitute to the mold surfaces and to the surface of the cast. Pack and process using clear acrylic resin.

7.163.3.2.3. Finish and polish the template. The tissue surface of the template is used as a guide for surgically shaping the ridge to conform to the tissue surface of the denture. The principle behind the template is that skin over bony areas is compressed between the bone and the transparent plastic. Looking through the plastic, these compression areas appear white in contrast to the reddish coloration of the surrounding tissue.

7.163.4. Pack, cure, and deflask the immediate denture. Restore the denture's occlusal vertical dimension. Finish and polish the denture (Figure 7.136-F).

Section 7AE—Cast Metal Denture Bases

7.164. Overview. The cast metal base denture is usually made of either chrome or an aluminum alloy. It is adaptable to either an upper or a lower denture.

7.165. Advantages of Cast Metal Denture Bases. There are advantages to using cast metal bases. Metal bases are primarily used in patients who continually fracture their dentures during a normal function. The strength factor allows the denture to be made much thinner across the palate. As a result, the quality of the patient's speech improves. Mouth tissue tolerates chrome and aluminum alloy well. Metal bases generally fit tissue contours more accurately than processed resin. Metal is a much better conductor of temperature than acrylic resin, and many patients claim better taste sensations as a result. If a metal base is intentionally made to be heavy, the sheer weight helps keep the lower denture in place.

7.166. Disadvantages of Cast Metal Denture Bases. There are also disadvantages to using cast metal bases. Cast metal denture bases are more time-consuming to make and difficult to reline. All borders of the denture that are made of metal must be accurately placed relative to limiting structures in the mouth because metal borders are difficult to adjust.

7.167. Metal Denture Base Designs. There are two basic designs for metal denture bases. In the first design, all denture bearing areas as well as all denture borders are covered in metal (Figure 7.138-A). (Note the retention beads and finish lines.) The second design is a combination of metal and resin coverage. Metal reinforces only those critical areas of the denture base subject to fracture; processed resin accounts for the rest (Figure 7.138-B). The dentist chooses the design.

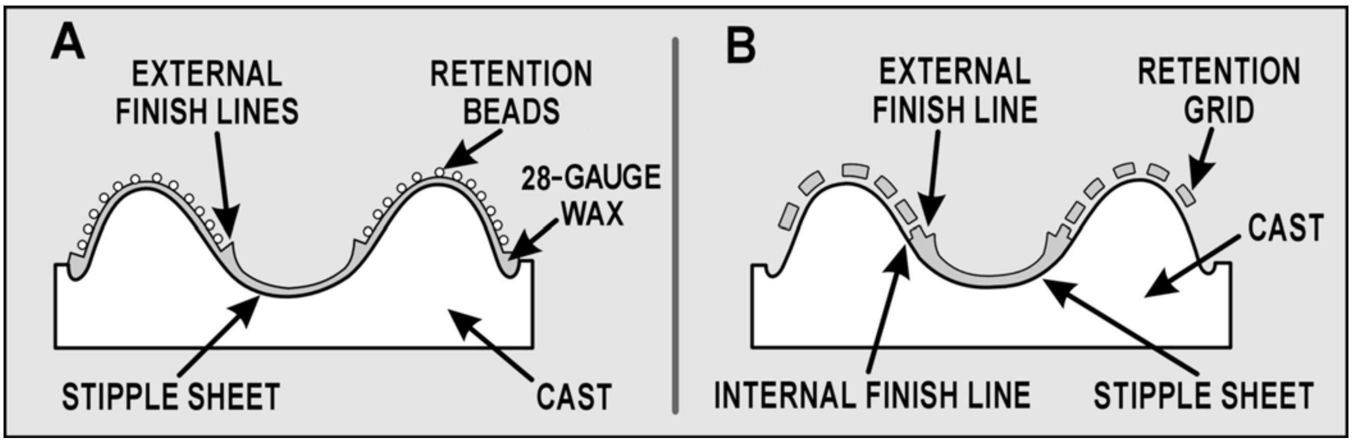
7.168. Combination Resin and Metal Maxillary Denture Base. Metal forms the palatal and posterior palatal seal portions of the denture and the rest is resin (Figure 7.138-B). To construct this denture base, perform the following:

7.168.1. Read the instructions for relief, duplication, waxing, casting, and finishing metal frameworks described in Chapter 8. Remember the following very important steps:

7.168.1.1. Relieve areas under acrylic resin retention grids before master cast duplication so the grid can properly anchor the resin.

7.168.1.2. Incorporate distinct internal and external finish lines into the wax-up so the resin meets the cast framework in a butt joint.

Figure 7.138. Cast Metal Denture Bases.



7.168.2. If the posterior palatal seal is to be in metal, it is the responsibility of the dentist to establish the boundaries of this area on the cast. Make sure the posterior palatal seal has been cut into the cast. Following the dentist's design on the diagnostic cast, block out the labial and buccal undercuts, and seal the relief wax to the master cast in the appropriate areas. Make sure the palatal border of the relief wax is straight and well defined because it forms the finish line for the acrylic resin on the tissue side of the denture.

7.168.3. Duplicate the master cast in investment.

7.168.4. Adapt a 26-gauge stipple sheet to the palate. Add a retention grid over the relief areas of the investment cast (Figure 7.139). Seal them together and to the cast.

Figure 7.139. Cast Metal Denture Base (Wax Pattern).

7.168.5. Make the external finish line with 14-gauge half-round wax and sprue the pattern.

7.168.6. Coat the pattern with a wetting agent. Apply the "paint-on" layer of investment in a uniform 3 mm thickness.

7.168.7. After the paint-on layer of investment hardens, mix the outer investment and fill the flask. Submerge the pattern and cast in the flask. When the investment hardens, eliminate the wax and make the casting.

7.168.8. Finish and polish the casting.

7.168.9. The finished metal base must be accurately seated on the master cast. Continue with the denture tooth setup in the conventional manner. ***NOTE:*** The details of waxing a pattern and casting a metal palate are in Chapter 8 of this volume.

Section 7AF—Tooth-Supported Dentures (or Overdentures)

7.169. Overview. Occasionally, teeth purposely cut down close to the level of the gum line are left in the alveolar bone to reduce the rate of ridge resorption. When a denture is made to fit "over" these remaining teeth, the denture assumes the name *overdenture* (or *tooth-supported denture).* The dentist may choose to retain from one to five teeth as overdenture abutments. Most commonly two abutments are chosen. The decision to save teeth as overdenture abutments is based on their periodontal health, decay, potential for endodontic treatment, and their position in the dental arch. From a technical point of view, there is very little that is unusual about these dentures. The difficulties associated with overdentures arise due to the space limitations caused by the presence of abutment teeth.

7.170. Increasing Denture Base Strength. Tooth-supported dentures (overdentures) often need strengthening to prevent fracturing the denture base, specifically in the area of the abutment teeth. This can be done by selecting a high impact resin using alternative packing techniques or by making a cast metal base.

7.170.1. **High Impact Resin.** Using Lucitone 199 ® (by L.D. Caulk Co., Milford DE) or an alternative high impact resin is believed to create a stronger denture base. Follow the manufacturer's directions for polymer to monomer ratios and for curing procedures. ***NOTE:*** Even though the manufacturer states that Lucitone 199 acrylic does not need to be trial packed, standardized trial packing procedures generally yield more consistent results (paragraph 7.117).

7.170.2. **Alternative Packing Techniques.** Alternative packing techniques may also be utilized. Improving the bonding between the denture base acrylic resin and the teeth can strengthen the denture base. The bonding surface area and chemical attachment are improved when the ridge laps of the teeth are prepared prior to packing. Prepare the posterior teeth by cutting dovetailed grooves approximately 2 mm wide and 2 mm deep. Do not cut grooves into the anterior teeth because this may affect the shade of these teeth. Instead, drill shallow holes with a round or inverted cone bur on the ridge laps of the anterior teeth. Also, lightly roughen the polished ridge lap surface of the anterior teeth to remove the "glaze" layer. After completing the tooth preparations, carefully clean all debris from the mold, apply a tin foil substitute to the mold, remove any tin foil substitute applied to the teeth, and continue packing procedures.

7.170.3. **Cast Metal Bases.** Cast metal bases can also be used to increase denture base strength. Strength is the basic purpose for making cast metal bases for a tooth-supported denture. Cast metal base designs are quite different from the one depicted in Figure 7.138 for complete dentures. Coverage is usually restricted to the crest of the alveolar ridge. Also, these bases are normally made to be completely covered with acrylic, showing no exposed metal surfaces (paragraph 7.171). Cast metal bases can be grouped into two categories; full arch bases and minibases, as follows:

7.170.3.1. **Full Arch Bases.** This design consists of a cross arch casting using the anterior abutments bilaterally and including distal extensions to posterior abutments or residual ridges or both. In the maxillary arch, full palatal coverage or a palatal strap is added to increase rigidity.

7.170.3.2. **Minibases.** These small unit castings may be individual covers for abutment teeth or they may be united to increase cross arch strength. Minibases are always limited to the immediate areas of the abutment teeth.

7.171. Fabricating Cast Metal Bases. Cast metal bases for tooth-supported dentures are made of chrome alloys. Full arch castings can be made by using the partial denture framework fabrication sequence in Chapter 8. On the other hand, some minibases may be small enough to be constructed by using the procedures for making base metal fixed framework castings. This fabrication sequence is as follows:

7.171.1. Survey the case and mark undesirable undercuts.

7.171.2. Block out the gingival crevice around individual abutment teeth and tissue undercuts. (Relief wax will not normally be needed unless the framework design includes open retention for acrylic resin.)

7.171.3. Prepare the master cast for spruing and duplicate it in investment.

7.171.4. Transfer the design from the master cast to the refractory cast.

7.171.5. Adapt a layer of 24-gauge sheet-casting wax to the refractory cast and trim to the outline scribed earlier. Seal the casting wax to the cast and lightly flame the pattern. Apply tacky liquid to the wax and sprinkle tiny retention beads on the surface. Two small 18-gauge wax wire handles can also be added in the posterior area for the dentist's use during jaw relation procedures. ***NOTE:*** On larger metal bases, use 22-gauge wax; on smaller ones, use 26-gauge wax.

7.171.6. Sprue, invest, and cast in the usual manner.

7.171.7. Desprue the casting and trim the borders of the casting to the desired extensions in a perpendicular direction to the cast surface. Finish the axial walls of the abutment indentations with a fine stone.

7.171.8. Sandblast, electro-polish, rubber, and polish the casting. Avoid excessive polishing of tissue-bearing surfaces.

7.171.9. Fit the framework to the cast. Grind on any areas that prevent seating and then repolish them.

7.171.10. Note that the cast metal base *may* need to be opaqued and will *probably* need to be cemented to the cast prior to packing. Opaquing the retention side of the metal base with a pink opaque (for example, Synfony®) is not usually a consideration unless there is a possibility of metal showing through a thin denture base. The dentist may ask that the casting be opaqued if conditions warrant it.

7.171.11. Lastly, the cast metal base must be cemented to the cast to prevent dislodgment during packing. This is especially important with minibases because they may not have any bracing qualities at all. A thin mix of zinc phosphate cement is used to hold the metal base in place. Cyanoacrylate cement or Zap-It® may also be used.

7.171.12. After the cement has set, remove any excess. The denture can now be packed and completed in a normal manner.

7.172. Tooth-Supported Dentures With Retentive Attachments. This entirely special area of denture technology will not be discussed here. However, for an authoritative reference, see Brewer, A.A. and Morrow, R.M., *Overdentures,* St. Louis, L.V., Mosby Co.

Section 7AG—Acrylic Denture Tooth Repairs

7.173. Tooth Repair Possibilities. There are at least two categories of denture tooth repair as follows:

7.173.1. The first category of denture tooth repair is when the collar area of the denture base (to include the facial and proximal plastic surrounding the affected tooth) is still intact. It is not necessary to alter the collar area of the denture base to perform the repair.

7.173.1.1. Reattach the original tooth if it is still salvageable. Sometimes a porcelain or plastic tooth may pop out of its seat in a denture base without damaging the base.

7.173.1.2. Replace a lost or broken tooth with a duplicate that has the exact collar and proximal shape. This is only possible if the collar and proximal contours of the original tooth were not modified in any way and there is a duplicate handy.

7.173.2. The second category of denture tooth repair is when the collar area of the denture base (to include the facial and proximal plastic surrounding the tooth) must be altered to perform the repair.

7.173.2.1. The following possibilities may exist: the facial plastic of the denture base is still intact, the original denture tooth is lost or broken, or the shape of the available replacement tooth does not conform to the shape of the original "seat."

7.173.2.2. In almost all repairs involving a plastic tooth, the original "seat" for the tooth is destroyed. A broken acrylic tooth must be completely drilled out before performing a repair. Plastic teeth that are accidentally knocked out usually carry some of the attached denture base with them.

7.174. Repair Procedures. Repair procedures are shown in Figure 7.140 and as follows:

7.174.1. **Removing the Broken or Loose Tooth From the Denture Base.** If a porcelain tooth is loose or broken, but it is still embedded in the denture base, free any mechanical retention (pins, diatoric) by cutting away the denture base material from the lingual surface. Do not cut through to the facial. Pop the denture tooth loose. The tooth should easily and accurately go back to its original position. In the case of an acrylic tooth, the only choice is to cut or grind the tooth out down to the denture base material.

7.174.2. **Selecting a Replacement Tooth.** If a new tooth is used, obtain the mold number of the original tooth, indicating size and shape, from the imprint of the ridgelap in the denture base. If this information is not available, select a replacement based on the apparent mold of the rest of the setup. Determine the shade from the adjacent teeth with the aid of a shade guide.

7.174.3. **Preparing the Repair Site.** Differences in preparation depend on whether the facial resin of the denture base is affected or not, as follows:

7.174.3.1. If the facial denture base resin is not affected:

7.174.3.1.1. Roughen the ridgelap of acrylic teeth to guarantee good chemical bonding with the repair material. Cut a small diatoric into a plastic tooth as additional retention.

7.174.3.1.2. Make a "box" preparation in the denture base lingual to the tooth to be repaired (Figure 7.140-A).

7.174.3.1.3. Position the tooth in its seat and sticky-wax it in place from the lingual (Figure 7.140-B).

7.174.3.1.4. Construct a labial matrix to hold the tooth in position during repair (Figure 7.140-C).

7.174.3.1.5. Remove the sticky wax after the stone is set (Figure 7.140-D).

7.174.3.1.6. Paint the matrix with a tinfoil substitute.

7.174.3.1.7. Reassemble the denture, tooth, and matrix in correct alignment (Figure 7.140 -E).

7.174.3.1.8. Sticky-wax the tooth to the matrix and the matrix to the denture.

7.174.3.2. If facial denture base resin is not or cannot be left intact:

7.174.3.2.1. Position the tooth by grinding either the denture base or the tooth, as required. Since denture base references for positioning a replacement tooth are unreliable, use a cast of the opposing natural teeth or opposing denture for positional reference. Sticky wax the replacement tooth in place from the lingual.

7.174.3.2.2. Reconstruct the missing facial denture base plastic in white (Ivory) wax.

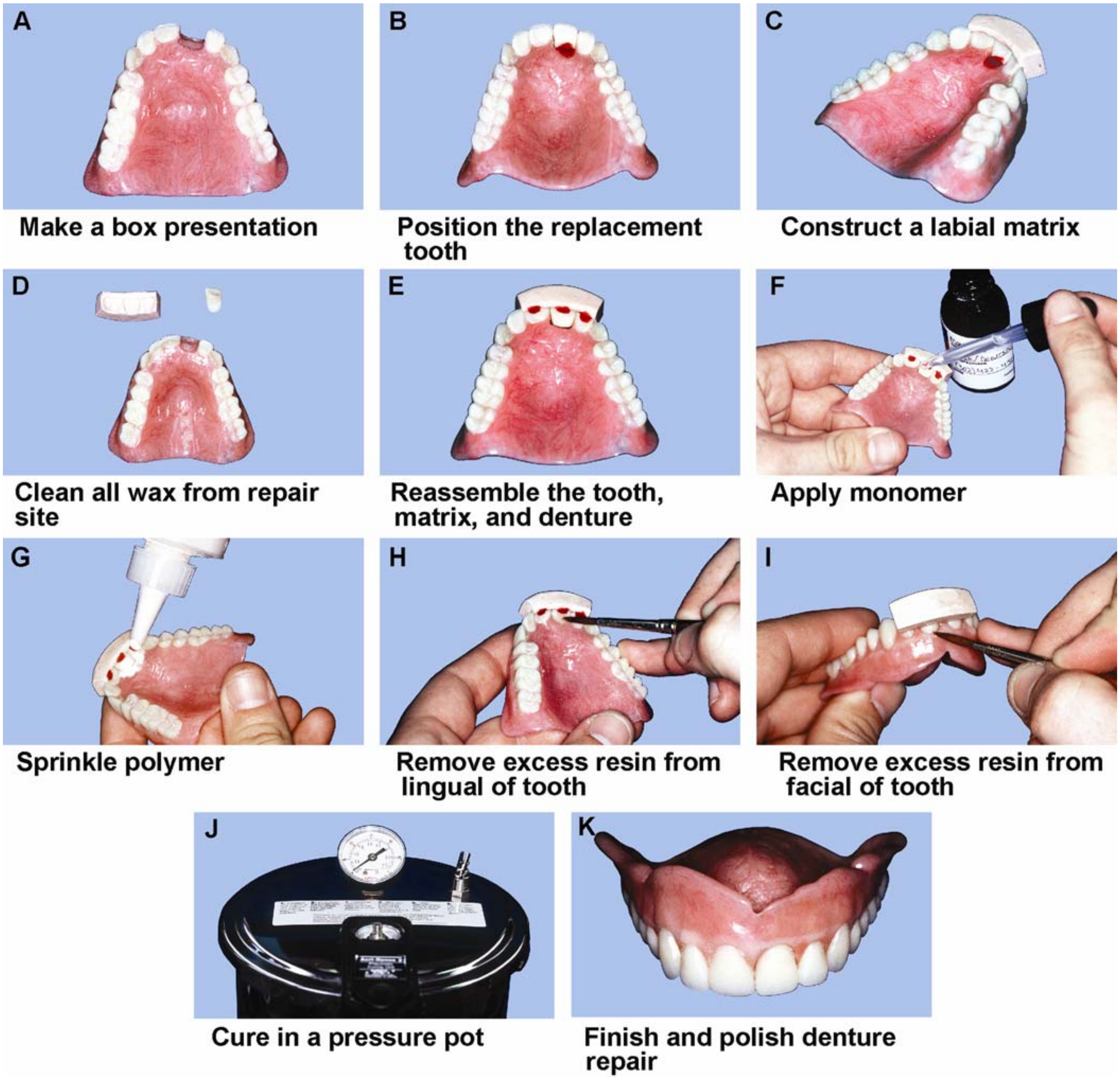
7.174.3.2.3. Make a facial matrix. During the progress of the repair, it holds the tooth in position and shapes the facial surface of the denture base.

7.174.3.2.4. Paint the matrix with a tinfoil substitute.

7.174.3.2.5. Remove all the wax from the teeth and denture base. Roughen the ridgelap area of resin replacement teeth. Cut a small diatoric into a plastic tooth as additional retention insurance.

7.174.3.2.6. Lingual to the tooth to be repaired, make a box preparation in the denture base. Create butt joints between the denture base and the repair material where possible.

Figure 7.140. Denture Tooth Repair.



7.174.3.2.7. Reassemble the denture, the tooth, and the matrix in proper alignment.

7.174.3.2.8. Sticky wax the tooth to the matrix. Attach the matrix to the denture with sticky wax in two or three widely separated places.

7.174.4. **Adding the Autopolymerizing Repair Resin:**

7.174.4.1. Moisten the repair area with monomer (Figure 7.140-F) and sprinkle with a layer of polymer (Figure 7.140-G). Alternate the polymer and monomer until the repair resin is built up slightly higher than the surrounding denture base. Using a small brush moistened with monomer, remove any excess acrylic from the lingual and facial of the denture tooth (Figure 7.140-H and -I).

7.174.4.2. Let the resin cure in a pressure pot according to the manufacturer's directions (Figure 7.140-J) Immersion of the repair in water retards monomer evaporation; while warm water speeds up resin polymerization. In the absence of directions, hold water temperature to about 110 °F in the pot at a depth deep enough to cover the repair. Secure the lid to the pot and apply a minimum 15lb/in^2 of air pressure for 10 minutes. Air pressure reduces bubble size and makes the resin denser.

7.174.5. **Finishing and Polishing the Repair.** Use conventional finishing and polishing procedures to blend the repaired area to the existing denture base (Figure 7.140-K).

Section 7AH—Acrylic Denture Base Repair

7.175. Causes of Denture Breakage. Very often an already existing weakness or fault in the prosthesis causes the breakage of the denture itself; and, unless this fault is remedied at the time of the repair, it may soon break again from the same cause.

7.175.1. The dentist must make every effort to see that causes such as faulty occlusion, poor fit due to mouth changes, or careless handling by the patient are corrected before proceeding with the repair.

7.175.2. Before the introduction of the self-curing resins, most acrylic resin repairs were done by flasking. This frequently resulted in warpage of the denture base caused by a release of strains in the original resin at curing temperature. The self-curing acrylic resins eliminate this hazard and are recommended for virtually all repair procedures.

7.176. Conditions for Success in any Repair Procedure. For a denture base repair to have a chance to be successful, the parts must be perfectly clean, assembled with total accuracy, and kept absolutely immobile while the repair resin cures.

7.177. Types of Denture Base Fractures:

7.177.1. **Simple.** In this type of fracture, the denture has usually been broken into pieces, and there is absolutely no doubt about how the pieces fit together. The patient's presence and clinical cooperation are not necessary. (See paragraph 7.178 for repair procedures.)

7.177.2. **Complex.** In this type of fracture, the pieces cannot be made to fit against one another in precise relationships, and sometimes one or more fragments have been lost (for example, loss of a flange). The pieces can be realigned or new resin added only if the dentist assists in the reconstruction and the patient is present. (See paragraph 7.179 for repair procedures.)

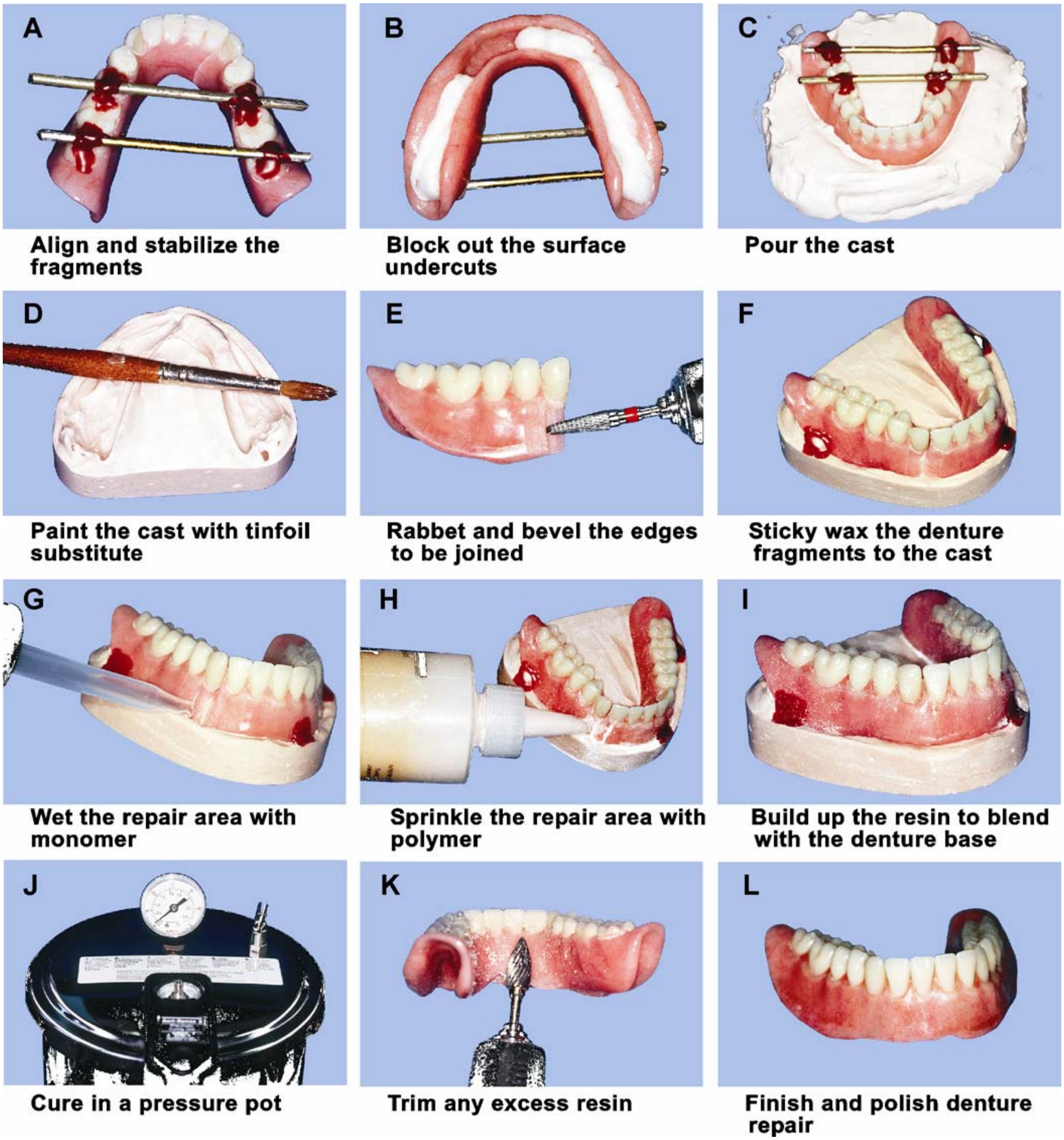
7.178. Repair Procedures for Simple Denture Base Fractures:

7.178.1. Assemble the parts of the denture. Apply sticky wax to the fracture line to maintain the pieces in correct apposition. It is a definite advantage to have a helper when joining the pieces.

7.178.2. Attach two or more old burs or pieces of coat hangar wire across the fracture line of the denture to reinforce the denture until the matrix is made (Figure 7.141-A). Do not use wooden sticks, as wood tends to warp.

7.178.3. Block out all tissue surface areas outside the repair area with wet tissue or other suitable material (Figure 7.141-B). Pour a cast of the denture to include generous areas on either side of the fracture line and on all denture borders (Figure 7.141-C). After the stone sets, remove the denture from the cast and trim the borders.

Figure 7.141. Denture Base Fracture Repair (Sprinkle-On Method).



7.178.4. Prepare the cast. Soak the cast in SDS to remove the air. Blow off the excess moisture. Apply a tinfoil substitute to the cast at least 8 mm beyond the denture fracture line in all directions (Figure 7.141-D). Allow the tinfoil substitute to dry.

7.178.5. Rabbet and bevel the edges of the fracture line on the pieces to be joined to increase the amount of bonding area between the old and new acrylic resin (Figure 7.141-E).

7.178.6. Rabbet along the edge of each fragment. Cut a rabbet channel 3 to 4 mm wide and halfway through to the tissue surface of the denture. (The total width of the groove on the polished side of the denture should equal 6 to 8 mm.)

7.178.7. Bevel along the edge of each fragment. Straighten and smooth the edges of the fragments with an arbor band. Bevel the fracture line so there is 2 mm of space on the tissue side and 3 mm of space on the polished surface side.

7.178.8. Replace the denture fragments on the cast in perfect alignment. Tack the fragments down with sticky wax (Figure 7.141-F).

7.178.9. Add the repair resin, using either the dough method or the sprinkle method. Use autopolymerizing resin with both systems.

7.178.9.1. **Dough Method:**

7.178.9.1.1. When using the dough method, first soak tissue paper in warm water to form a soft pulp. Pack the pulp into the preparation and contour it to the desired shape. Prepare lingual and facial matrices that cover the tissue. (Before making the matrices, paint a separating medium onto the cast surfaces that come in contact with fluid plaster.)

7.178.9.1.2. Remove the hardened matrices and wet tissue from the cast. Paint each matrix with tinfoil substitute. Mix self-curing resin according to the manufacturer's directions and let it reach packing consistency.

7.178.9.1.3. Lightly moisten the repair area with monomer and press the doughy acrylic resin into the repair area. Put the matrices in place and hold with a rubber band. Place the assembly in a pressure pot and cure according to manufacturer's directions.

7.178.9.2. **Sprinkle Method.** To use the sprinkle method, start by moistening the repair site with self-curing resin monomer (Figure 7.141-G). Sprinkle a layer of polymer over the desired area (Figure 7.141-H). Apply the monomer and polymer alternately until the material is built up to overfill the preparation slightly. (Overbuilding allows the finishing procedures after the resin cures.) Let the buildup stand for a few minutes until the sheen disappears from the surface (Figure 7.141-I). Place the assembly in a pressure pot.

7.178.10. Let the resin cure in a pressure pot according to the manufacturer's directions (Figure 7.141-J). Immersion of the repair in water retards monomer evaporation; warm water speeds up resin polymerization. In the absence of directions, hold water at about 110 ^{o}F in the pot at a depth deep enough to cover the repair. Secure the lid to the pot and apply a minimum 15lb/in^2 of air pressure for 10 minutes. Air pressure reduces bubble size and makes the resin denser.

7.178.11. Recover the repair and finishing. Release the pressure from the pot. Carefully remove the repaired denture from the cast. Trim the new material so it is even with the old acrylic resin (Figure 7.141-K). Assuming it already has the proper thickness, trim the old material no more than is necessary. Finish and polish the denture in the usual manner (Figure 7.141-L).

7.179. Repair Procedure for Complex Denture Base Fractures. In this type of repair, the most likely problem is that a piece of the denture is missing and must be replaced. Patients routinely fracture a denture flange and lose the fragment. The dentist will use a material-like modeling plastic, add it to the denture's fracture line, place the denture in the patient's mouth, and shape a new section for the lost piece of the denture. The technician will receive a denture with a replacement area made from modeling plastic. The modeling plastic will be converted into resin, using the following sequence:

7.179.1. Use wet paper towels or wet tissue to pack undercut areas not involved in the repair. Pour a cast that includes all denture borders and the tissue surface of the modeling plastic section, plus an additional 8 mm of denture tissue surface.

7.179.2. After the stone is set, remove the denture from the cast. Cut the modeling plastic away from the denture and bevel the denture's broken margin. Paint tinfoil substitute onto the cast to take in all of the repair area and 8 mm beyond.

7.179.3. Replace the denture on the cast and tack it down with sticky wax.

7.179.4. Repair the denture by the dough or sprinkle method.

7.179.5. Finish and polish the denture.

Section 7AI—Relining a Complete Denture

7.180. Resurfacing the Tissue Side of a Denture:

7.180.1. A *reline* is the resurfacing of the tissue side of a denture, using new base material to make the denture fit more accurately.

7.180.2. The reline can represent a solution to two problems, and one or both problems can exist at the same time. The first problem is a denture that is unstable on the residual ridge. The second problem is that a patient's occlusal vertical dimension is showing progressive overclosure because of generalized denture tooth wear or ridge resorption.

7.180.3. There are a number of acceptable ways to perform a reline. Two methods are described in this chapter; the jig method (paragraph 7.182) and the flask method (paragraph 7.183).

7.181. Clinical Procedures. In the clinical part of the reline procedure, the dentist must first modify the denture by grinding out tissue surface undercuts and uniformly reducing the flanges about 2 mm. Using the denture as a custom tray, the dentist will make a new impression on the arch. The patient will hold the teeth in centric occlusion and the mandible in centric relation while the impression material is setting. This combined denture impression-jaw relationship record will be delivered to the dental laboratory (Figure 7.142-B).

7.182. Jig Method. The following procedures are included in the jig method:

7.182.1. **Cast Fabrication.** Box and pour the impression. Use equal parts plaster and pumice to box elastic impression materials. Use conventional wax beading and boxing for zinc oxide-eugenol impressions (Figure 7.142-C). After the cast is poured, trim it (Figure 7.142-D) and cut index notches in the base (Figure 7.142-E). Do not remove the denture from the cast at this time.

7.182.2. **Mounting the Assembly in the Jig (Mandibular Denture):**

7.182.2.1. Start by shaping a dental stone patty on the bottom half of the jig. Gently press the occlusal surfaces and incisal edges into the mix. Do not sink the denture past the greatest diameters of the teeth. Get a decent imprint of occlusal surfaces and incisal edges. After the stone sets, it should be possible to pull the denture out of the tooth indentations without difficulty.

7.182.2.2. Assemble the jig. Tighten the locknuts and make certain the shoulders of the upper half fit flush on the posts in metal-to-metal contact. Make sure the denture teeth are perfectly seated in the index and tack the teeth to the dental stone with sticky wax.

7.182.2.3. Remove the upper half of the jig to attach the cast to the jig. Apply dental stone to the base of the cast being sure to fill the index notches. Replace the upper half of the jig and tighten the locknuts. Make certain the upper half jig is making metal to metal contact with the posts and the undercut hole in the upper half is filled in completely.

Figure 7.142. Jig Relining of a Maxillary Complete Denture.

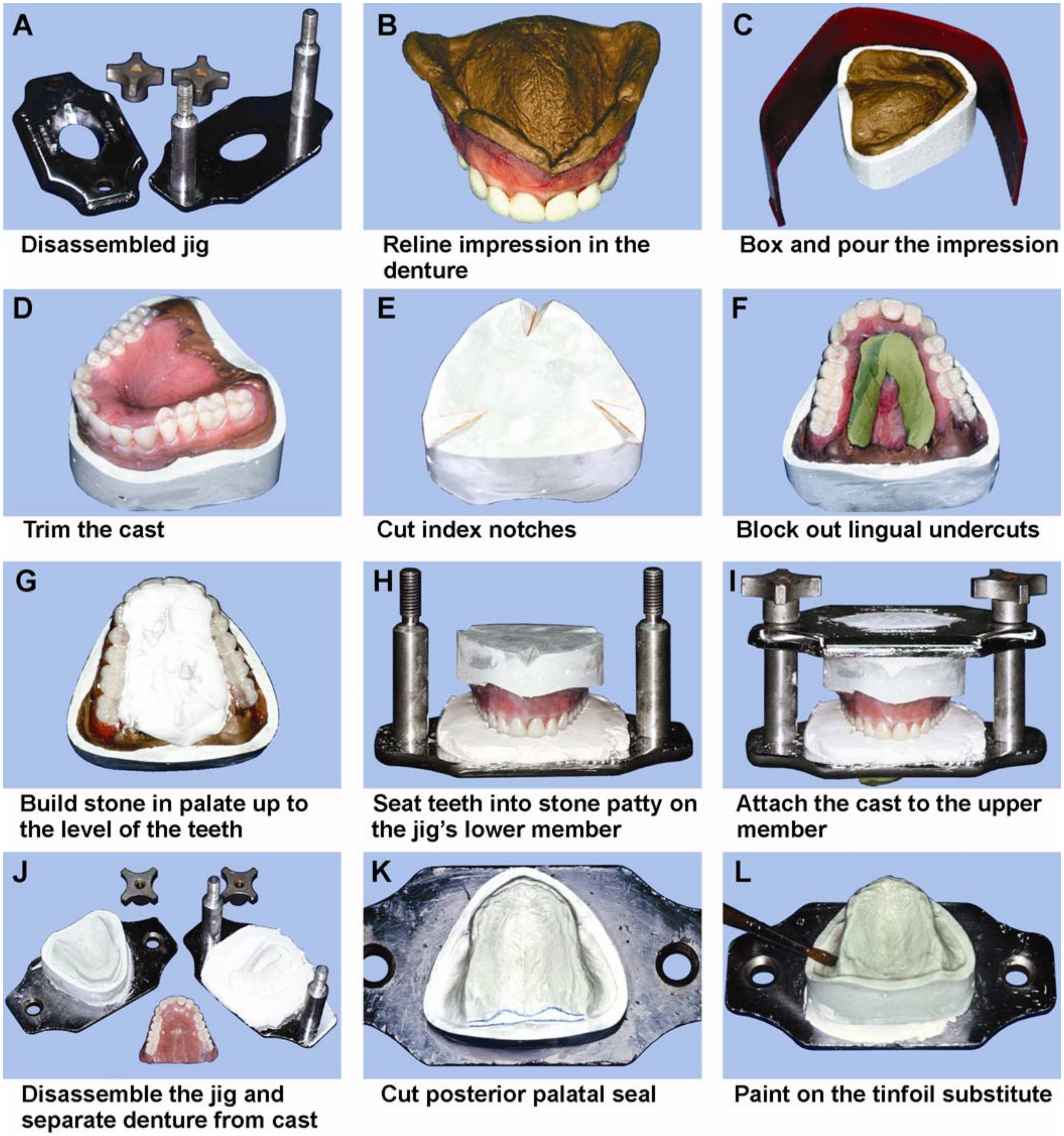
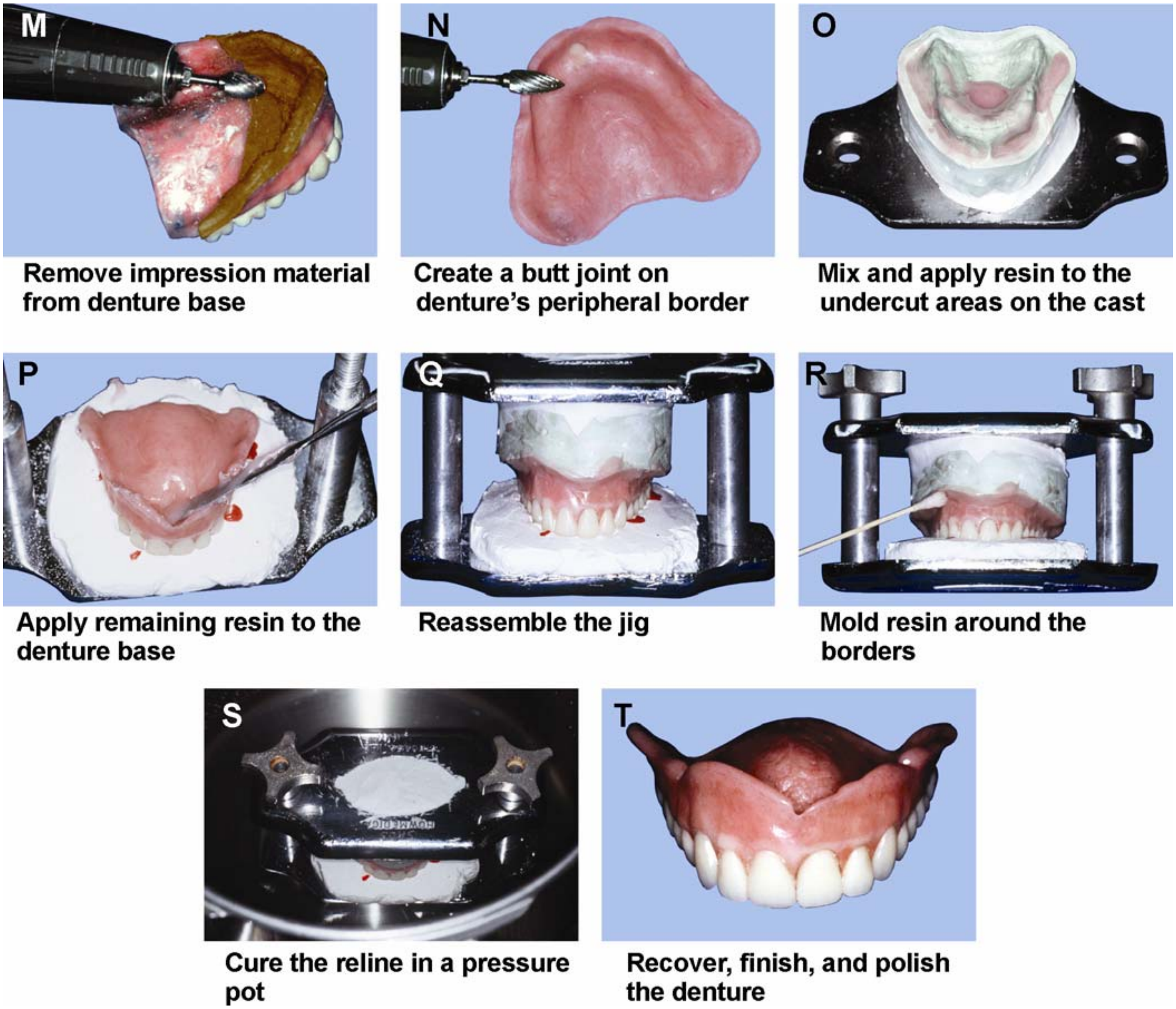


Figure 7.142. Continued.



7.182.3. **Mounting the Assembly in the Jig (Maxillary Denture):**

7.182.3.1. A maxillary denture uses a slightly different treatment. Make sure the vault of the denture is supported against forces generated during the packing phase of the reline procedure. Block out all undercuts on the linguogingival surfaces of the teeth and the palatal surface of the denture using a color of material that contrasts against white and pink (Figure 7.142-F).

7.182.3.2. Form a dental stone mound on the bottom half of the jig. Fill the palatal vault of the denture with stone up to the level of the teeth (Figure 7.142-G). Center the denture on the patty without burying the facial surfaces of the teeth (Figure7.142-H).

7.182.3.3. After the stone sets, take the denture off the index and remove every trace of blockout wax. Seat the denture back in the index and sticky-wax it down. Attach the cast to the upper half of the jig in the same manner described for the mandibular denture (Figure 7.142-I).

7.182.4. **Preparing the Cast:**

7.182.4.1. Remove the locknuts and lift the denture from the occlusal index. Carefully separate the denture from the cast (Figure 7.142-J). Do not break the denture or the cast. The retromylohyoid area of a mandibular denture's lingual flange has the most potential for being severely undercut. If the mandibular denture cannot be removed from its cast because of such an undercut, cut off the specific part of the lingual flange. When removing an undercut flange, the cut extends through the plastic to the impression material. Be careful not to cut into the cast.

7.182.4.2. When dealing with a maxillary denture, ask the dentist to cut the posterior palatal seal (Figure 7.142-K).

7.182.4.3. Soak the cast in lukewarm SDS for 5 minutes. Flush the cast with hot water.

7.182.4.4. Paint the cast with a tinfoil substitute and let it cool (Figure 7.142-L).

7.182.5. **Preparing the Denture:**

7.182.5.1. Grind out the impression material from the denture (Figure 7.142-M).

7.182.5.2. If the dentist hasn't already done it, relieve all undercuts on the tissue surface of the denture and create a butt joint at the flange borders (Figure 7.142-N).

7.182.5.3. Uniformly roughen the entire tissue surface of the denture. This helps improve the bond between the denture base and the new resin.

7.182.6. **Mixing and Applying the Resin:**

7.182.6.1. Use a ratio of two parts self-curing resin powder to one part liquid. The fluid consistency this ratio produces is essential for minimum entrapment of air and good bonding with the denture base material.

7.182.6.2. Put the liquid in a glass jar and slowly add the powder. Swirl the jar until the powder is saturated. Use a spatula to spread the resin around the buccal and labial sulci of the cast. Be sure to fill all undercuts with resin (Figure 7.142-O). Push the resin ahead of the spatula, being careful not to trap the air.

7.182.6.3. So far, the tissue surface of the denture base has been roughened to improve the bond between the new resin and the denture base. To enhance that bond even further, paint the tissue surface of the denture with monomer. Then spread the remainder of the fluid resin onto the tissue side of the denture (Figure 7.142-P).

7.182.7. **Packing the Denture:** (***NOTE:*** Always wear disposable gloves when handling acrylic resin.)

7.182.7.1. First, allow the remaining resin to gel until it no longer runs freely. Place the denture into the tooth index on the bottom half of the jig (Figure 7.142-Q). Attach the top plate of the jig with thumbnuts and close it just short (about 2 mm) of the metal-to-metal contact. Use a moistened-gloved finger or cotton tip applicator to push the resin back between the denture and the cast (Figure 7.142-R).

7.182.7.2. Wait until the resin is doughy and firm. Premature jig closure could result in a porous reline. Tighten the thumbnuts, alternating sides, until there is metal-to-metal contact between the top plate and the shoulders of the posts. Metal-to-metal contact *must* be achieved.

7.182.8. **Curing the Denture.** Cure the denture in a pressure pot with lukewarm water (110 ^{o}F). Apply a minimum of 15 lb/in^2 for at least 10 minutes (Figure 7.142-S).

7.182.9. **Finishing and Polishing the Denture.** Finish and polish the relined denture using procedures for complete dentures (Figure 7.142-T).

7.183. Flask Method:

7.183.1. **Cast Fabrication.** Box and pour the denture containing the impression in artificial stone in the same manner as the jig method, except no index notches are required. Flask the denture the same way as in complete denture techniques (paragraph 7.104).

7.183.2. **Separating the Flask Halves.** To soften the impression material, place the flask in boiling water for 4 minutes. Remove the flask from the water and open the flask.

7.183.3. **Preparing the Cast.** Flush the debris from the cast and let the flask halves cool down. Give the cast to the dentist for placement of the posterior palatal seal. On return, paint tinf oil substitute onto the cast surface and let it dry.

7.183.4. **Preparing the Denture.** Grind out all remaining impression material and uniformly roughen the tissue surface of the denture with an acrylic bur.

7.183.5. **Packing and Curing.** Use self-curing resin as the reline material; with its use, there is less danger of warping the denture base. *Be sure the mold is cold before packing.* Mix the acrylic resin according to the manufacturer's instructions. Moisten the tissue side of the denture base with monomer and place the new resin in the mold. There is a relatively short working time with self-curing resins, so work efficiently to ensure at least one trial pack. Bench cure the resin in the flask press for 1 hour.

7.183.6. **Deflasking, Finishing, and Polishing.** Use the commonly accepted procedures for complete dentures.

Section 7AJ—Rebasing (Duplicating) a Denture Base

7.184. What is Rebasing? Rebasing a denture involves refitting the denture using a corrective impression (as in a reline) and replacing all the denture base material with new acrylic resin. It can be done for those dentures whose base material is discolored after being used for years or for dentures that have been repaired several times.

7.184.1. Rebasing is not done frequently because acrylic teeth in most old dentures show advanced wear and are not serviceable. However, rebasing an old denture is a great deal quicker than making a new one. Rebasing is the treatment of choice when the time factor is important or when the teeth are in good condition. A rebased denture serves as the perfect temporary prosthesis while a new denture is being made.

7.184.2. Because the denture base material is completely removed in rebasing, there must be a means of maintaining the relationship of the teeth to each other and to the ridge while the denture teeth are without support. Articulators were extensively used for this purpose, but their parts occasionally move or bend. The best option is to use a rigid relining jig. The procedures associated with using the reline jig are in paragraph 7.185.

7.185. Procedures for Using a Reline Jig:

7.185.1. **Cast Fabrication.** After the dentist makes the impression as described for a reline (paragraph 7.181), box and pour the impression. After the artificial stone has set, trim the cast and index the base. Replace the missing or broken teeth and wax them in position.

7.185.2. **Mounting the Assembly in the Jig.** Follow the procedures outlined in paragraphs 7.182.2 and 7.182.3.

7.185.3. **Recovering the Denture Teeth.** Remove the denture from the cast and then separate the teeth from the denture base as follows:

7.185.3.1. **Removing Porcelain Teeth.** Heat the teeth and adjacent acrylic resin slowly with an alcohol torch. (Rapid heating will cause the teeth to crack.) To distribute the heat more evenly, apply a thin film of petroleum jelly on the teeth. When the acrylic resin turns white, remove each denture tooth by prying it loose with an instrument. Clean and place each tooth in its proper position in the stone index. Apply small amounts of baseplate wax to the lingual aspect of each denture tooth to join them together as a unit.

7.185.3.2. **Removing Plastic Teeth.** If the denture teeth are made of acrylic resin, do not use heat to remove the base. Separate acrylic resin denture teeth from the old denture base in three sections; anterior, right posterior, and left posterior. Use discs, burs, and abrasive wheels to perform the separation. Remove all denture base material except a small amount on the ridgelaps of the denture teeth. Place the segments back in the index.

7.185.4. **Reconstructing the Denture Base in Wax.** Place a softened roll of baseplate wax on the teeth. Use enough wax so it presses down around the teeth and up around the ridge of the cast. Make alternating turns on the thumbscrews and close the top plate of the jig down until it makes contact with the shoulders of the posts. Seal the baseplate wax to the teeth and the cast. Wax and contour a denture base in the usual manner. When the wax cools completely, open the jig and complete the denture base wax-up in the conventional manner.

7.185.5. **Flasking, Boilout, and Packing the Denture.** Procedures for this are the same as those for making a new complete denture. If minimum time to denture delivery is very important, use compression-molded, self-curing resin for the denture base or use the pour acrylic resin method of denture base processing.

7.185.6. **Recovering, Finishing, and Polishing the Denture.** Recover the denture from the cast. Finish and polish the denture base. ***NOTE:*** If minor occlusal discrepancies are serious enough when the dentist checks the denture in the patient's mouth, the dentist will initiate the denture remount procedures.

Section 7AK—Duplicate Dentures (Dental Flask Method)

7.186. Overview. There may be occasions when a *duplicate* of a complete denture must be made. This duplicate denture is a spare denture for the patient whose original denture is either lost or may need repair. Duplicate dentures made completely of self-curing acrylic resin can be constructed quickly and accurately.

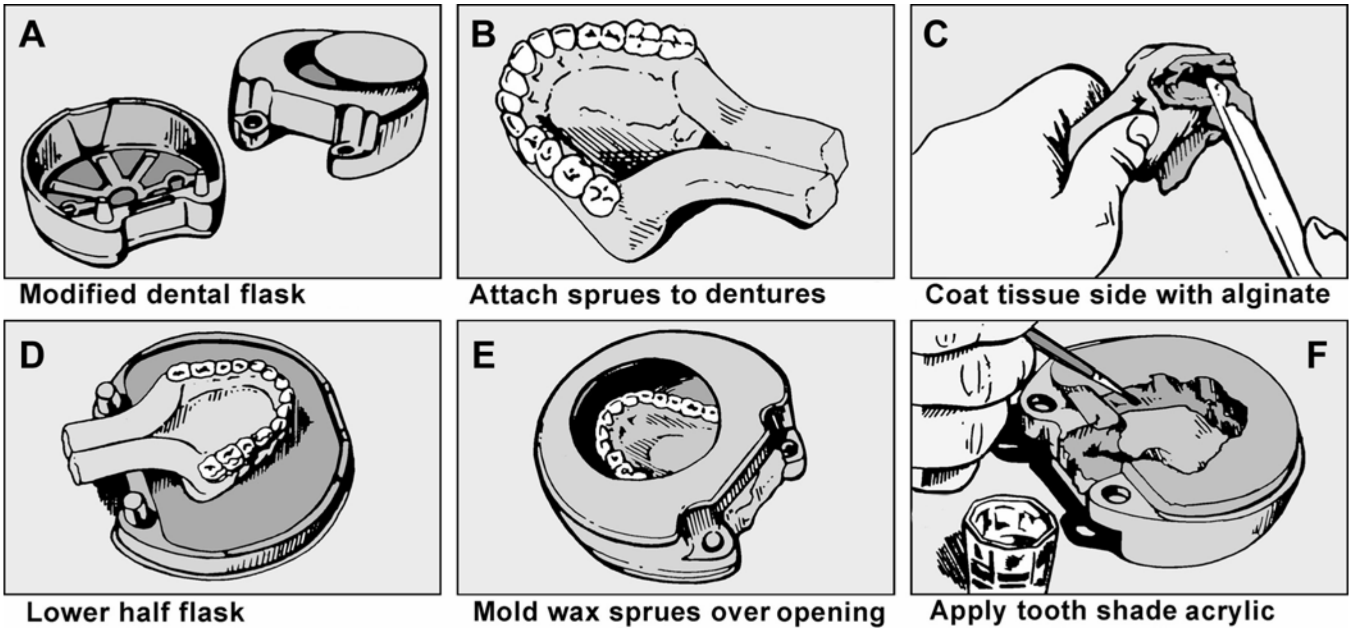
7.187. Equipment and Materials. The denture flask method uses the following equipment and materials, which are all readily available in the dental laboratory: mandibular denture flask, alginate impression material, utility wax or orthodontic tray wax, tooth-colored acrylic polymer, and reline or repair self-curing acrylic (monomer and polymer).

7.188. Procedures:

7.188.1. **Modifying the Denture Flask.** Cut a large rectangular opening in the rear part of the lower-half flask. In Figure 7.143-A, notice that the flask is shown upside down and the knock out plate is removed. From this point on, the flask parts are referred to in this upside down relationship, not by their customary names.

7.188.2. **Spruing the Denture.** Sprue the denture by rolling strips of utility wax together to form sprues about 3 inches long and 1/2 inch in diameter. Attach the sprues to the lingual surface of mandibular dentures and to the palatal surface of the tuberosity area of maxillary dentures (Figure 7.143-B). Draw the ends of the sprues together so they meet in the center.

Figure 7.143. Duplicate Dentures (Denture Flask Method).



7.188.3. **Preparing the Flask.** Apply alginate adhesive to the inside of the flask. This adhesive retains the alginate in the flask during later processing steps. Also, coat the lip of the knockout plate so it can be firmly attached to the *exterior* of the flask.

7.188.4. **Lower-Half Flasking the Denture.** Mix the alginate for the lower half using a mechanical spatulator. (Vacuum-mixing is preferred over hand-mixing). Coat the tissue surface of the denture with alginate, being careful to minimize voids (Figure 7.143-C). Fill the interior of the denture with alginate. Place the remaining mix of alginate in the lower flask. Settle the denture in the alginate-filled flask and make sure the denture borders are covered (Figure 7.143-D). Let it set 15 minutes.

7.188.5. **Full Flasking the Denture.** Assemble the upper half of the flask and make sure the sprues extend through the opening. Mold the sprue wax extensions over the opening to create a leak-proof seal (Figure 7.143-E). Make a larger mix of alginate for the upper half. Coat the teeth with alginate and then pour alginate through the knock out plate opening. Let the alginate set for 15 minutes before removing the denture.

7.188.6. **Preparing the Mold.** Carefully separate the flask and remove the denture. Use a gentle stream of air or absorbent tissue to remove moisture from the tooth imprints.

7.188.7. **Processing the Resin:**

7.188.7.1. Use the brush technique described in paragraph 7.125.3.5 to place tooth-colored resin into the tooth imprints (Figure 7.143-F). (Use an incisal shade and gingival tooth shade acrylic to make the dentures look more authentic.) Fill the imprints to the cervical line, but do not overfill them. Allow the resin to set for a few minutes before reassembling the flask.

7.188.7.2. Carefully dry the alginate surface in the lower flask. Place the flask halves together and secure them with a heavy rubber band. Mix the reline or repair acrylic using 2 parts polymer to 1 part monomer ratio. If a pour-type resin (for example, Pronto® or Tru-Pour®) is available, use it instead of the repair material.

7.188.7.3. Pour the resin mix into one sprue hole until it fills the other sprue. Use a vibrator to best accomplish this procedure. Attach two mounds of clay to the front of the flask so it stands upright. Half-fill a pressure pot with warm water (110 °F) and place the flask in it. Cure the denture at a minimum of 15 lb/in^2 for 10 minutes.

7.188.8. **Recovering, Finishing, and Polishing the Denture.** Recover the duplicate denture, desprue it, and finish and polish it in a normal manner. Be more careful of these (duplicate) teeth because they are softer than the standard denture teeth.

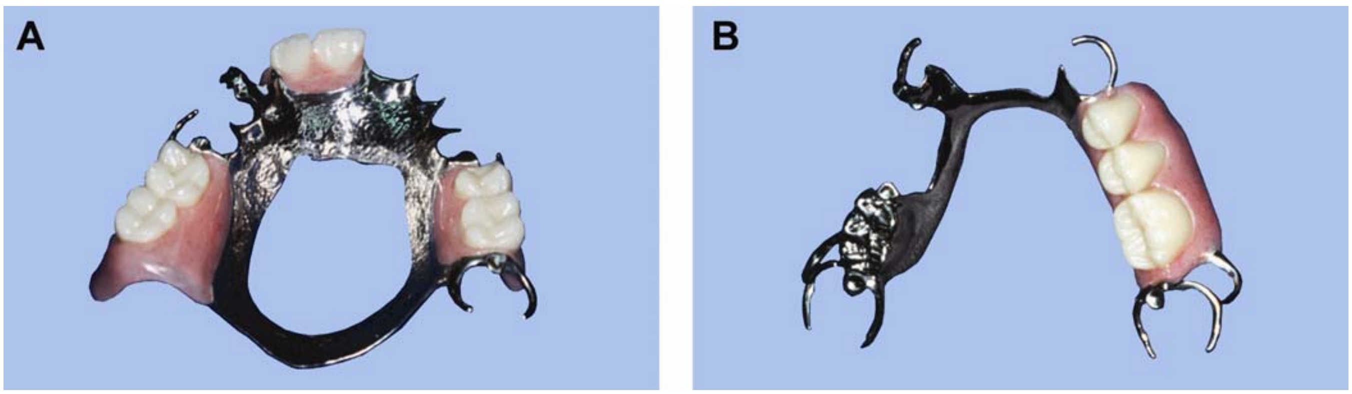
Chapter 8

CLASP-RETAINED REMOVABLE PARTIAL DENTURES (RPD)

Section 8A—Classifications

8.1. Definition of an RPD. An RPD is a removable replacement for missing natural teeth, gingival tissue, and supporting bone when one or more natural teeth still remain (Figure 8.1).

Figure 8.1. Maxillary and Mandibular RPDs.



8.2. Purpose of an RPD. An RPD's purpose is to restore a patient's appearance and chewing ability without damaging the natural teeth and supporting tissues.

8.3. RPD Categories:

8.3.1. **Cast Metal Framework RPD to Which Denture Plastic and Artificial Teeth are Attached.** The military dental laboratories use a nickel chrome-alloy, Ticonium® metal for RPD framework castings. Vitallium®, a chrome-cobalt alloy, is available for those with an allergy to nickel. Type IV gold might be used for a case that has special requirements.

8.3.2. **All-Metal RPD.** The entire RPD (frame, denture base, and teeth) is made from cast metal.

8.3.3. **Interim or Transitional Acrylic RPD.** *Most or all* of the RPD is made with acrylic and plastic denture teeth. This is called an "interim" RPD and is intended to be temporary in nature. Often, wrought wire clasps are added to the acrylic body of an interim RPD to help retain it in the mouth.

8.4. Structural Requirements. If an RPD is to serve its stated purpose, it must be:

8.4.1. **Retained.** It must stay in place in the mouth.

8.4.2. **Supported.** The various RPD parts must not damage the tissues they might cover within a mouth.

8.4.3. **Braced.** Shifting movements of the RPD from front to back or from side to side should be restricted as much as possible. To a large extent, RPDs are retained, supported, and braced by remaining natural teeth. (An abutment tooth is a natural tooth specifically used for RPD retention, bracing, or support.)

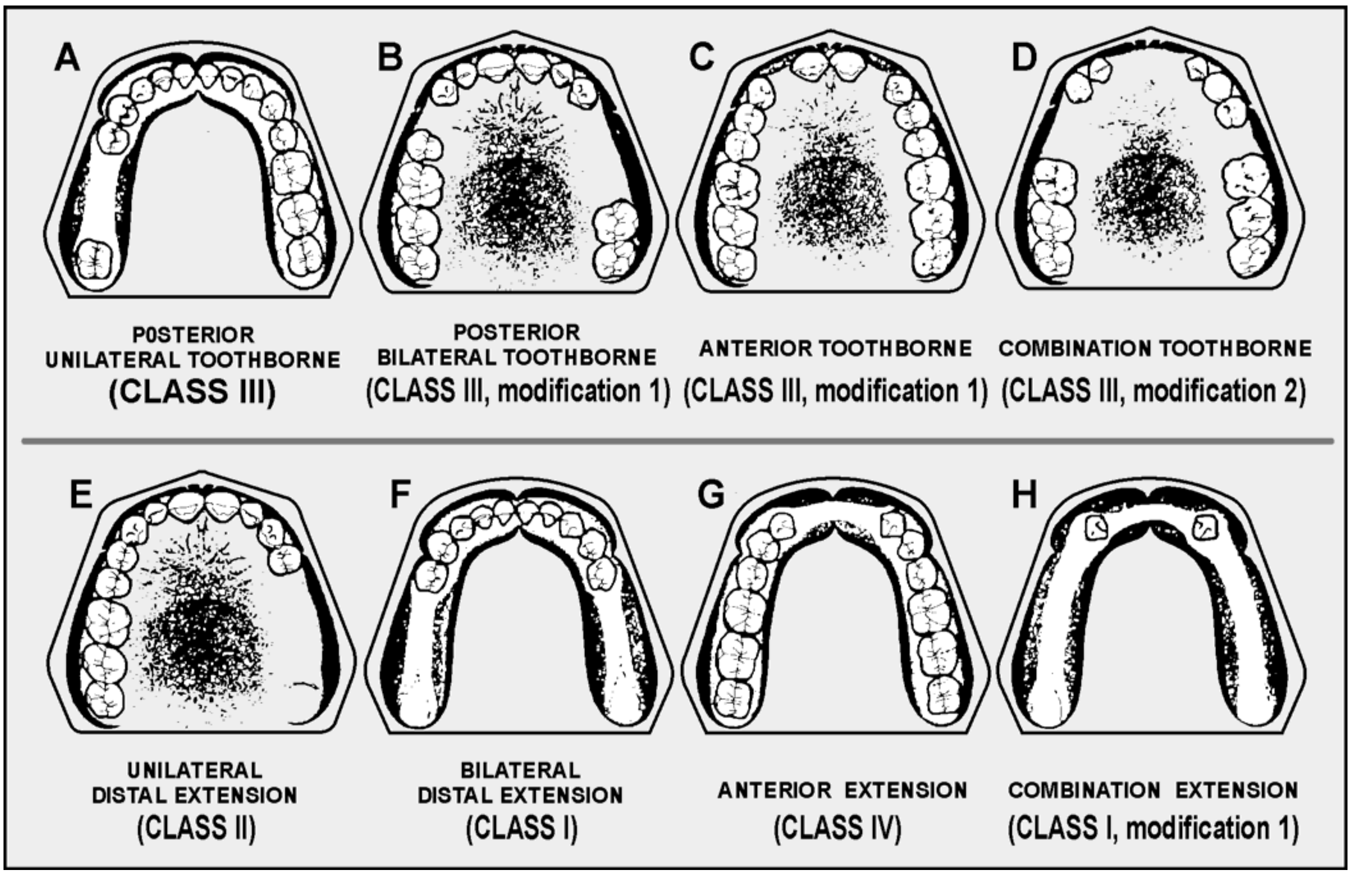
8.5. RPD Classifications Based on Patterns of Tooth Loss:

8.5.1. There are over 50,000 possible combinations of teeth and edentulous spaces in a single arch. Several methods of classifying partially edentulous arches are in use today. Two methods are presented in this chapter—the Word Picture classification (paragraph 8.6) and the Kennedy classification (paragraph 8.7).

8.5.2. All of the survey and design instruction in this chapter is keyed to the Word Picture classification. The Kennedy system, with its modifications, is the very elaborate classification taught in most dental schools. Although it has a high recognition factor among dentists, it is difficult to apply general survey and design rules to all of the subgroups in the Kennedy system. Thus, using the Word Picture classification is the simpler option.

8.6. Word Picture Method. This classification is practical and simple to remember. It recognizes eight basic patterns of tooth loss (Figure 8.2). An RPD is classified according to the pattern of loss it most closely resembles. For example, an RPD made to restore a posterior unilateral toothborne pattern of loss becomes a posterior unilateral toothborne RPD. The basic classifications (pattern of loss) are as follows:

Figure 8.2. Word Picture and Kennedy RPD Classifications.



8.6.1. **Toothborne RPDs.** These RPDs are supported entirely by the remaining natural teeth.

8.6.1.1. **Posterior Toothborne.** No anterior teeth are missing, and the defect is limited to the posterior area are as follows:

8.6.1.1.1. **Posterior Unilateral Toothborne.** This is characterized by unilateral posterior edentulous space (or spaces) with both anterior and posterior natural teeth remaining mesial and distal to the edentulous space (or spaces) (Figure 8.2-A).

8.6.1.1.2. **Posterior Bilateral Toothborne.** This is characterized by bilateral posterior edentulous spaces with natural teeth both anterior (mesial) and posterior (distal) to the spaces (Figure 8.2-B).

8.6.1.2. **Anterior Toothborne.** Anterior defect is present, and no posterior teeth are missing (Figure 8.2-C). The residual ridge and the teeth adjacent to it fall on a relatively straight line. More than one edentulous space might be present, but the largest space does not span more than two adjacent missing teeth.

8.6.1.3. **Combination Toothborne.** This is a mixture of anterior and posterior toothborne situations (Figure 8.2-D).

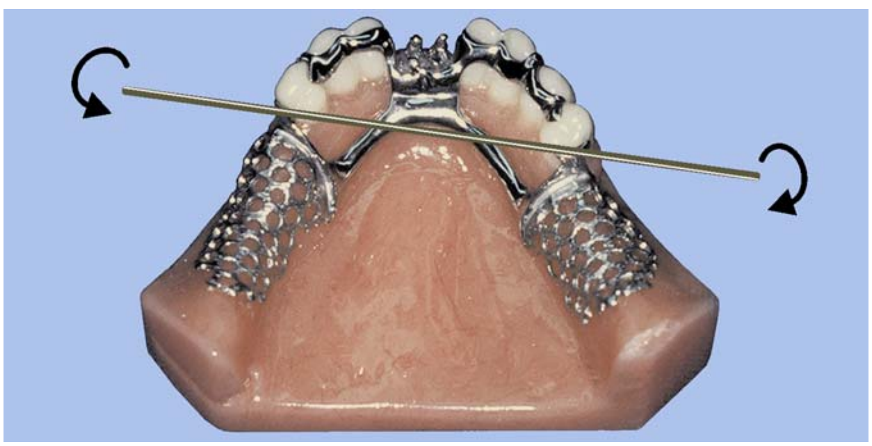
8.6.2. **Extension RPDs.** These RPDs are supported by the remaining natural teeth and the tissues of the residual ridges. All extension RPDs have an axis of rotation that runs through or near the rest nearest the extension base (Figure 8.3). The rotation occurs because the tissue beneath the extension base will compress much more than the teeth when the partial denture is used for chewing. Classifications include:

8.6.2.1. **Distal Extension.** This is the edentulous area is located posterior to the remaining natural teeth.

8.6.2.1.1. **Unilateral Distal Extension.** The distal extension defect is present on one side of the arch (Figure 8.2-E).

8.6.2.1.2. **Bilateral Distal Extension.** The distal extension problem is present on both sides of the arch (Figure 8.2-F).

Figure 8.3. Axis of Rotation for an Extension RPD.



8.6.2.2. **Anterior Extension.** This is a single edentulous area that *crosses* the midline. It is located anterior to the remaining natural teeth (Figure 8.2-G). The residual ridge and the teeth adjacent to it fall on a curved line. To be placed in this category, most patients will have three or more adjacent anterior teeth missing. The anterior extension defect can, and often does, include missing posterior teeth.

8.6.2.3. **Combination Extension.** This is a mixture of anterior and distal extension situations (Figure 8.2-H). ***NOTE:*** When a case shows a mixture of extension and toothborne defects, the case is classified according to the kind of extension situation it represents. (Extension defects are considered more serious than toothborne problems.)

8.7. Kennedy Classification:

8.7.1. In 1925, Kennedy devised a classification that concerned itself with the missing teeth rather than the type of RPD that would replace those teeth. Kennedy did research that showed the most frequently encountered RPD was the one replacing the most posterior teeth bilaterally. He named this bilateral distal extension situation Class 1. The next most common situation found by Kennedy was the unilateral distal extension base which he called Class II. Although the most frequently prescribed RPD today is not a Class I, the original rationale Kennedy used is an excellent aid to remembering his classification system.

8.7.2. This classification system (explained below) will enable the laboratory technician to converse with the dentist, using the same terminology:

8.7.2.1. Class I—bilateral edentulous areas located posterior to the remaining natural teeth.

8.7.2.2. Class II—a unilateral edentulous area located posterior to the remaining natural teeth.

8.7.2.3. Class III—a unilateral edentulous area with natural teeth remaining both anterior and posterior to it.

8.7.2.4. Class IV—a single, but bilateral (crossing the midline), edentulous area located anterior to the remaining natural teeth. There are no modifications to this situation.

8.7.3. There are important points to remember when using the Kennedy classification. Do not include missing teeth that are not to be replaced (for example, third molars). Choose the most posterior edentulous area (or areas) to determine the classification. Call any additional edentulous areas "modification spaces."

Section 8B—RPD Components and Construction

8.8. Overview. An RPD consists of the following parts or components: connectors (paragraph 8.9), support elements (paragraph 8.10), retainers (paragraphs 8.11 - 8.13), bracing elements (paragraph 8.14), and artificial replacements for natural teeth and tissue (paragraph 8.15).

8.9. Connectors. A *connector* is a component that joins one part of the RPD to another, as follows:

8.9.1. **Major Connectors.** Almost all RPDs have a right side and a left side. A major connector joins the two sides of an RPD and distributes some of the stress from chewing on one side to structures on the opposite side. A rigid major connector must unite retentive components such as clasps; otherwise, the retentive component does not perform as intended. Major connectors are either maxillary or mandibular, as follows:

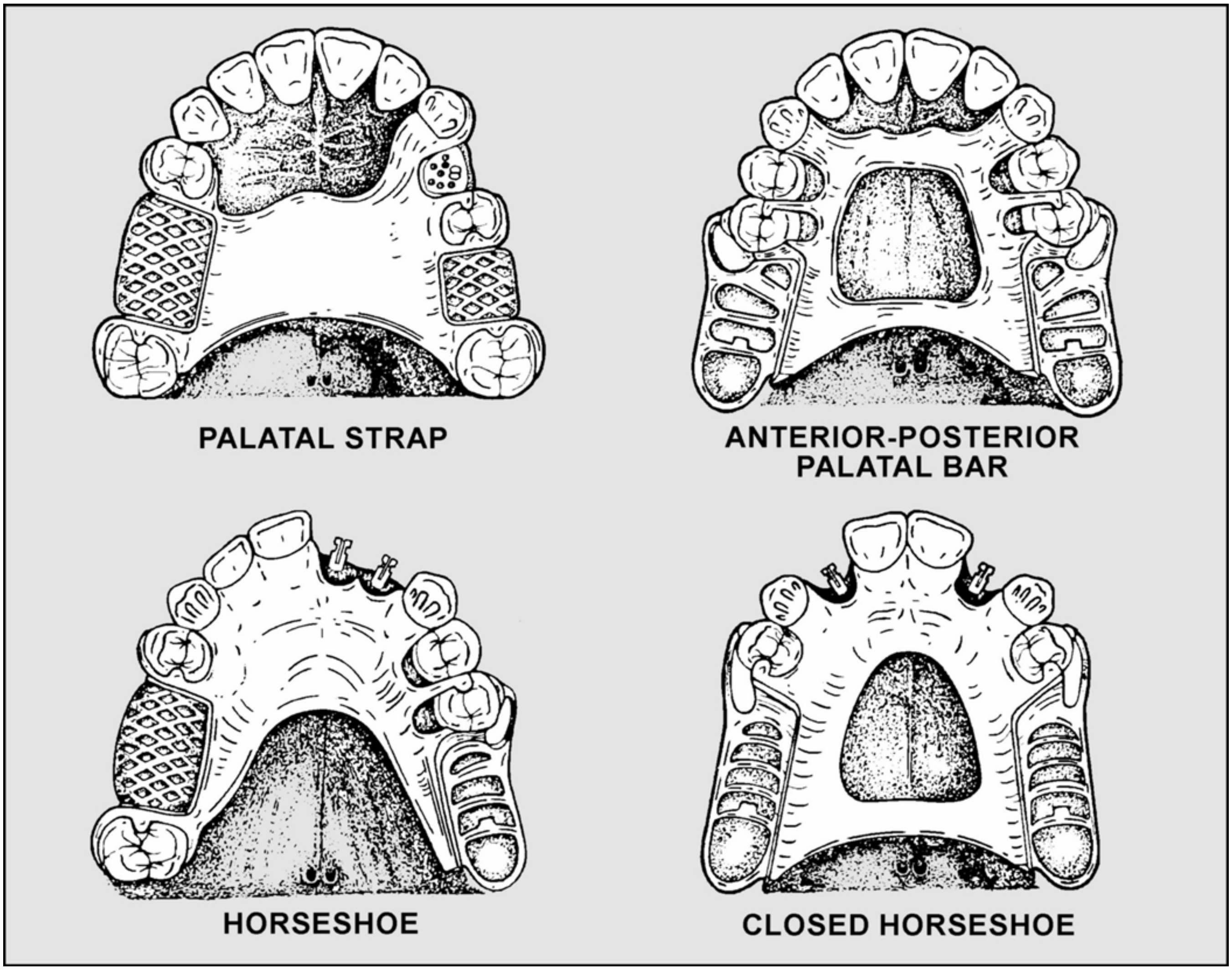
8.9.1.1. **Maxillary Major Connectors (Figures 8.4 and 8.5):**

8.9.1.1.1. **Palatal Strap.** The palatal strap major connector is a single wide strap that crosses the palate. It is most often used for simple bilateral posterior toothborne partial dentures. The strap must be 8 mm wide for adequate strength. A palatal strap should not cross over maxillary tori. Therefore, when tori are present, a palatal strap may not be possible.

8.9.1.1.2. **Palatal Bar.** Similar to a palatal strap, a palatal bar is narrower and thicker. Palatal bars are less comfortable for the patient and are rarely used.

8.9.1.1.3. **Anterior-Posterior Palatal Strap.** The anterior-posterior palatal strap is one of the most commonly used maxillary major connectors. The strap must be 6 to 8 mm wide. It is very rigid and well accepted by most patients.

Figure 8.4. Maxillary Major Connectors.



8.9.1.1.4. **Lingual Plate Design Variations.** The most important distinction between bar and strap major connectors and plate-type major connectors is the border of bar and strap major connectors is located at least 6 mm away from gingival margins, while the border of the plate major connectors ends on the lingual surface of teeth. Plating may be used to stabilize periodontally weakened teeth, reciprocate retentive clasps, and provide easy addition of replacement teeth if additional natural teeth are lost in the future. When the connector must cross the gingival margin, it must cross at a 90-degree angle. These designs are exemplified in the following connectors:

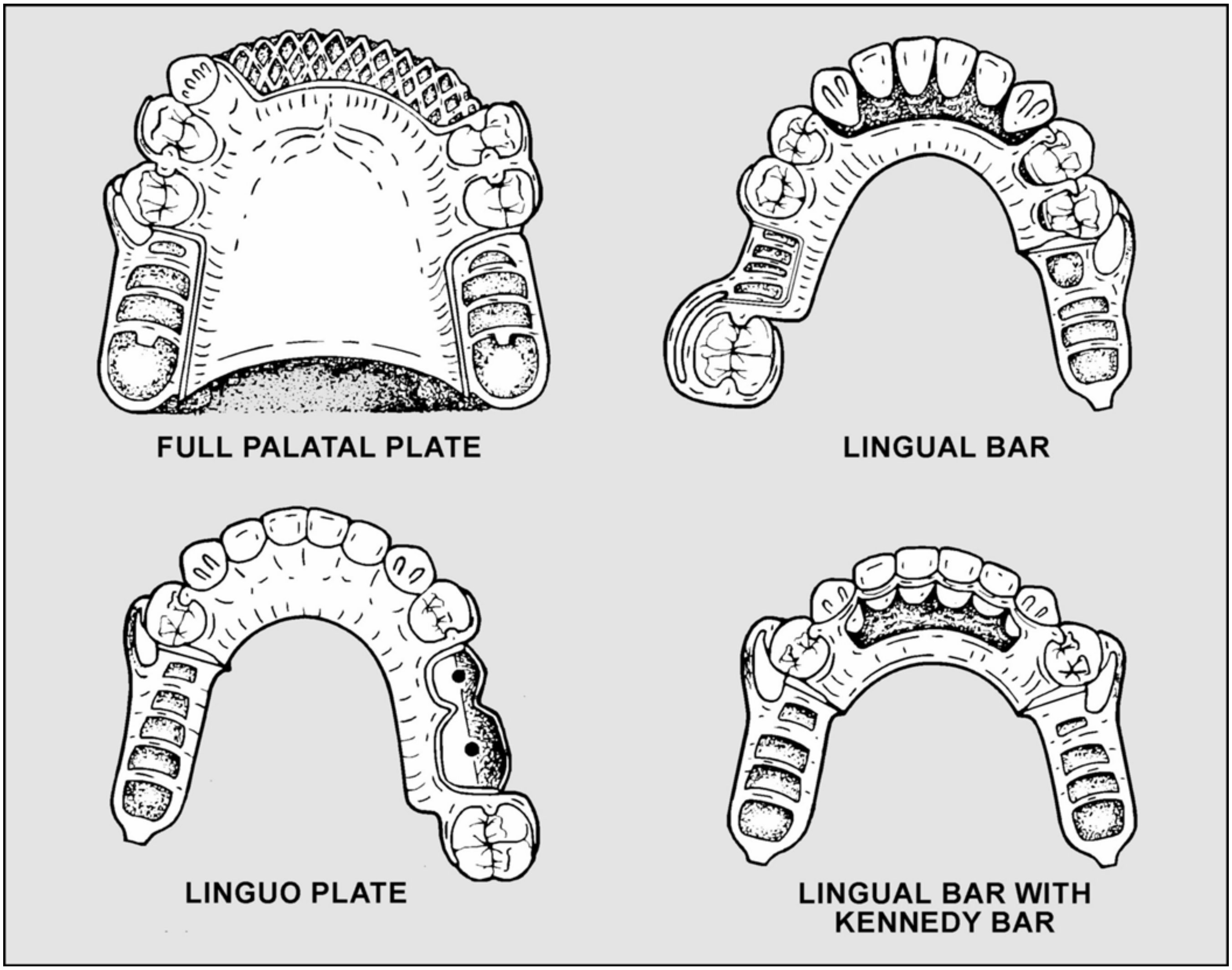
8.9.1.1.4.1. **Horseshoe.** This design is shaped like a horseshoe placed around the vault of the palate. It is less desirable than the anterior-posterior palatal strap because it is less rigid. It is normally used when the dentist is trying to avoid maxillary tori or when the palatal vault is very deep.

8.9.1.1.4.2. **Closed Horseshoe.** This connector is like a horseshoe with an added palatal strap connecting the two posterior sides. Another way to visualize this connector is as an anterior-posterior strap with lingual plating. This design is more rigid than either a horseshoe or an anterior-posterior strap.

8.9.1.1.4.3. **Full Palatal Plate.** This design is sometimes used to gain more support for the removable partial denture. The full palatal plate may be used when many teeth are missing or in combination anterior or posterior extension cases. However, many patients find the full coverage of the palate objectionable.

8.9.1.2. **Mandibular Major Connectors (Figure 8.5):**

Figure 8.5. Maxillary and Mandibular Major Connectors.



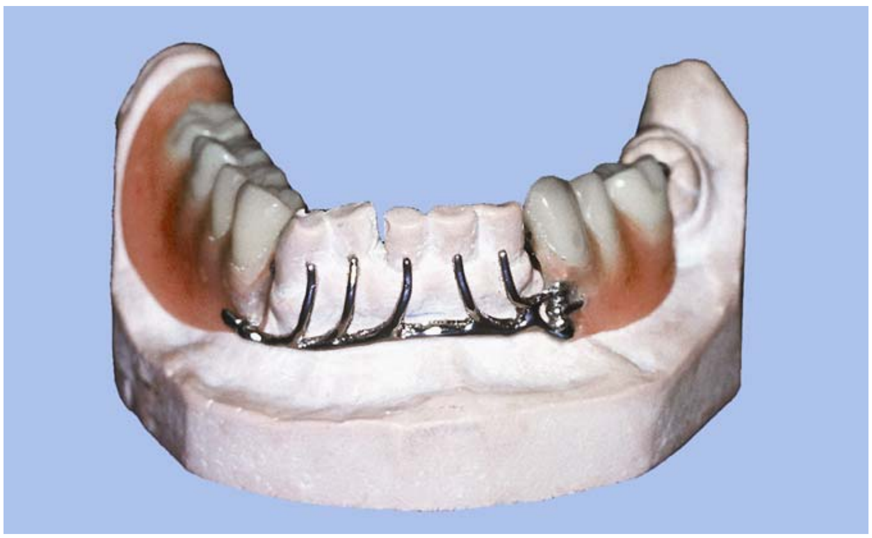
8.9.1.2.1. **Lingual Bar.** The lingual bar is the most commonly used mandibular major connector. When there is no requirement for additional indirect retention or stabilization of weakened teeth, it is the connector of choice. A lingual bar must be located a minimum of 4 mm distant from the gingival margin, must be 5 mm in width, and must not impinge on the floor of the mouth. Therefore, if 9 mm of space is not available from the gingival margin to the floor of the mouth, lingual plating must be used.

8.9.1.2.2. **Sublingual Bar.** This is a variation of a lingual bar. It is best thought of as a lingual bar turned 90 degrees to fit under the tongue. It may be indicated if there is insufficient room for a lingual bar and plating (or other alternatives) cannot be used to accommodate distal end extension cases.

8.9.1.2.3. **Kennedy Bar (Double Lingual Bar or Split Bar).** This variation of the simple lingual bar design provides indirect retention if adequate rests have been prepared in the cingulae of the mandibular incisors, and it contributes to horizontal stability of the prosthesis. It may be used if plating is the best choice for a major connector. However, because of recession of the gingival, many spaces exist in the lingual embrasures, making the metal of a lingual plating design visible from the front of the mouth. The lingual bar with augmenting Kennedy bar may create an unpleasant food trap that patients find objectionable.

8.9.1.2.4. **Labial Bar (Figure 8.6).** A labial bar is used as a last resort when severe, bilateral, posterior lingual, or anterior lingual undercuts prevent placement of a lingually oriented major connector.

Figure 8.6. Labial Bar.



8.9.1.2.5. **Cingulum Bar.** This major connector runs across the cingulae of the teeth with its inferior border at least 3 mm away from the tissue. It may be used if there is little or no lingual vestibule present. All of the bars except the lingual bar are rarely used.

8.9.1.2.6. **Lingual Plate.** When it is not possible to place the superior border of the lingual bar 4 mm away from the gingival margin, a lingual plate is an excellent alternative. A lingual plate provides improved horizontal stability of the RPD, stabilizes periodontally weakened teeth, and facilitates the future replacement of natural teeth. As is any plate design, metal covers the gingival tissues and may be less comfortable than a bar to some patients. The plate can compromise esthetics if there are spaces between the teeth, allowing the metal to show. If the incisors are rotated or overlapped, it may not be possible to seal plating against the teeth unless the dentist reshapes the lingual surfaces of the teeth.

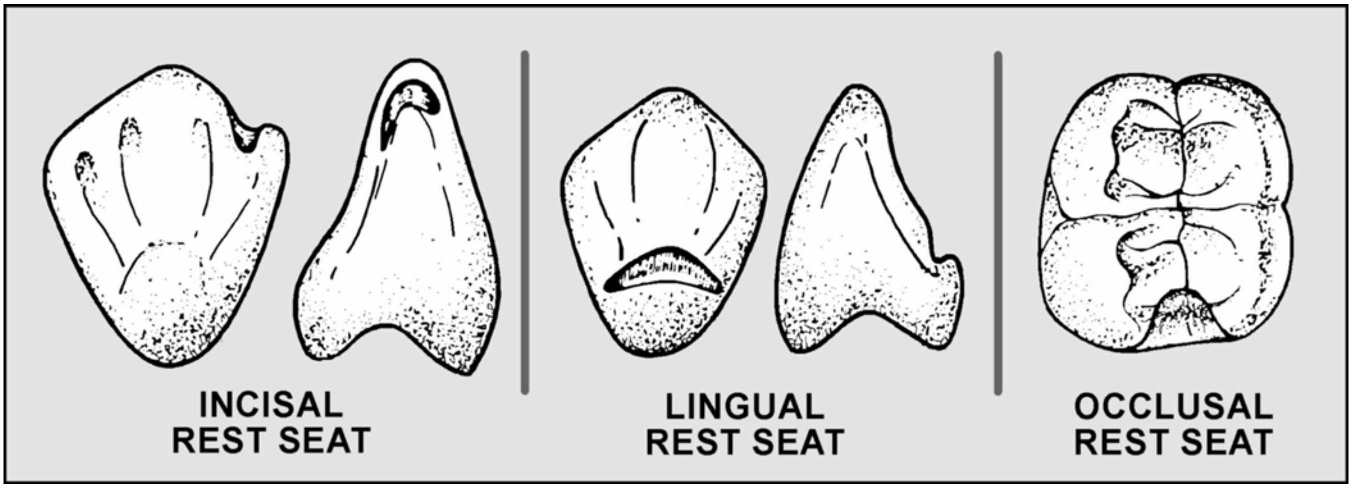
8.9.2. **Minor Connectors.** Minor connectors join a major connector to other components of the RPD. Minor connectors fall into two categories; (1) metal struts that join clasp assemblies and auxiliary rests to a major connector, and (2) metal grids that join resin denture base areas to the major connector.

8.10. Support Elements. Support elements prevent the RPD from pushing gingivally into the tissue of the mouth. Support elements consist of rests in contact with properly contoured rest seats and broad-based coverage of edentulous ridges.

8.10.1. **Rests:**

8.10.1.1. **Rest Seats.** Abutments are teeth used for support and retention. Before making a final impression for an RPD, the dentist cuts special depressions (rest seats) into abutment teeth (Figure 8.7). On a cast of the patient's mouth, partial denture units called rests are constructed to fit into the rest seats. Types of rest seats are as follows:

Figure 8.7. Rest Seats.



8.10.1.1.1. Incisal rest seat--a preparation located on the incisal edge of an anterior tooth.

8.10.1.1.2. Lingual rest seat--a preparation located on the lingual surface of an anterior tooth.

8.10.1.1.3. Occlusal rest seat--a preparation located on the occlusal surface of a posterior tooth.

8.10.1.2. **Types of Rests.** Rests can be named or identified in either of the following two ways, clasp assembly or auxiliary, as follows:

8.10.1.2.1. **Clasp Assembly Rest (Figures 8.8. and 8.9-A).** A clasp assembly rest is part of an RPD component complex called a *clasp assembly*. A clasp assembly consists of a clasp, rest, and minor connector. (Some assemblies consist of more than one clasp.) According to the seats that clasp assembly rests occupy, there are incisal clasp assembly rests, lingual clasp assembly rests, and occlusal clasp assembly rests.

8.10.1.2.2. **Auxiliary Rest (Figure 8.9-B).** By exclusion, *auxiliary rests* are all rests that are not part of clasp assemblies. According to the seats auxiliary rests occupy, there are incisal auxiliary rests, lingual auxiliary rests, and occlusal auxiliary rests.

8.10.1.3. **Rest Requirements.** All rests must be thick enough (at least 1 mm) to withstand chewing forces without breaking. It is the dentist's responsibility to cut rest seats into the patient's teeth to ensure the interior of the rest is slightly deeper than the exterior and to make the seats deep enough (1 to 1.5 mm). If the dentist has properly prepared the seats, the responsibility for fabricating the rests of adequate thickness shifts to the technician.

8.10.2. **Broad-Based Coverage of Edentulous Ridges (Snowshoe Principle).** The tissue replacement portion of an RPD should cover as much area as possible to widely distribute chewing forces across the underlying tissue. This is particularly true in all types of extension cases. Tuberosities must be covered in maxillary distal extension cases. It is just as critical for *at least half* of the retromolar pad area to be covered in mandibular distal extension cases. Failure to properly extend the tissue replacement portion in extension cases can cause irreversible damage to gingiva and underlying bone.

Figure 8.8. Clasp Assembly.

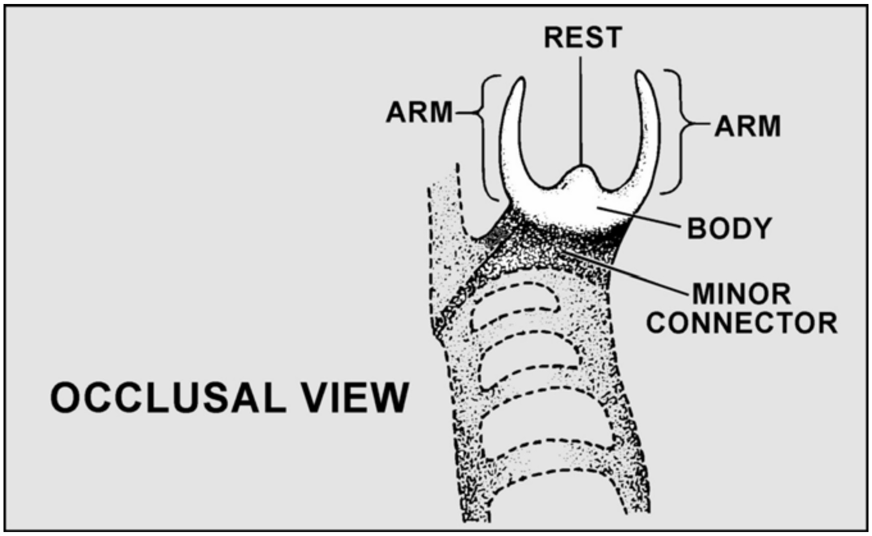
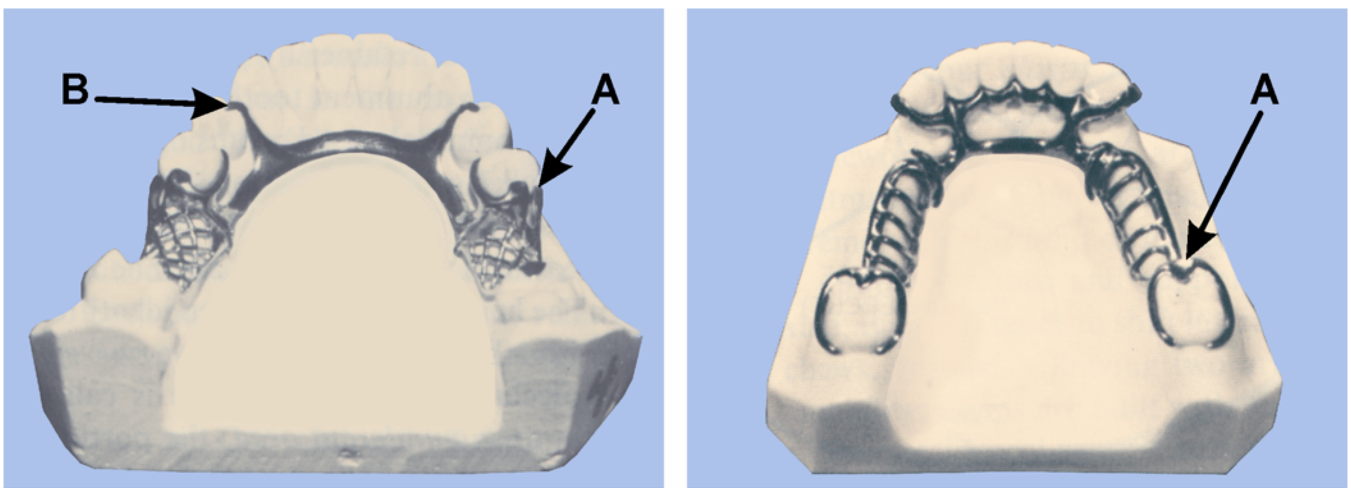


Figure 8.9. Rests—Clasp Assembly (A) and Auxiliary (B).



8.11. Retainers. There are two broad categories of retainers, direct and indirect. Both varieties hinder movement of an RPD occlusally; the difference is in how they do it. Direct retainers either grasp or are grasped by an abutment tooth to resist the removal of the RPD in an occlusal direction. On an extension base RPD, it is best to place direct retainers only on abutment teeth on the axis of rotation. (See paragraphs 8.12 for the characteristics of direct retainers.) Indirect retainers are rests placed opposite the axis of rotation from the denture base on an extension base RPD to change the fulcrum when the denture base is moved occlusally, such as when eating sticky foods. (See paragraphs 8.13 for the characteristics of indirect retainers.)

8.12. Direct Retainers:

8.12.1. **Precision Attachments.** Most precision attachment devices are retentive systems. A large variety of precision attachments are available. These vary from ball and socket components to miniature metal tracks, where a track (male), which is attached to the framework, slides into a keyway (female) housed within a metal crown on an abutment tooth. Retention (resistance to occlusal movement) may be obtained by frictional resistance, springs, O-rings, magnets or other devices.

8.12.2. **Clasps:**

8.12.2.1. **Overview.** A clasp is the part of an RPD that acts as a direct retainer by partially encircling and contacting an abutment tooth. The clasp is the most commonly used means of direct retention. It is important to define some terms before examining clasps in detail. A tooth's greatest circumference is called its *height of contour*. The height of contour, when identified and marked with a black pencil, becomes a *survey line*. The area occlusal to the survey line is called the *suprabulge* or *nonundercut area;* the portion of a tooth cervical to a survey line is called the *infrabulge* or *undercut area* (Figure 8.10). A clasp is made to flex in and out of an *undercut* (Figure 8.11). The metal's resistance to flexing is responsible for most of the clasp's retentive ability.

Figure 8.10. Survey Line.

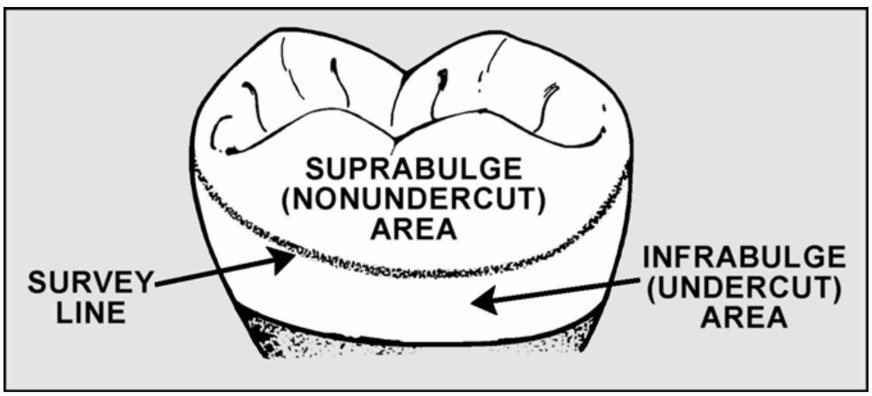
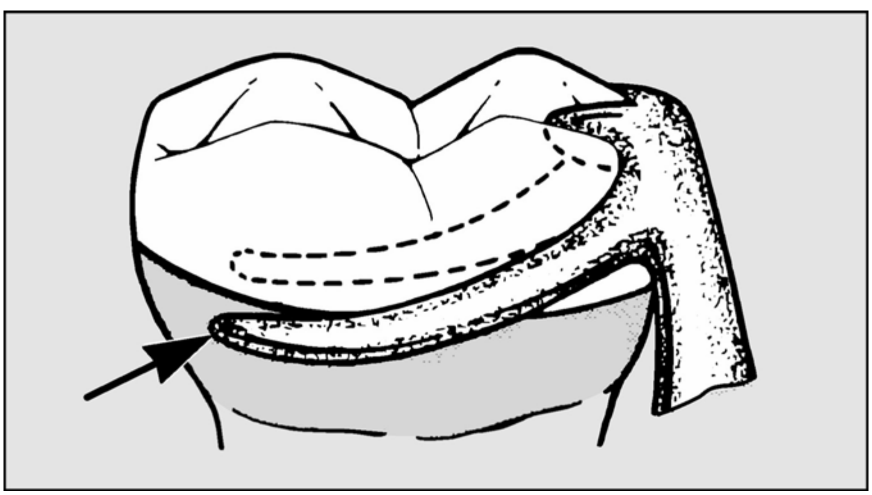


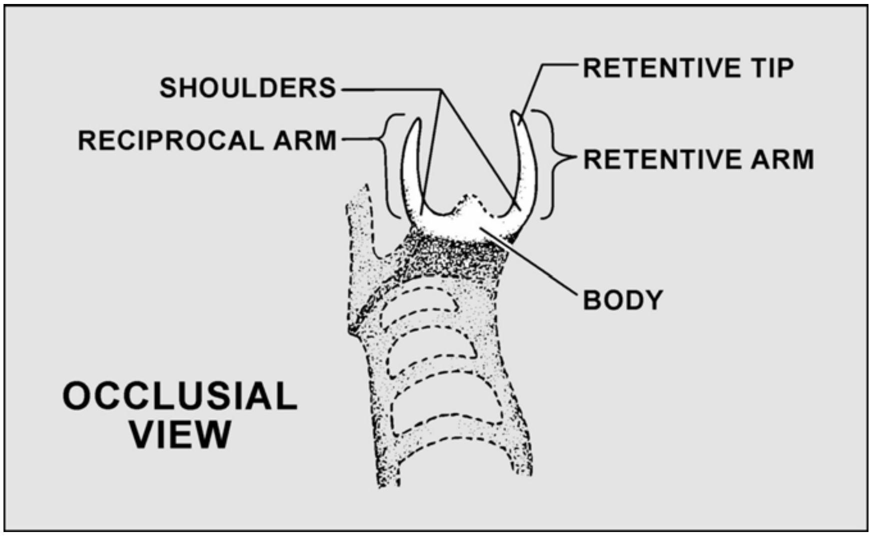
Figure 8.11. Clasp-Engaging Undercut.



8.12.2.2. **Groups of Clasps.** There are two broad groups of clasps—circumferential clasps and bar clasps. However, each may have three or more names that are used almost interchangeably.

8.12.2.2.1. **Circumferential Clasps (Suprabulge or Akers).** The parts of a circum ferential clasp are the body, retentive arm , retentive tip, reciprocal arm, and shoulders (Figure 8.12). The retentive tip of a circumferential clasp consists of the terminal one-third of the retentive arm; the shoulder is the one-third of a cl asp arm closest to the body. The distinguishing characteristic of this clasp group is that the retentive arm approaches the undercut area of the tooth from above the survey line.

Figure 8.12. Circumferential Clasp Parts.



8.12.2.2.2. **Bar Clasps (Infrabulge or Roach).** Bar clasps approaches the tooth's undercut area from below the survey line. The approach arm usually exits the framework from an area designed to hold artificial teeth. Instead of th e retentive arm being continuous with the body as in the circumferential clasp, the retentive tip of a bar clasp is continuous with its approach arm (Figure 8.13). The parts of a bar clasp m ay include the body, approach arm , retentive tip, bracing tip, reciprocal arm , and shoulder (as in the T-bar), or it m ay include only an approach arm and retentive tip (as in the I-bar).

8.12.3. **Functional Requirements of a Clasp.** Clasps are expected to perform the following four functions:

8.12.3.1. *Retention*—the ability to resist removal of the RPD in an occlusal direction.

8.12.3.2. *Reciprocation*—the m eans by which a nonretentive pa rt of an RPD counteracts the lateral forces exerted on the abutment tooth by the retentive arm.

8.12.3.3. *Bracing*—the resistance the clasp contributes to anteroposterior and lateral shifting of the entire RPD.

8.12.3.4. *Encirclement*—a design principle where m ore than 180 degrees of an abutm ent's circumference is surrounded so the tooth does not drift from the confines of the clasp (Figure 8.14).

Figure 8.13. Parts of a Bar Clasp.

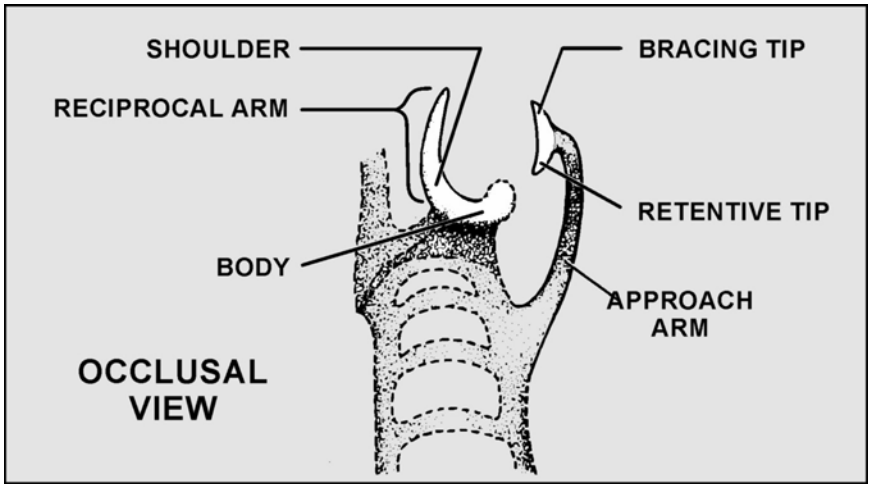
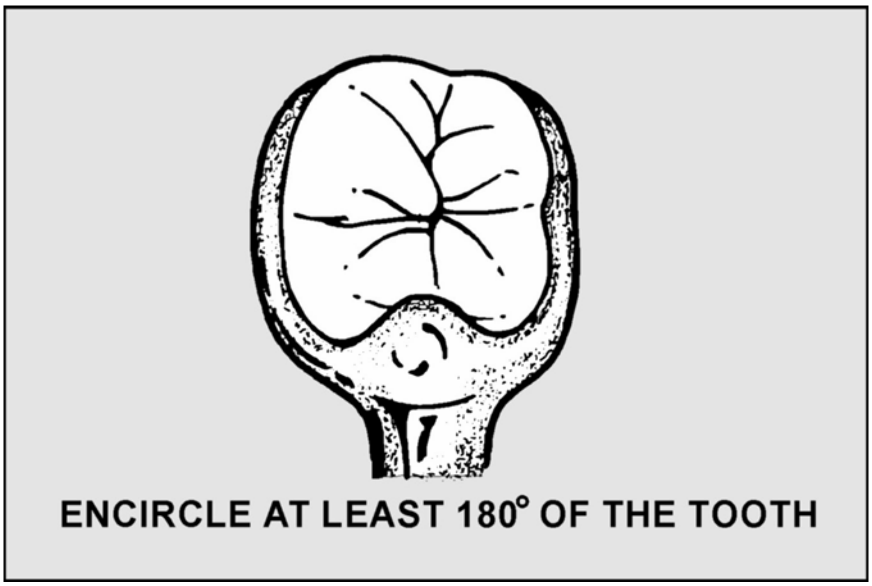


Figure 8.14. Encirclement.



8.12.4. **Other Requirements of a Clasp.** Clasps may be the most difficult component of the RPD to properly construct. As much as possible, they must be hidden from view in the patient's mouth, be sufficiently strong, and blend into the existing contour of the natural teeth.

8.12.5. **Relative Importance of Retention, Reciprocation, Bracing, and Support:**

8.12.5.1. Retention prevents occlusal movement of the RPD.

8.12.5.2. Reciprocation prevents horizontal movement of individual teeth.

8.12.5.3. Bracing prevents the RPD from moving horizontally.

8.12.5.4. Support prevents vertical movement of the RPD toward the gingival tissues.

8.12.5.5. Of these factors, retention is the least important, because horizontal and tissue-ward movement can damage the teeth, tissues, and underlying bone, causing loss of the remaining teeth. Excessive retention may also cause damage. In the absence of adequate bracing and support, the effectiveness of retention is reduced because the RPD moves more when the patient chews. Patients usually desire firm retention and may ask the dentist to increase the retention of the RPD, further aggravating the situation. Because patients often may not notice the damage their RPD does to their mouth, it is usually desirable to use the least amount of retention they can tolerate.

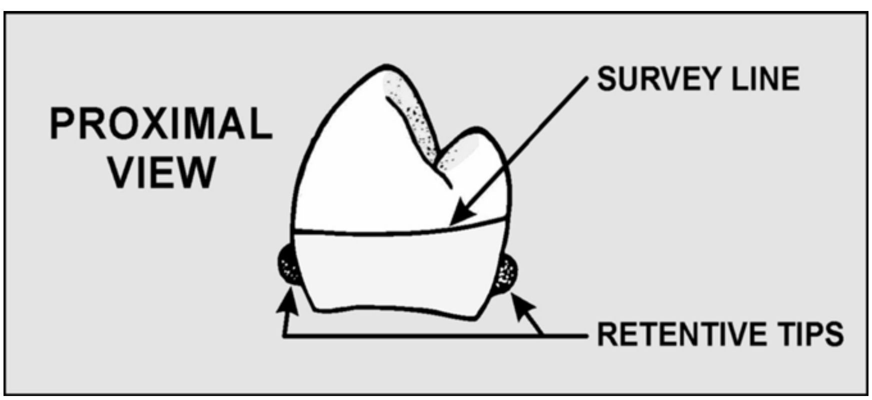
8.12.6. **Mechanics of Retention and Reciprocation.** An RPD tends to remain seated in the mouth because clasp arms that carry retentive tips resist flexing when the tips are forced to move out of undercuts. The retentive tip of a clasp arm is the only part of an RPD intentionally made to fit into an undercut area. Almost all other parts of the RPD are not supposed to flex and must be constructed to avoid undercuts. The *shoulder* of a circumferential clasp's retentive arm is the zone of transition between the rigid "body" and the flexible "tip." A shoulder has some spring to it, but not much. The parts of a clasp cannot be positioned randomly on an abutment tooth's surface because each part has a definite relationship with the survey line.

8.12.6.1. **Clasp Arm Design and its Relationship to the Survey Line:**

8.12.6.1.1. In general, suprabulge clasps should be made as long as possible. A longer clasp is more flexible and places less stress on the abutment tooth. One way to effectively lengthen a clasp is to follow the gingival contour of the tooth. In addition to traveling the mesial-distal dimension of the tooth, the clasp also travels the occlusal-gingival distance. Because only the retentive tip should be below the survey line and most natural teeth have a high survey line at the line angles, the dentist must alter the shape of the tooth to change the height of contour. This change will allow the technician to place all parts of the clasp except the retentive tip above the survey line.

8.12.6.1.2. Figure 8.15 illustrates an independent retentive clasp unit in which both arms were constructed to engage undercut. The clasp resists removal from the tooth with no assistance from other parts of the RPD. *Clasps are not ordinarily designed this way.* This design would be used only if there are natural teeth remaining on just one side of the mouth. If this clasp design is used, the retentive arms will push the abutment tooth laterally when the RPD is inserted or removed. This kind of stress can lead to irreparable abutment tooth and supporting bone damage.

Figure 8.15. Independently Retentive Clasp.



8.12.6.1.3. Instead of having two arms with retentive capability, clasps are built with one retentive arm and one reciprocal arm. A reciprocal arm helps neutralize (reciprocate) the lateral pressure generated by a retentive tip sliding over an abutment's height of contour. Also, the combined action of reciprocal arms (two or more clasp) braces an RPD against movement in the horizontal plane. This is how the retentive and reciprocal arms of a simple circumferential clasp relate to a survey line most of the time (Figure 8.16). Observe that the shoulder of the retentive arm is positioned above the survey line and the retentive tip goes into undercut. The cervical border of the entire reciprocal arm falls on the survey line.

8.12.6.1.4. Figure 8.17 illustrates the way the arms of a bar clasp normally relate to the survey line. The approach arm crosses gingival tissue at 90 degrees and makes first contact with the tooth at the survey line. The retentive tip proceeds into the undercut, and the bracing tip (if present) is positioned in the suprabulge area. The rest and minor connector do not engage an undercut and can, therefore, be considered reciprocating surfaces. The cervical edge of the reciprocal arm is located on the survey line.

Figure 8.16. Relationship of Circumferential Clasp Arms to the Survey Line.

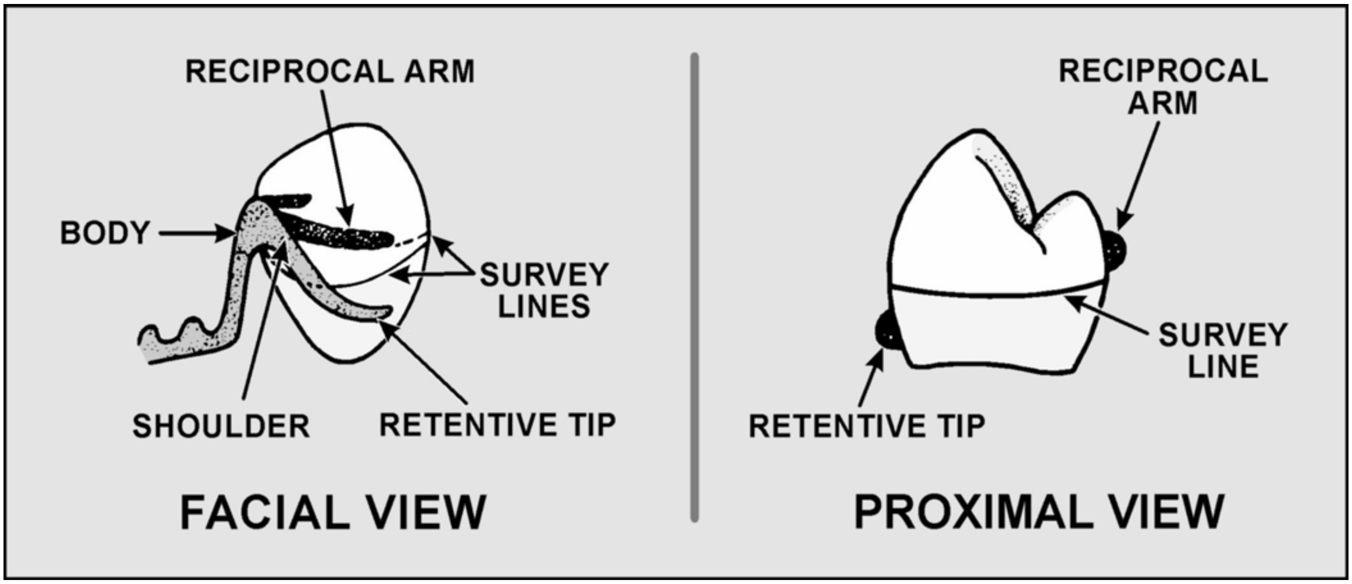
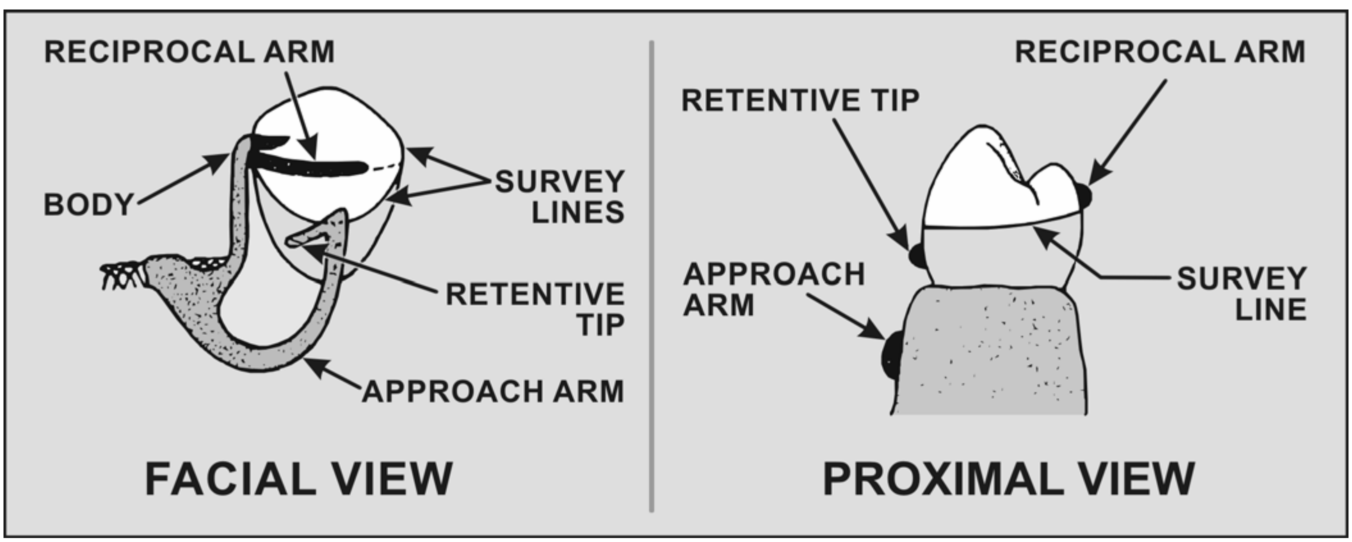


Figure 8.17. Relationship of Bar Clasp Arms to the Survey Line.

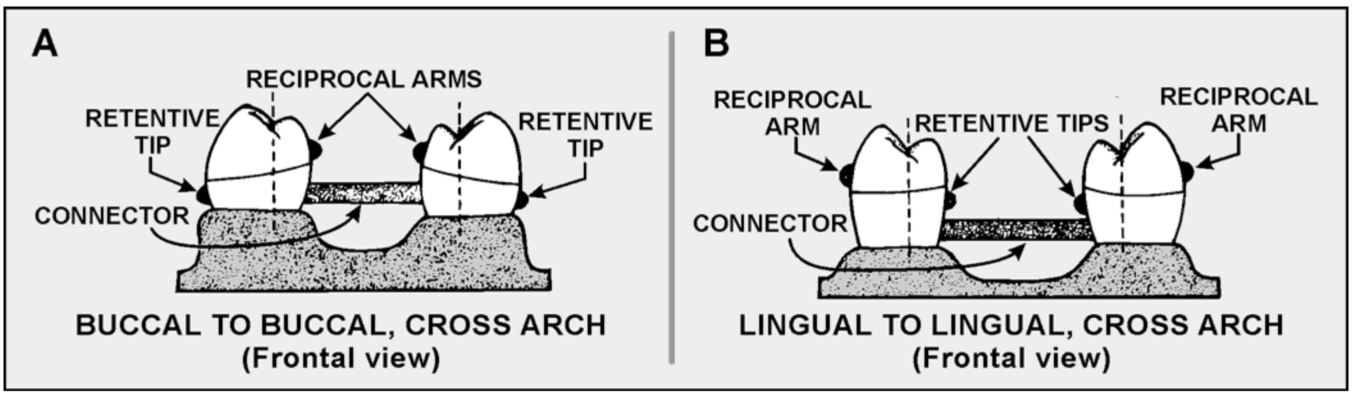


8.12.6.1.5. As stated in paragraph 8.12.6.1.2, clasps with both arms engaging undercuts are independent retentive units. However, there are serious drawbacks to using clasps this way. The typical circumferential and bar clasps just described are not independently retentive. When considered in isolation from other parts of the RPD, clasps with one arm above the survey line and the other arm below the survey line may not be retentive.

8.12.6.2. **Interactions Among Clasps:**

8.12.6.2.1. The most effective retention is realized by selecting opposing undercut surfaces on two or more teeth, placing the retentive tips of the clasps on those surfaces, and uniting the clasps with rigid connectors. The result is a retentive complex where the action of one clasp is opposed by the action of another to generate retention for the RPD as a whole. Reciprocation and bracing requirements of the RPD are also satisfied. The possible combinations of opposing surfaces are buccal to buccal, cross arch (Figure 8.18-A), lingual to lingual, cross arch (Figure 8.18-B), and buccal to lingual on the same side opposed by a buccal or lingual surface undercut on the opposite side.

Figure 8.18. Examples of Opposing Clasps.



8.12.6.2.2. In Figure 8.19, the buccal undercut on the right second molar (A) opposes the lingual surface undercut of the second premolar on the same side (B), and the buccal undercut of the right second molar (A) also opposes the buccal undercut of the second premolar on the opposite side (C).

8.12.6.3. **Reciprocal Plating as an Alternative to Reciprocal Arms (Figure 8.20).** There are oral conditions that limit the use of a clasp arm for reciprocation purposes. Three such solutions are as follows:

8.12.6.3.1. In the first situation, the retentive arm makes contact with the tooth much earlier than the reciprocal arm as the partial denture is going to place. There is a need for more effective reciprocation than a reciprocal clasp arm can provide. Conversely, during RPD removal the retentive arm exerts pressure on the abutment long after the reciprocal arm breaks contact. A second situation occurs when the abutment tooth is very short without enough room for a reciprocal arm of sufficient width. In the third situation, the gingival border of a reciprocal arm and the edge of a major connector are within 6 mm of each other, creating a food trap.

Figure 8.19. Opposing Undercuts on the Same and Opposite Sides.

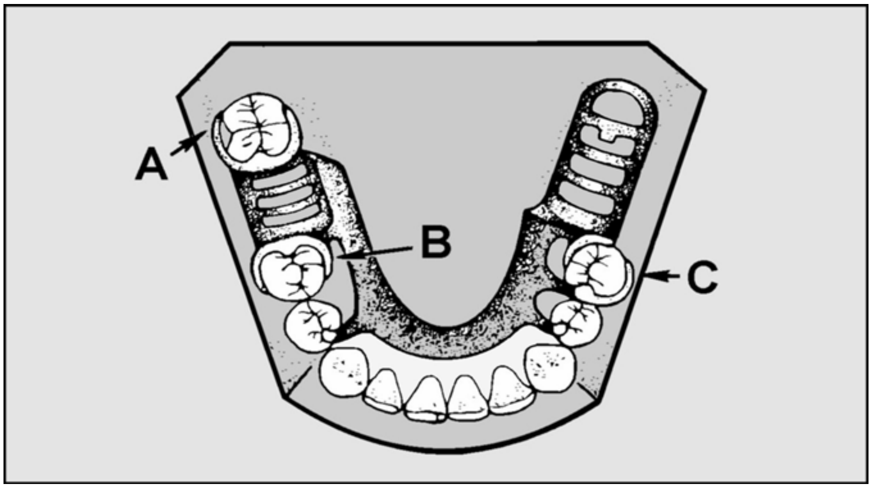
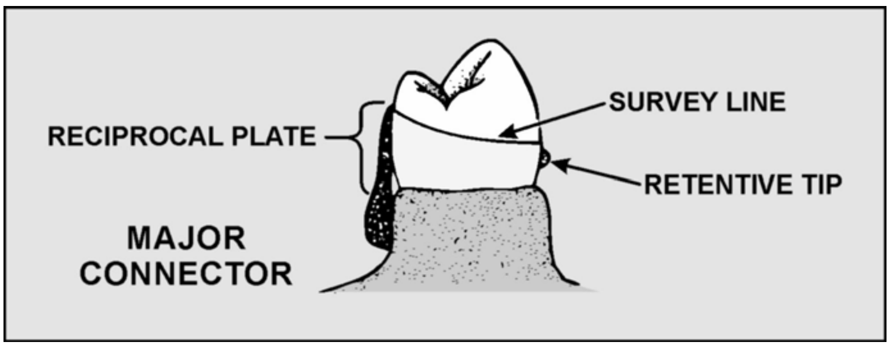


Figure 8.20. Proximal View.



8.12.6.3.2. When any of these situations exist, it is common to make the gingival border of a reciprocal arm and the edge of the major connector continuous with one another. The result of this joining is called a *reciprocal plate*. The reciprocal plate has a different relationship to the survey line than a reciprocal arm. The superior edge of a reciprocal plate is slightly occlusal to the survey line.

8.12.6.4. **Exceptions to the Usual Clasp Arm-Survey Line Relationships.** When clasps are to be used for support, but not for retention, both buccal and lingual clasp arms are placed above the survey lines like reciprocating arms. In this case, they function to prevent the tooth from migrating away from the supporting rest. Occasionally, a patient will have all of the teeth in one quadrant missing. Cross arch undercut antagonism is impossible. In this case, each clasp is made with two retentive arms, one on the buccal and the other on the lingual of the tooth the clasp engages.

8.12.6.5. **Generating Specific Amounts of Retention With Clasps.** If clasps do not act to retain the RPD, the RPD tends to lift off the teeth. On the other hand, too much retention can cause severe tooth abrasion, intolerable tooth soreness, loss of bone support around abutments, and varying amounts of difficulty when the RPD is put in or taken out. The amount of retention that the clasp shows depends on the flexibility of the retentive arm and the amount of undercut engaged.

8.12.6.5.1. **Clasp Arm Flexibility.** In this case, flexibility is the resistance to bending exhibited by a retentive arm passing over a tooth's height of contour. The general relationship between flexibility and retention is that retention increases as flexibility decreases. The following four factors that influence the clasp arm's flexibility:

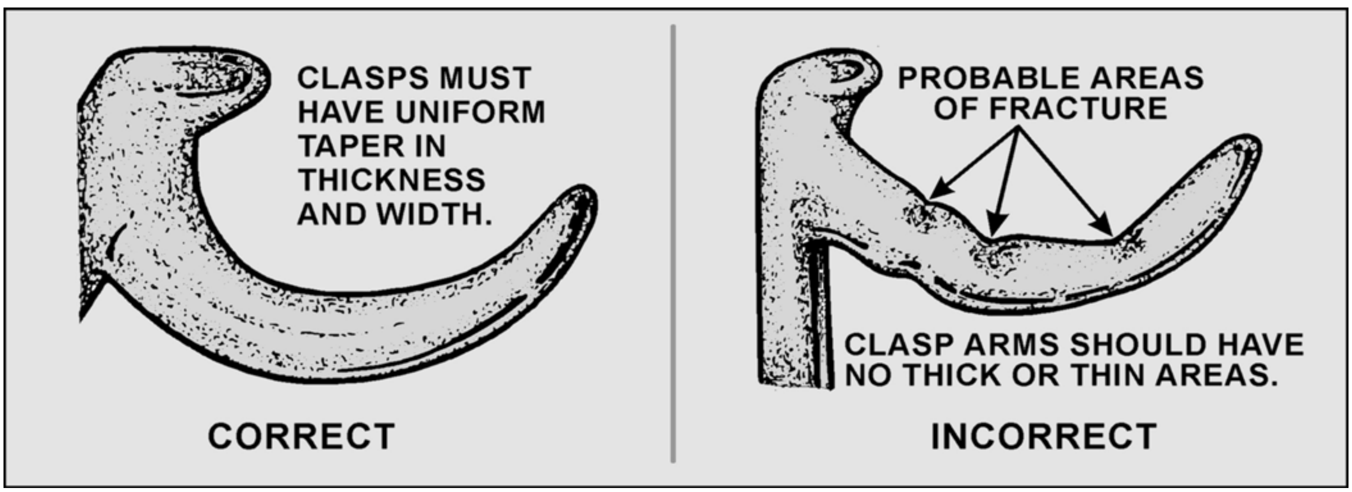
8.12.6.5.1.1. The first is the *length of the arm.* As length increases, flexibility increases and retention decreases.

8.12.6.5.1.2. *Cross-sectional size* is another factor. As cross-sectional size increases, flexibility decreases and retention increases. Clasp arms must be made with a progressive reduction in cross-sectional size from shoulder to tip. This is why the tip can flex and the shoulder cannot flex. Progressive reduction in cross-sectional size is called uniformity of taper. It is critical that there be no interruption in the uniformity of taper by thick or thin areas (Figure 8.21).

8.12.6.5.1.3. A third consideration is the clasp arm's *cross-sectional shape.* Clasp arms with round cross-sectional shapes are more flexible than clasp arms with half-round shapes.

8.12.6.5.1.4. The fourth factor is the *type of metal used.* A dentist has access to three kinds of metals for clasp construction; cast chrome-alloy, cast gold, and noncorrosive wires. (The wires are cut and bent into the shape of clasp arms and then incorporated into the chrome-alloy or gold castings.) Cast chrome-alloy is the stiffest per unit length, wires are the most flexible, and the relative flexibility of cast gold falls between the two. The stiffer the metal, the greater the retention.

Figure 8.21. Uniform Taper.



8.12.6.5.2. **Tooth Undercut as a Factor in Retention.** An *undercut* is the portion of a tooth that is cervical to the survey line. The amount of undercut, progressing from the survey line cervically, usually increases. As retentive tips engage greater amounts of undercut, the retention increases.

8.12.6.5.2.1. The dentist and the technician must be able to measure undercut to maintain control over the amount of framework retention. The amount of undercut at any given point on the infrabulge surface of a tooth is the perpendicular distance between a vertical line that touches the tooth's height of contour and the point in question (Figure 8.22-A).

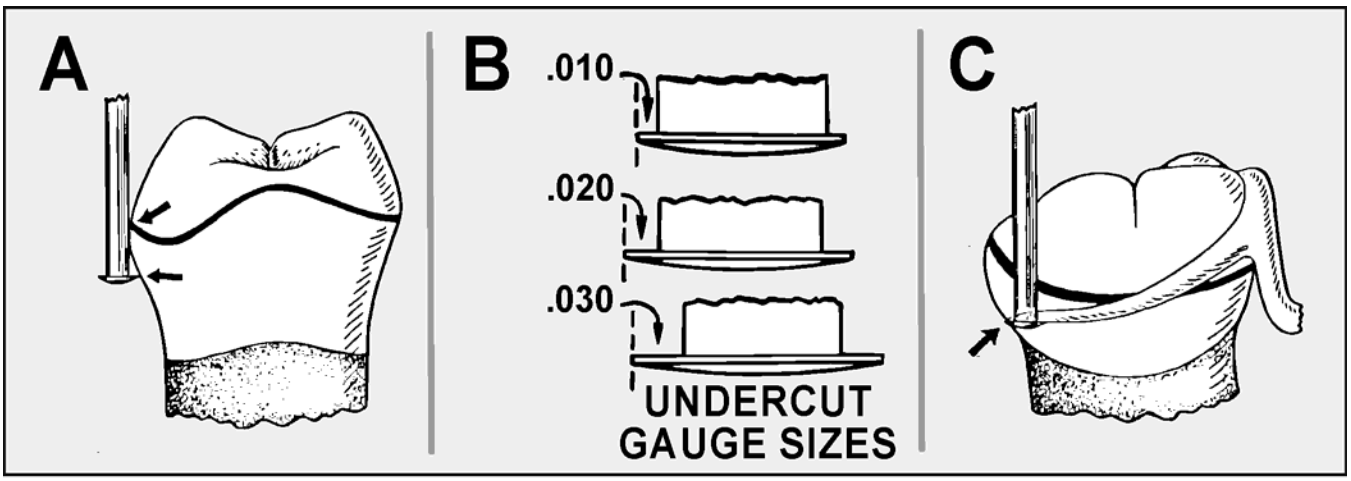
8.12.6.5.2.2. The unit of undercut measurement is *thousandths-of-an inch.* Undercut is measured with an undercut gauge mounted in an instrument called a *surveyor.* Undercut gauges are produced in standard .010, .020 and .030 inch sizes (Figure 8.22-B). The 0.005 and .015 inch gauges are custom made and have been found to be very satisfactory intermediate amounts of undercut for certain clasping situations.

8.12.6.5.3. **Clasp Type and Retention.** In general, bar clasps produce more retention per undercut unit than circumferential clasps, even though bar clasps tend to be longer and more flexible. An analogy would be pushing the tip of a stick along a sidewalk as opposed to pulling or dragging it. The tip of the bar clasp tends to engage into the surface of the tooth when an attempt is made to withdraw it.

8.12.6.5.4. **Integrating Clasp Arm Flexibility and Tooth Undercut To Achieve Retention.** The retentive tip of a clasp is positioned on a tooth's surface relative to a measured amount of undercut (Figure 8.22-C).

8.12.6.5.4.1. The ability to control the degree of framework retention depends on whether flexibility and undercut variables are manipulated to advantage. All of the variables mentioned can be controlled, but the ones that most immediately influence retention are the choice of metal for clasp construction, length of the clasp arm, and amount of undercut engaged.

Figure 8.22. Measurement of Undercut.



8.12.6.5.4.2. The relationship among these variables is important. For example, placing a cast chrome alloy clasp into .010 inch undercut should produce roughly the same amount of framework retention as placing the same sized gold clasp in an .020 inch undercut. Wrought wire would require .020 inch undercut to produce the same retention, but the dentist is usually attempting to reduce the stress on the abutment when using wire and will choose less undercut.

8.12.6.5.4.3. Clasp arm length is the variable that probably changes most from abutment tooth to abutment tooth. If the retentive area on a tooth like a large molar is longer than average, more undercut than the norm for the type of metal must be engaged to produce sufficient retention (.015 inch instead of .010 for chrome-alloy). The reverse is true when retentive arms are shorter than average (.005 inch to .010 inch for chrome-alloy metal).

8.12.6.5.4.4. It is the responsibility of the dentist to prescribe the type of clasp assembly and amount of retentive undercut to be used.

8.12.6.6. **Clarification of Terms.** The term *clasp* properly refers to an RPD component consisting of a retentive part, reciprocating part, and body (Figures 8.12 and 8.13). The complex of parts consisting of a clasp, rest, and minor connector is correctly called a *clasp assembly* (Figure 8.8).

8.12.6.7. **Types of Circumferential Class Assemblies:**

8.12.6.7.1. **Simple Circumferential Assembly (Figure 8.23).** This assembly is composed of two clasp arms, a rest and a minor connector. It is the most commonly used clasp assembly.

8.12.6.7.2. **Embrasure (Crib) Assembly (Figure 8.24).** This assembly consists of two simple circumferential clasps, two rests, and one minor connector. The rests are located in adjacent triangular fossae and marginal ridges of two teeth; the simple circumferential clasps are joined at their bodies. Embrasure clasps are weaker than other clasp assemblies and tend to fracture where the minor connectors cross the buccal or lingual marginal ridges.

8.12.6.7.3. **Ring With Supporting Strut (Ring Clasp) Assembly (Figure 8.25).** In this assembly, a single arm almost completely encircles the abutment tooth. A reinforcing strut is attached to the arm midway between the minor connector and the retentive tip. Mesial and distal occlusal rests are another feature of this assembly. A common variations is to not place the supporting strut.

Figure 8.23. Simple Circumferential Assembly.

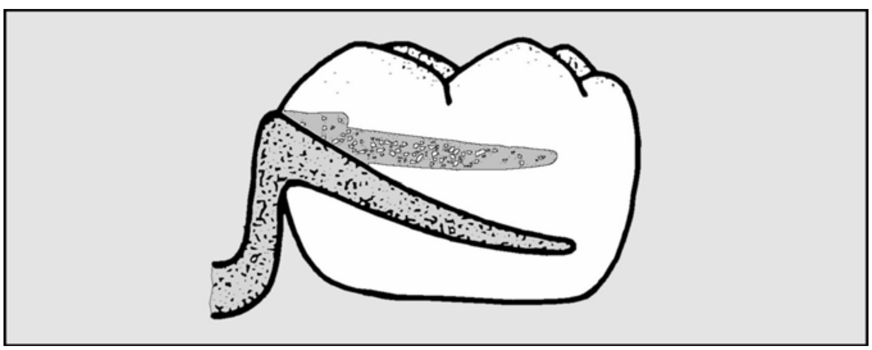


Figure 8.24. Embrasure (Crib) Assembly.

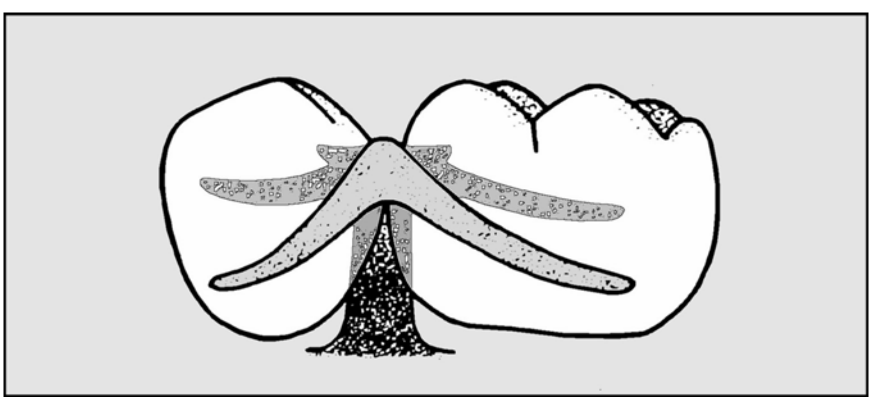
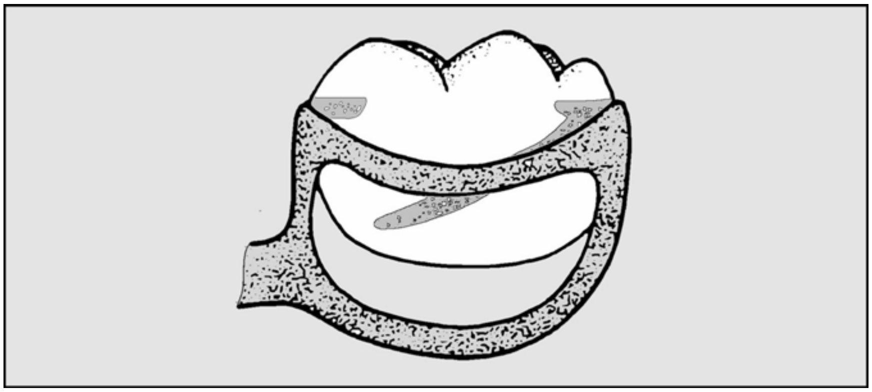


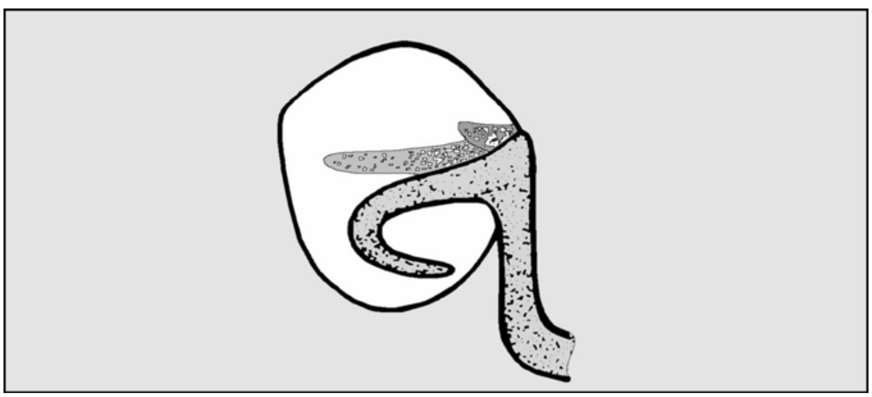
Figure 8.25. Ring With Supporting Strut (Ring Clasp) Assembly.



8.12.6.7.4. **Reverse Action (Hairpin) Assembly (Figure 8.26).** This is basically a simple circumferential clasp assembly with a retentive arm that turns back on itself and engages an undercut gingival to its shoulder. This clasp covers a lot of tooth structure and requires a long clinical crown. When used on the buccal of a mandibular tooth, it frequently interferes with the maxillary buccal cusps. This clasp should be avoided.

8.12.6.7.5. **Half-and-Half (Split) Clasp Assembly (Figure 8.27).** The half-and-half circumferential clasp assembly has two rests and two minor connectors. Each minor connector carries a clasp arm.

Figure 8.26. Reserve Action (Hairpin) Assembly.



8.12.6.7.6. **Multiple Circumferential Assembly (Figure 8.28).** The distinctive feature of this assembly is that two simple circumferential clasps oppose each other and are joined at the terminal ends of the reciprocal arms.

8.12.6.7.7. **Combination Circumferential Assembly (Figure 8.29).** Instead of both arms being cast in metal, this simple circumferential clasp assembly uses a wire retentive arm and cast reciprocating arm. This assembly is commonly used on an abutment next to a distal extension space.

Figure 8.27. Half-and-Half (Split) Clasp Assembly.

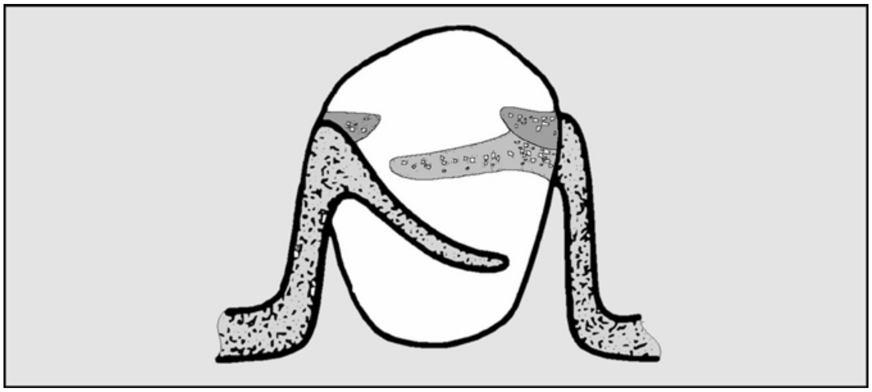


Figure 8.28. Multiple Circumferential Assembly.

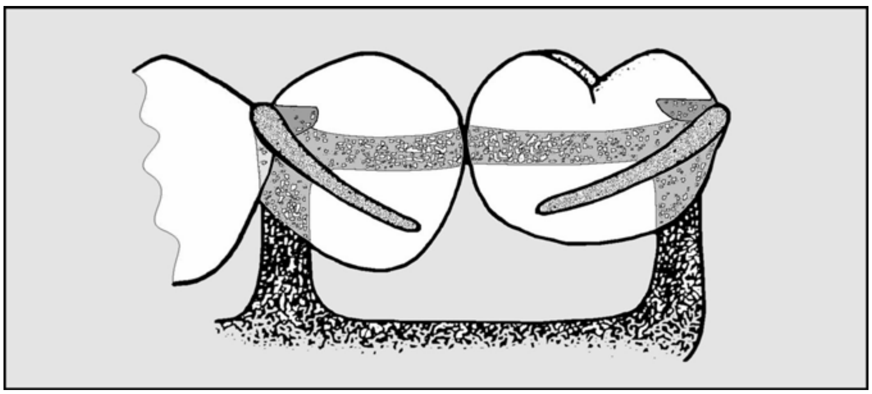
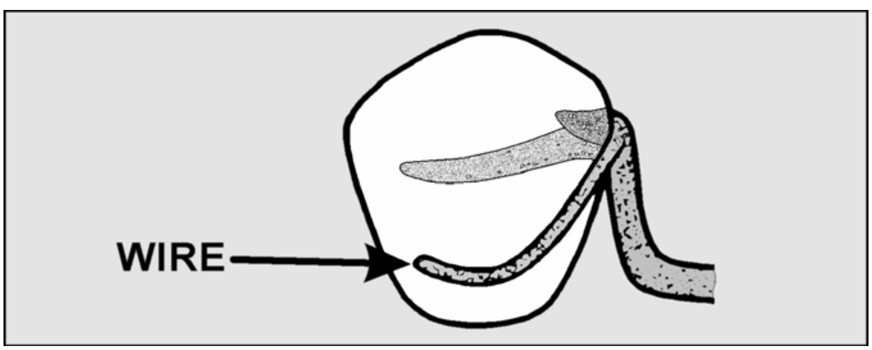


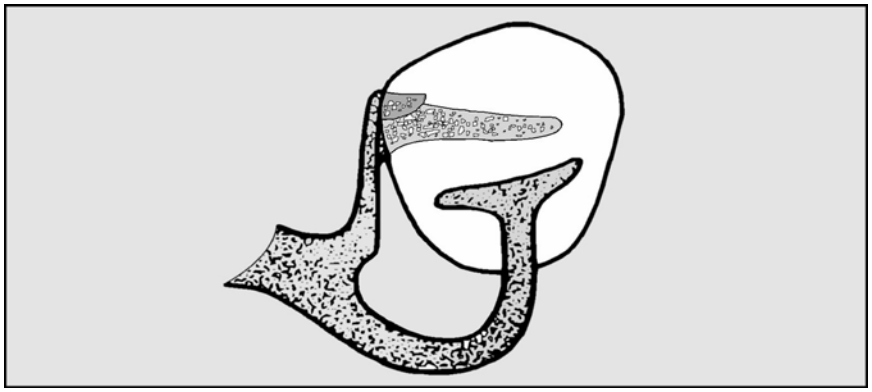
Figure 8.29. Combination Circumferential Assembly.



8.12.6.8. **Types of Bar Clasp Assemblies:**

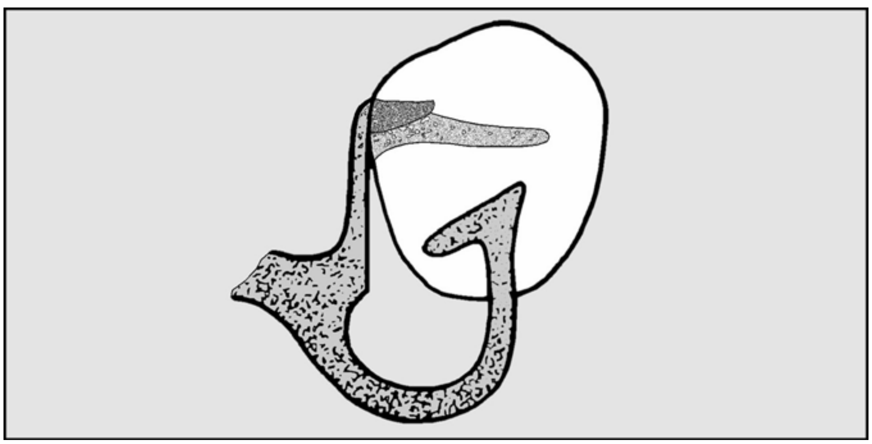
8.12.6.8.1. **T-Bar Assembly (Figure 8.30).** The T-bar clasp assem bly has a rest, reciprocal arm, and m inor connector as extensions from the body. An approach arm carries retentive and bracing tips. The approach arm originates in a denture base of the RPD. The clasp gets its name from the appearance of the approach arm and its tips.

Figure 8.30. T-Bar Assembly.



8.12.6.8.2. **Modified T-Bar Assembly (Figure 8.31).** This is merely a T-bar clasp assembly with the approach arm's bracing tip removed. Although the bracing effectiveness of the bar clasp depends on the stiffness of the reciprocal and approach arms, some bracing action is lost by omitting the approach arm's bracing tip.

Figure 8.31. Modified T-Bar Assembly.



8.12.6.8.3. **I-Bar Assembly (Figure 8.32).** The retentive and bracing tips associated with the approach arm of a T-bar clasp are gone. Instead, the end of the approach arm is the retentive tip of this kind of clasp.

8.12.6.8.4. **RPI Clasp Assembly (Figure 8.33).** This is a common variation of the basic I-bar form. It is composed of a mesial rest and a minor connector, a distal plate, and an I-bar retentive portion. The clasp has no reciprocal arm. Reciprocation comes from the distal plate and the medial minor connector. I-bar and RPI clasp assemblies are commonly used on abutment teeth adjacent to distal extension bases. One reason for changing the T-bar clasp assembly configuration into modified "T" and "I" bar varieties was to make the clasps less conspicuous in the mouth.

8.12.6.8.5. **Combination Bar Assembly (Figure 8.34).** The combination bar is another "I" configuration. It consists of a wire approach arm and a cast reciprocal arm.

Figure 8.32. I-Bar Assembly.

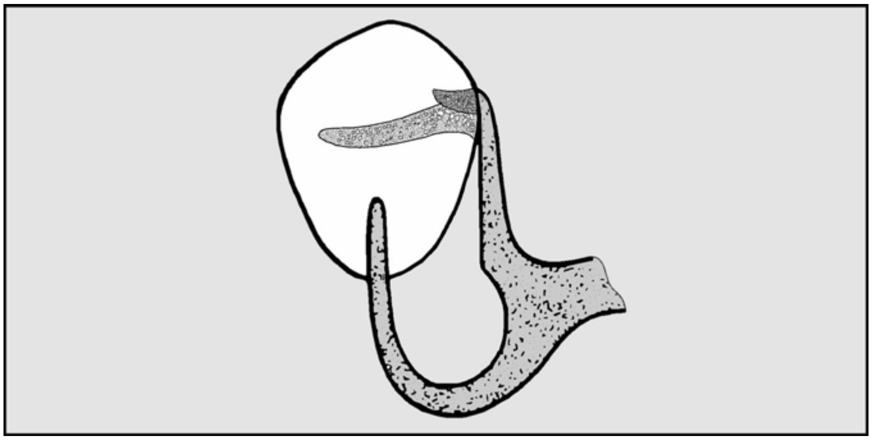


Figure 8.33. RPI Clasp Assembly.

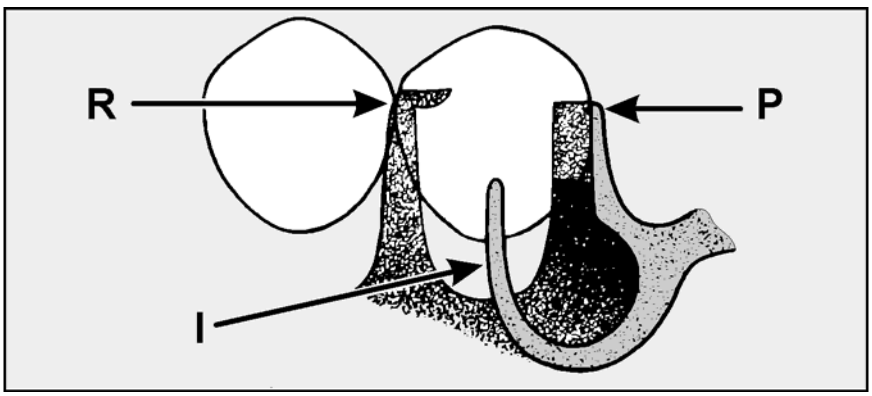
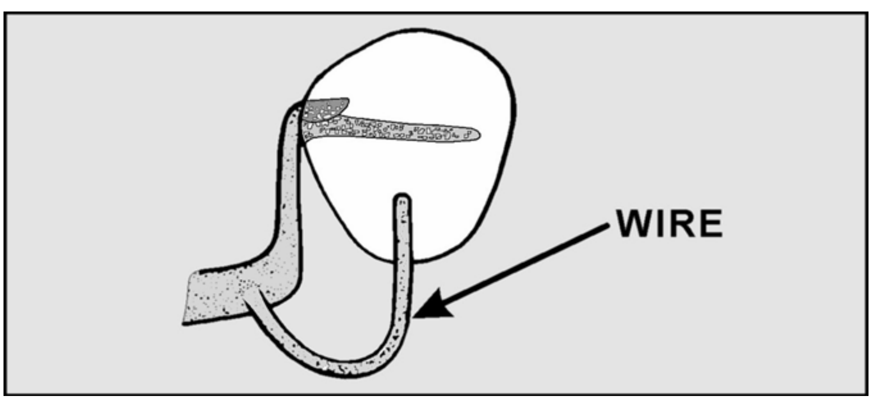


Figure 8.34. Combination Bar Assembly.



8.12.6.9. **Rationale for the Variety of Clasp Assemblies.** Factors such as occlusion, esthetics, and the presence of gingival tissue undercuts can restrict the access of retentive tips to abutment tooth undercuts of proper location and depth. The dentist usually chooses a clasp assembly that will put the *least stress possible* on the abutment tooth next to an extension base. The variety of circum ferential and bar clasp asse mblies should be viewed as an assortm ent of options for retaining an RPD in the best manner possible. The details of using the assemblies to their best advantage are in paragraphs 8.27 and 8.35.

8.13. Indirect Retainers. Up to this point, characteristics of direct retention have been outlined. However, indirect retention is another important principle in RPD design.

8.13.1. An *indirect retainer is* a part of an extension base RPD which inhibits the extension base from lifting off the ridge tissue. This *indirect retention* occurs because the indirect retainer resists the rotation of the RPD around the axis of rotation (fulcrum line), resulting in decreased movement and increased stability of the RPD. The improved stability improves the effectiveness of the direct retention. Movement of a toothborne RPD in an occlusal direction is prevented by clasps on abutment teeth located at each end of the edentulous space.

8.13.2. Distal extension base RPDs tend to rotate around an axis that passes through the distal abutment on each side (Figure 8.35-A and -B). In an anterior extension case, the axis of rotation passes through the most anterior abutment on each side of the arch. If sticky food is acting to pull an extension base away from the ridge tissue, the part of the RPD on the opposite side of the axis of rotation tends to rotate toward the gingival tissue if that part is unsupported.

8.13.3. The most effective indirect retention features are additional rests placed opposite the axis of rotation from the extension base (Figure 8.36). All extension base RPDs should have indirect retention built into them. The farther away from the axis of rotation the indirect retentive features are, the more effective they are.

Figure 8.35. Axes of Rotation.

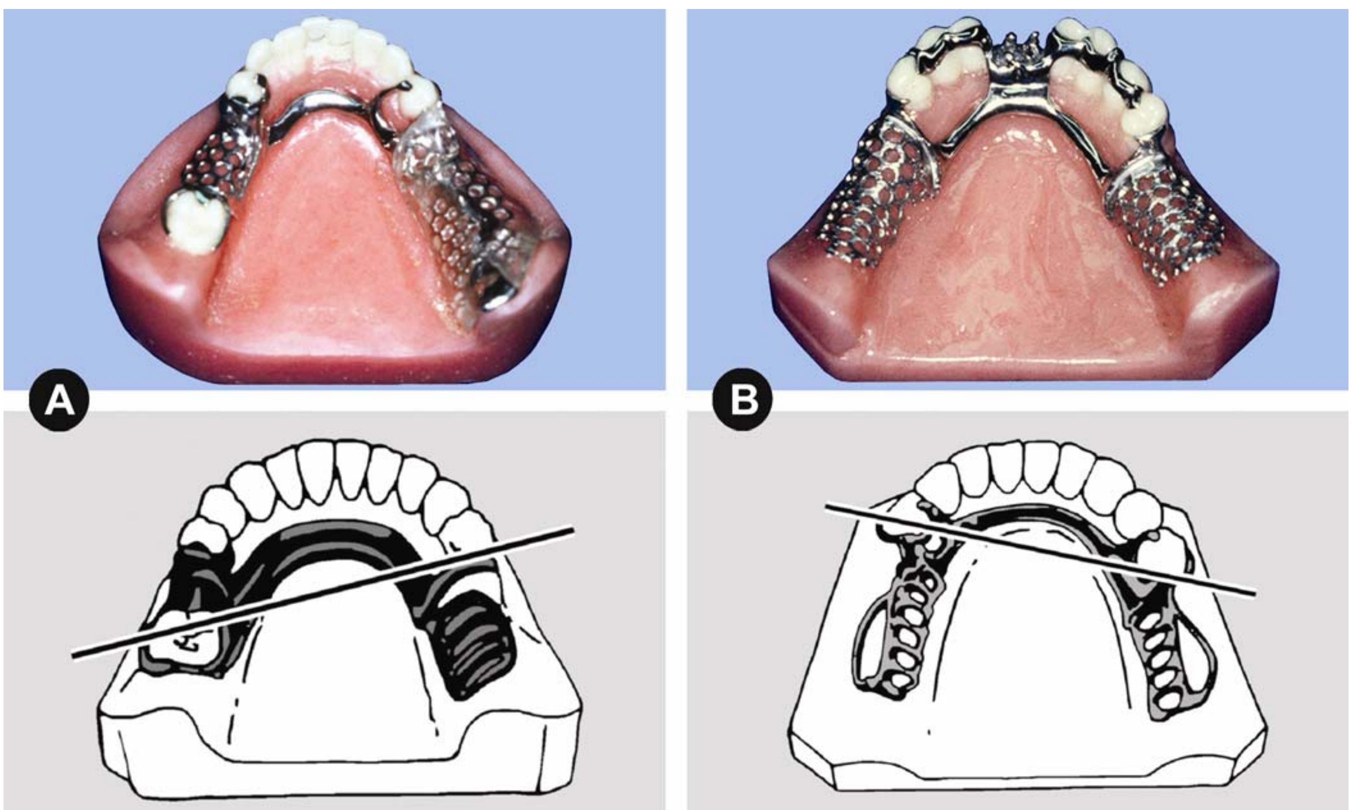
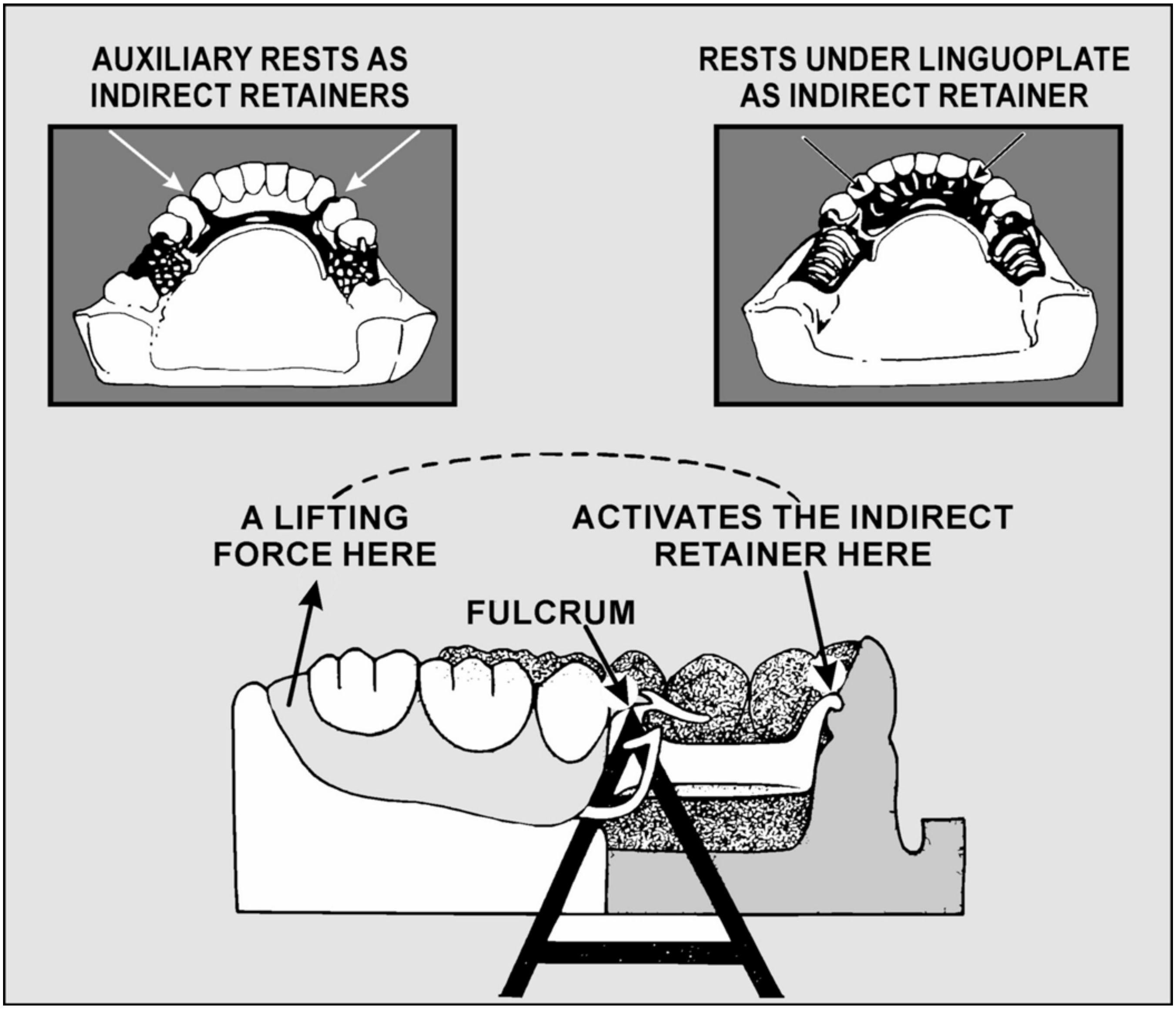


Figure 8.36. Principle of Indirect Retention.



8.14. Bracing Components. These components act to prevent shifting of the RPD laterally and anteroposteriorly as follows:

8.14.1. Guide planes are flat vertical areas on tooth surfaces that contact and stabilize the RPD. They sometimes are naturally occurring, but usually are prepared by the dentist. Properly constructed guide planes are the most important elements for bracing and stabilizing the RPD. For guide planes to be effective, they must have the following characteristics:

8.14.1.1. Multiple guide planes must be parallel to each other. They brace against each other and stabilize the RPD.

8.14.1.2. The longer the guide plane, the better the stabilizing effect. Sometimes the dentist will crown the abutment tooth and request a long guide plane. Ideally, the guide plane should extend from the occlusal surface to near the gingival tissue. The exception to this rule is when an RPI clasp assembly is used. In this case, the guide plane is intentionally made short.

8.14.2. Other components of an RPD also add bracing as follows:

8.14.2.1. Minor connectors associated with clasp assemblies and auxiliary rests.

8.14.2.2. Clasps. These following parts of a clasp brace an RPD:

8.14.2.2.1. The entire reciprocal arm.

8.14.2.2.2. The shoulder of the retentive arm of a circumferential clasp.

8.14.2.2.3. The approach arm and bracing tip of a bar clasp (minimally effective).

8.14.2.2.4. The clasp body braces against lateral or anteroposterior movement depending on where the body of the clasp is located relative to the tooth's surface.

8.14.2.2.5. Reciprocal plating.

8.14.2.3. RPD denture bases. The denture bases lap over the facial and lingual aspects of residual ridges. The taller the ridges, the better the bracing.

8.15. Replacing Natural Teeth and Tissue. The purpose of an RPD is to replace natural teeth and tissue. Natural tooth and tissue replacements must be joined to the framework in some way. The dentist indicates how the artificial replacement teeth and tissue are to be attached.

8.15.1. The replacements are generally composed of artificial denture teeth, acrylic resin replacement tissue, and metal support and retention components as follows:

8.15.1.1. Artificial teeth may be plastic, porcelain, composite resin, or metal. (However, porcelain teeth are rarely used anymore because of their tendency to chip, break and wear opposing natural teeth.) Tooth replacements may be made using metal, tooth-colored methyl methacrylate resin, or other esthetic composite resin veneering materials, such as Symphony®. But most commonly, stock denture teeth are used.

8.15.1.2. Pink acrylic resin (heat-cured or self-curing) is normally used to replace missing tissue and attach artificial teeth to the framework.

8.15.1.3. Metal support and retaining components may include beads, posts, rods, mesh, and bars.

8.15.2. Selection of the method of tooth and tissue replacement is based on the space available, the strength required, esthetic considerations, and future needs for modifying or adding to the RPD. Common combinations of artificial teeth, denture base materials, and attachment methods are as follows:

8.15.2.1. Reinforced acrylic pontic (RAP) used in anterior areas where there is average or limited room and biting force is more than normal. This is one of the strongest replacements for anterior teeth. A RAP is made from a denture tooth and is attached to the framework using a metal backing.

8.15.2.2. Plastic denture teeth embedded in denture resin retained by an open retention grid. Open retention may be constructed from mesh or ladder-type retention. Open retention is often selected when there may be a future need to reline the denture base area. It is also used when the dentist anticipates difficulty arranging the teeth. Mesh is weaker than ladder-type retention, but is easier to adjust and fabricate.

8.15.2.3. Plastic denture teeth embedded in denture resin retained by metal beads that are part of a metal base. These are used when space is somewhat limited and/or when a metal surface is desired against the tissue or additional strength is required, but the time to set RAPs is not justified.

8.15.2.4. Tooth-colored resin processed to a spiral retention post on a metal base. Frequently referred to as a braided post, it is often used with beads for added retention. It is stronger than metal and beads alone.

8.15.2.5. Metal replacement teeth and a metal base cast with the rest of the frame. This is the strongest tooth replacement and is used when space is very limited. Because metal facial tooth surfaces are unsightly, the tooth is usually hollowed out from the facial before it is cast. After casting, the facial surface is restored with appropriately shaded, tooth-colored resin.

8.15.2.6. Tube tooth (teeth) retained by a post on a metal base. This complex technique offers little advantage over a braided post with beads and is much more difficult to fabricate. A metal base and post are fabricated to fit an artificial tooth the dentist has correctly fitted to the patient's mouth. A finish line is prepared on the tooth, and a post hole is drilled into the tooth before the framework is made. The tooth is bonded to the framework with a self-curing resin.

8.15.3. Other considerations when selecting and fabricating replacement tooth and tissue areas are as follows:

8.15.3.1. Minor connectors should extend from the occlusal surface of the abutment tooth, down the guide plane, and about 1 mm onto the gingival tissues when a resin denture base is used. Because the tooth-tissue junction is considered to be vulnerable to disease, metal in this area is usually kinder to the tissue than acrylic resin.

8.15.3.2. The finish line, where the metal of the framework ends and the acrylic resin of the tooth replacement area begins, is critical. If a border of resin ends in a thin edge, this area will be weak and may chip or break. Therefore, a 1 mm thick finish line is placed in metal where the resin starts. This finish line allows the resin to blend smoothly with the metal section and creates in the resin a 90-degree butt joint in this critical area. Finish lines are internal or external, depending on the location and extent of the resin, but the requirements remain the same. Metal bases have only external finish lines.

8.16. Major Steps in RPD Construction. The following information (and Figure 8.37) outline the major steps required to make an RPD:

8.16.1. The dentist makes preliminary impressions of the patient's dental arches. The technician pours and trims the diagnostic casts.

8.16.2. The dentist performs a survey procedure on a diagnostic cast and composes a tentative design.

8.16.3. Using the survey lines and other marks on the diagnostic case as a guide, the dentist prepares rest seats and alters the survey lines of teeth in the patient's mouth.

8.16.4. If the dentist makes major changes in the patient's mouth, an impression for another diagnostic cast may be made. The cast is resurveyed to determine if modifications to the original design are required.

8.16.5. The dentist makes a final impression. (Some dentists use stock trays; others order custom trays.) Then the technician pours a master cast. A master cast must be a precise, positive duplicate of the patient's dental structures from which a prosthesis can be made.

8.16.6. Depending on the nature of the case, master casts might be mounted in an articulator. The procedure could require record bases and occlusion rims.

Figure 8.37. Major Steps in RPD Construction.

Figure 8.37. Continued.

8.16.7. The surveyed and designed diagnostic cast, along with an unsurveyed master cast, are sent to an area dental laboratory (ADL) for framework fabrication.

8.16.8. An ADL technician transfers the dentist's design from the diagnostic cast to the master cast.

8.16.9. Undesirable tooth and soft tissue undercuts are blocked out, and a thin sheet of wax is adapted to the ridge areas under proposed retention grids. The blockout procedure consists of using a surveyor to fill in selected undercuts on a master cast with wax, tissue, or modeling clay.

8.16.10. A reversible hydrocolloid impression is made of the blocked out master cast so it can be duplicated and poured in a heat-resistant investment material. A duplicate cast is poured, using a investment material is known as a *refractory cast.*

8.16.11. The refractory cast is dehydrated in an oven and sealed by wax immersion. The water within the cast is eliminated by heating in an oven, and the cast is sealed with beeswax.

8.16.12. The design is transferred from the master cast to the refractory cast.

8.16.13. The framework is constructed on the refractory cast with inlay wax and plastic patterns.

8.16.14. The refractory cast with the wax framework is invested in a ring of investment material and put in a heated oven. The wax burns out of the investment material, leaving a hole precisely the size and shape of the desired partial denture.

8.16.15. Chrome-alloy metal is melted and cast with centrifugal force into the hole.

8.16.16. The metal frame is broken out of the investment, cleaned, finished, and polished.

8.16.17. The dentist fits the framework in the patient's mouth. The occlusion of the RPD frame is checked and adjusted against the opposing natural teeth.

8.16.18. The master casts are mounted on the articulator. The dentist might require record bases and occlusion rims for a jaw relationship record procedure. The occlusion rims are often made right on the adjusted RPD frameworks.

8.16.19. The dentist might request the *corrected cast procedure* (altered cast) for distal extension cases.

8.16.20. The remaining steps are (1) setting the artificial teeth, (2) waxing the denture bases, and (3) processing the denture base. All these resin-processing steps must be made with the framework *accurately* seated on the master cast.

Section 8C—Diagnostic Casts, Custom Trays, and RPD Survey and Design

8.17. Use of Preliminary Impressions, Diagnostic Casts, and Custom Trays:

8.17.1. The average partially edentulous dental arch has many deep undercuts around the remaining teeth and alveolar ridges. Dentists prefer to use elastic impression material to make impressions for RPDs. The two types of materials used are *hydrocolloid* and *rubber base.* Chapter 7 describes the fragility of hydrocolloid materials and explains the procedures used to pour diagnostic casts (Section 7C). Diagnostic casts are used for the initial evaluation of the patient's dental problems, custom tray fabrication, and preliminary survey and design.

8.17.2. After the dentist alters the contours of the patient's teeth, he or she makes a final impression to produce a master cast. This impression is most often made in alginate. Most dentists use prefabricated trays for this purpose although some use custom trays. When a custom tray is ordered, use a 4 mm spacer to create the required amount of room for alginate impression material. Use baseplate wax for the spacer in acrylic resin trays (Section 7D). If the dentist so directs, take a #8 round bur and drill holes in the tray about 6 mm apart. This helps retain the alginate impression material in the tray. If the tray is destined to be used with rubber base impression material, the holes are not needed. Rubber base is retained with a bonding material such as contact cement.

8.17.3. Return the diagnostic cast and the finished tray to the dentist. The dentist surveys the diagnostic cast and draws a tentative RPD design on it. During the patient's next appointment, the dentist uses the diagnostic cast as a visual aid to cut rest seats and guide planes and to make any other necessary contour modifications. Next, the dentist takes a prefabricated tray or a custom tray and makes a final impression from which a master cast may be poured.

8.18. RPD Survey and Design:

8.18.1. **Survey.** The survey consists of analyzing a cast with a surveyor to select the most favorable path of insertion (the direction of travel the proposed RPD takes when going to place) and then marking cast features such as abutment tooth undercuts necessary for retention, the heights of contour of the remaining natural teeth, and soft tissue heights of contour.

8.18.2. **Design.** The design procedure involves making selections among various components using the survey procedures as a basis for choice and then combining component selections into a single, workable entity and drawing the design on the cast.

8.18.3. **Survey Versus Design.** If the definition of *design* is narrowly confined to drawing an illustration of the proposed RPD on a cast, then *designing* does properly follow *surveying.* What really happens is that a mental picture of the design forms while the survey is in progress. When the survey is finished, the design should be virtually complete in the mind's eye. Drawing the design is almost anticlimactic.

8.19. Dental Surveyor:

8.19.1. **Purposes of a Surveyor:**

8.19.1.1. **Survey the Cast.** A surveyor is an instrument that enables a person to draw a "contour map" on the teeth and tissue areas of a cast so the helpful features can be used and the undesirable ones minimized in the design.

8.19.1.2. **Block Out the Cast.** This process fills in undesirable tooth and soft tissue undercuts to allow the travel of rigid RPD parts past undercut areas. It reduces the possibility of hydrocolloid distortion during the duplication phase of RPD construction.

8.19.1.3. **Shape the Wax.** A surveyor is sometimes used to shape the axial surfaces of wax patterns when making crowns that act as RPD abutments (surveyed crowns).

8.19.1.4. **Position the Precision Parts.** Another surveyor function is to orient precision tracks; for example, RPD precision attachments and fixed partial denture precision rests.

8.19.2. **Parts of a Surveyor (Figure 8.38):**

8.19.2.1. Horizontal base.

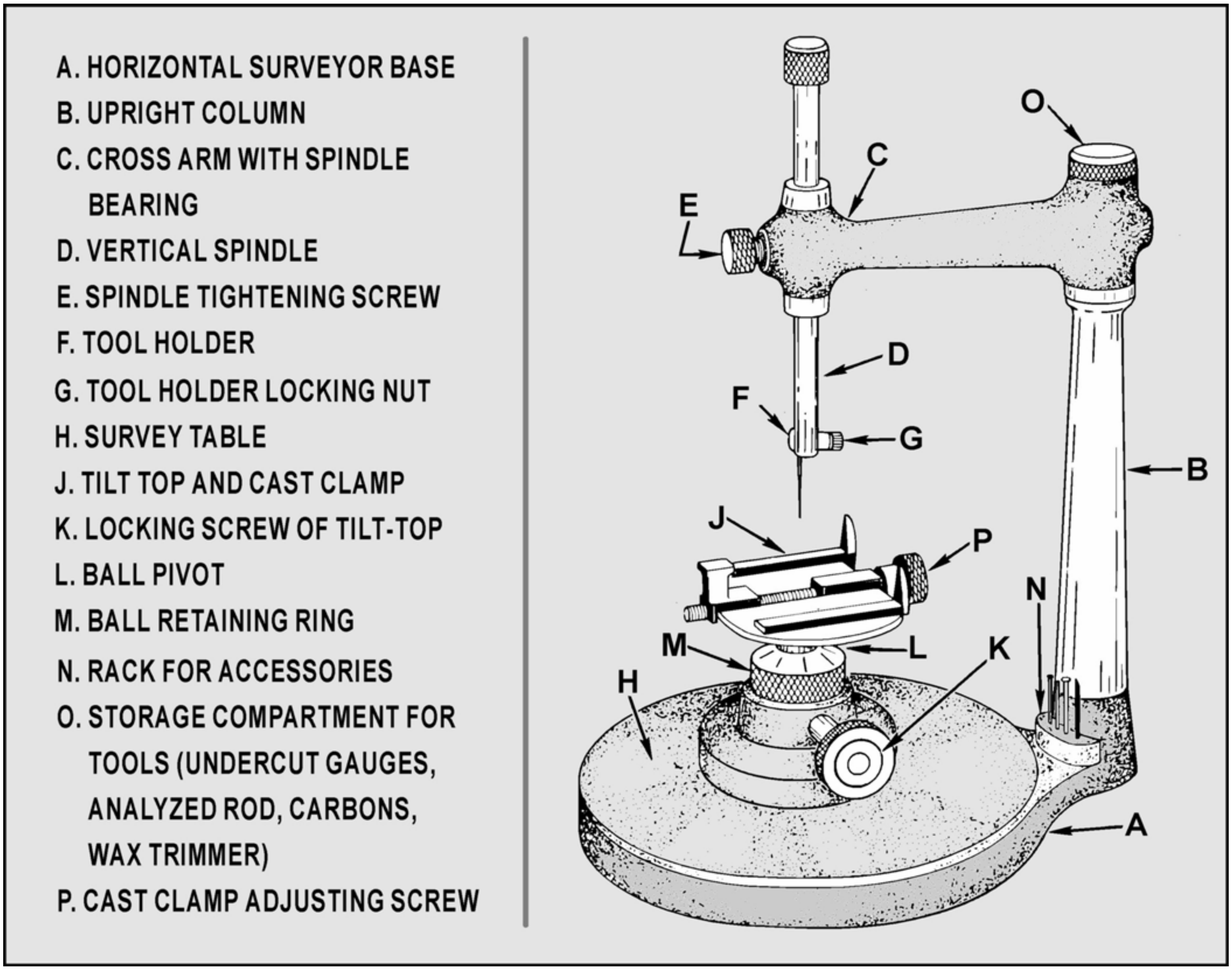
8.19.2.2. Upright column.

8.19.2.3. Cross arm with spindle housing.

8.19.2.4. Spindle with tool holder.

8.19.2.5. Survey table, which includes a base, tilt top with cast clamp, and tilt top lock screw. The occlusal plane of a cast mounted on a tilt table can be oriented at different angles to tools held in the tool holder of the spindle. Once a satisfactory orientation is found, the tilt top is locked in position with its lock screw.

Figure 8.38. Parts of a Dental Surveyor.



8.19.3. **Surveying Tools (Figure 8.39):**

8.19.3.1. **Analyzing Rod.** The analyzing rod consists of a thin, straight metal shaft used as a gross check on the presence or absence of undercuts. This tool has no ability to measure the amount of undercut.

8.19.3.2. **Carbon Marker.** The marker is a black pencil lead used to mark survey lines on teeth and soft tissue surfaces of the cast after the path of insertion has been chosen (Figure 8.40).

8.19.3.3. **Undercut Gauges.** Standard undercut gauges come in three sizes; .010, .020, and .030 inch. Gauges of .005 and .015 inch are frequently custom made. The amount of undercut needed to produce a standard amount of resistance to clasp removal is directly proportional to the flexibility of the retentive arm. To compensate for variations in clasp arm flexibility, different amounts of tooth undercut are engaged. A ten thousandth of an inch undercut (.010) is used most often. A twenty thousandth of an inch undercut (.020) is used with long or delicate clasps, such as 19-gauge wrought wire. A thirty thousandth of an inch undercut (.030) is rarely used.

Figure 8.39. Surveying Tools.

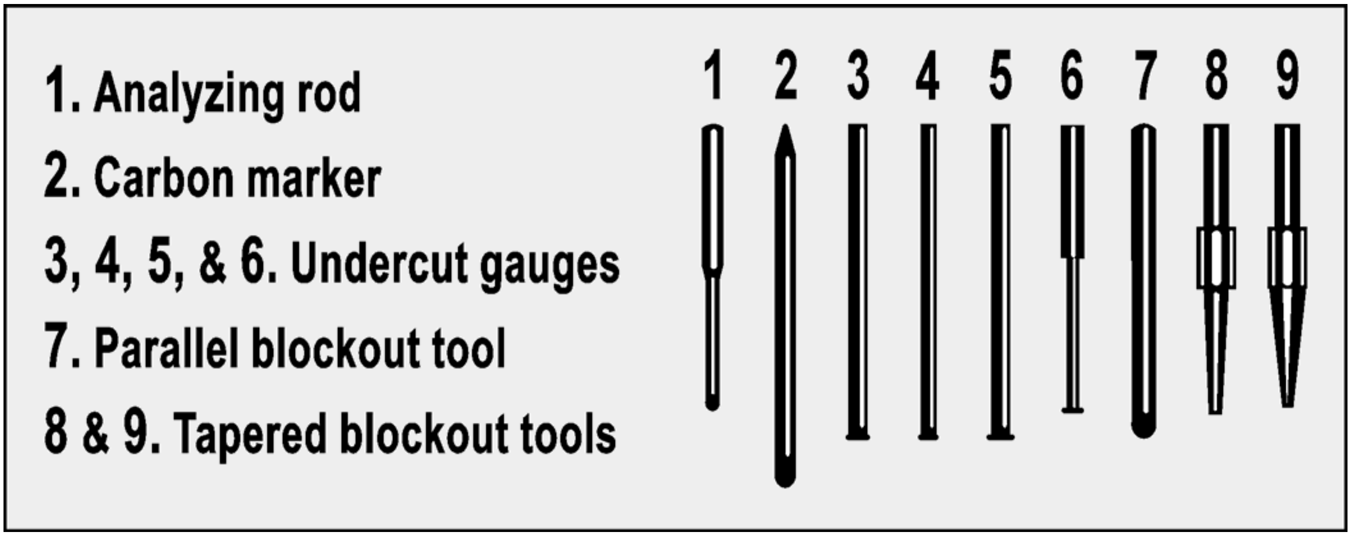
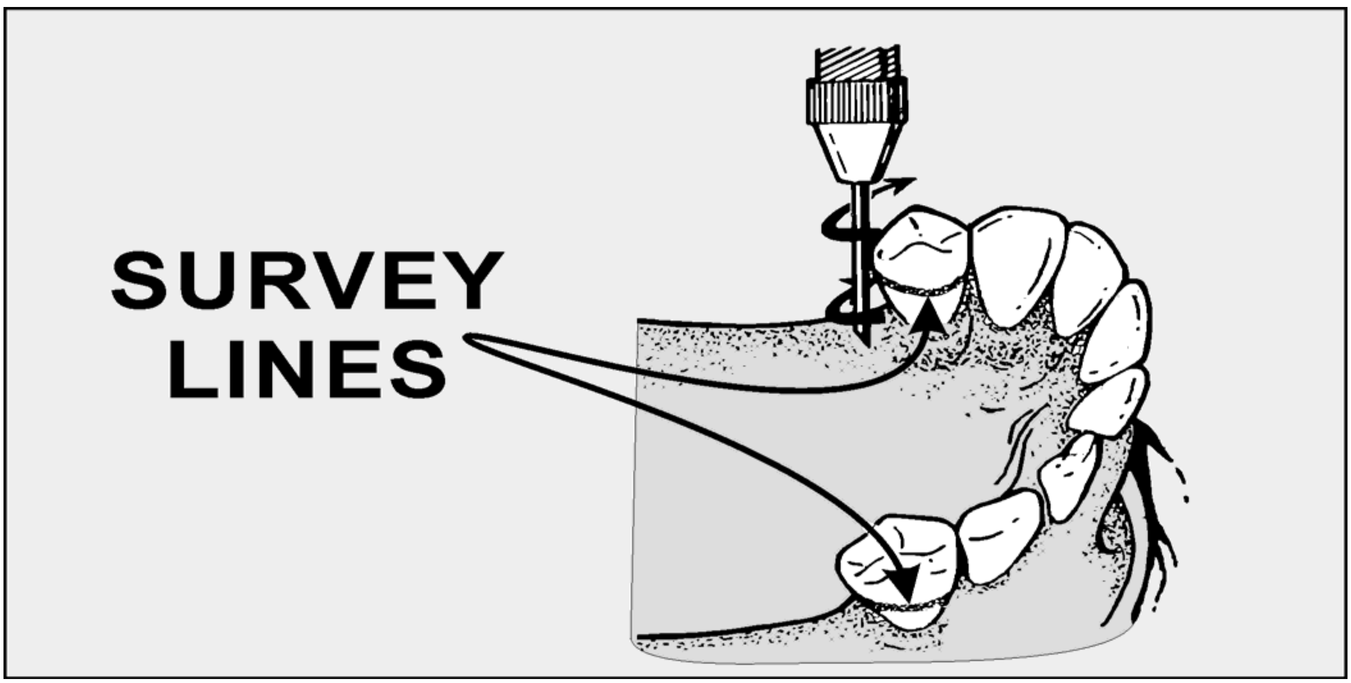
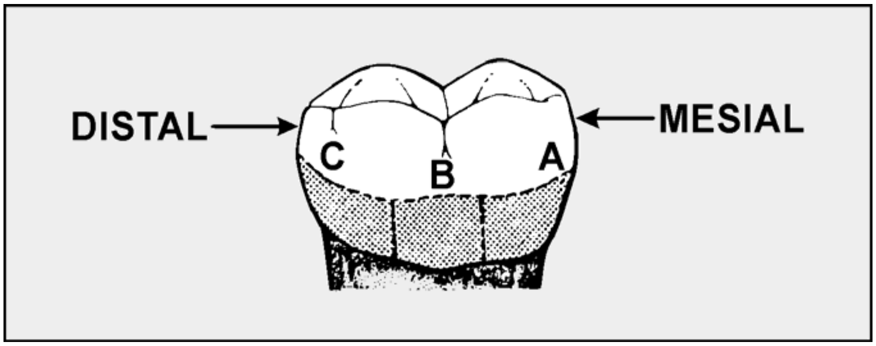


Figure 8.40. Marking a Survey Line With a Carbon Marker.



8.19.3.3.1. **Desirable Undercuts.** A desirable undercut is an area of undercut on a tooth's surface that has sufficient depth, suitable location, and reasonable accessibility in relation to clasp assemblies chosen for the RPD design. There are many *zones* on the infrabulge surface of a tooth where the retentive tips of various clasp types might be positioned. For example, I-bar clasps are frequently used to engage undercuts located in the midfacial surfaces of a tooth. The most common zones to check for desirable undercuts are the mesiofacial, midfacial, and distofacial (Figure 8.41). When undercuts are not available on facial surfaces, mesiolingual, midlingual, or distolingual undercuts may be used.

Figure 8.41. Mesiofacial (A), Midfacial (B), and Distofacial (C) Zones of Undercut on a Lower Molar.



8.19.3.3.2. **Undesirable Undercuts.** Undesirable undercuts are all tooth and soft tissue undercuts along the path of insertion that are not used for retention. The rigid parts of an RPD must not contact undesirable undercuts when going to place. If the rigid parts of the RPD were constructed to conform to tooth and tissue undercuts, the RPD would not seat. Undesirable undercuts may also distort the hydrocolloid during duplication. Undesirable undercuts are eliminated in the blockout and duplication phases of RPD construction.

8.19.3.3.3. **Positioning a Clasp Tip Within a Zone of Desirable Undercut (Figure 8.42).** Undercut gauges consist of a shaft and a lip. When contact of the shaft at the tooth's height of contour and contact of the lip with the infrabulge surface happen at the same time, the amount of undercut specified by the undercut gauge is present at the lip's point of contact with the tooth. The tip of a clasp's retentive arm should be positioned on that spot.

8.19.3.4. **Blockout Tools.** All tooth and soft tissue undercuts are subject to blockout except in the infrabulge area between a retentive tip's cervical border and the survey line. The blockout procedure is accomplished with blockout tools mounted in the vertical spindle of a surveyor. There are two types of blockout tools; (1) a parallel or (0 degrees) blockout tool, and (2) a tapered tool that ranges from 2 to 6 degrees. Tapered tools are occasionally used to block out undesirable undercuts beneath minor connectors that are part of clasp assemblies or lead to auxiliary rests.

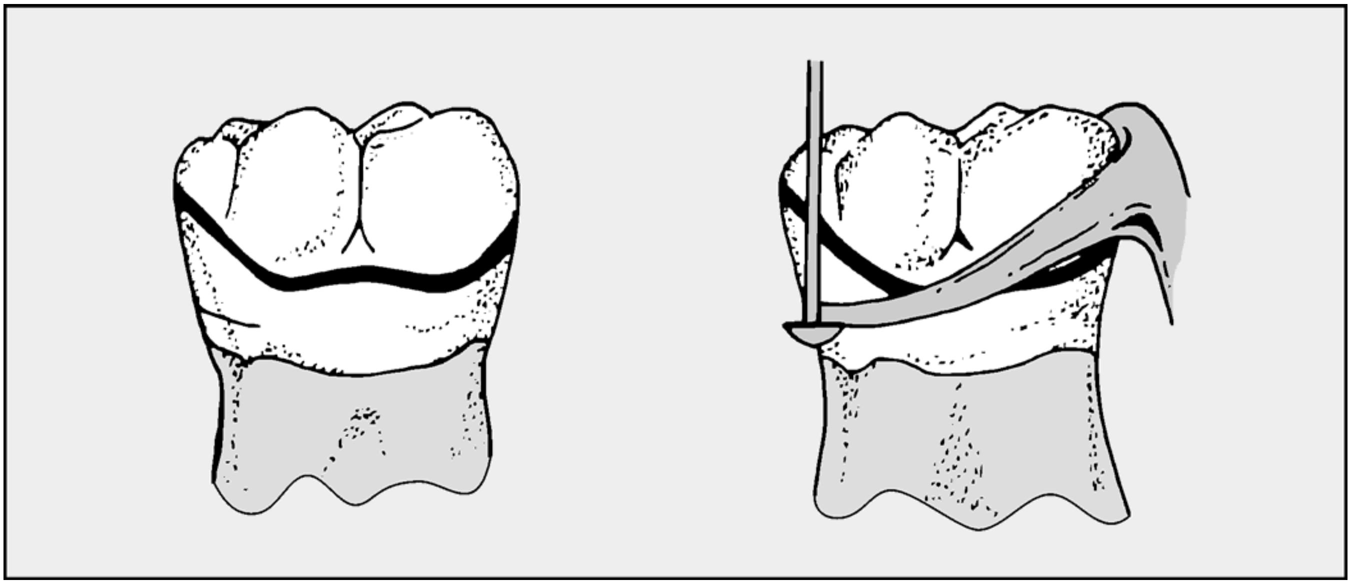
8.20. Knowledge of Survey and Design Principles:

8.20.1. A thorough knowledge of survey and design principles has value for many reasons. It is necessary to understand all types of instructions and interpret the dentist's design drawn on the cast. The technician is responsible for accurately transferring a design from the diagnostic cast to the master and refractory casts.

8.20.2. The starting point for this discussion is a diagnostic cast poured from a preliminary impression. No rest seats have been cut into the patient's natural teeth because many acceptable designs are possible. The design process should indicate the location of rest seats rather than the location of rest seats dictating the design.

8.20.3. Once the dentist cuts the rest seats, the design possibilities are reduced. This is an indication that the dentist has a definite RPD design in mind. The RPD should be kept as simple as possible; components should not be added without a reason.

Figure 8.42. Positioning a Clasp Tip Within a Zone of Desirable Undercut.



8.21. Procedures for Arriving at an RPD Design Drawn on a Cast: (***NOTE:*** The 17 procedures listed in the following subparagraphs are further detailed in paragraphs 8.22 through 8.38.)

8.21.1. Evaluate the relationship between the m axillary and mandibular casts in centric occlusion (paragraph 8.22).

8.21.2. Decide which artificial tooth and tissue repl acements are best suited to the case (paragraph 8.23).

8.21.3. Classify the case according to the Word Picture System (paragraph 8.24).

8.21.4. Determine the need for indirect retention (paragraph 8.25).

8.21.5. Tentatively pick a major connector (paragraph 8.26).

8.21.6. Determine how many clasp assemblies are needed and make a preliminary judgment about their placement (paragraph 8.27).

8.21.7. Identify surfaces to use as guide planes (paragraph 8.28).

8.21.8. Choose a path of insertion to confirm an occlusal plane tilt (paragraph 8.29).

8.21.9. Limit and improve the tilt (paragraph 8.30).

8.21.10. Place tripod marks on the cast (paragraph 8.31).

8.21.11. Mark the tooth and soft tissue survey lines with a carbon marker (paragraph 8.32).

8.21.12. Decide where tooth modifications will enhance RPD function (paragraph 8.33).

8.21.13. Mark the location of retentive tips. (paragraph 8.34)

8.21.14. Select a clasp assembly for each abutment tooth (paragraph 8.35).

8.21.15. Decide if all requirements for rests have been met (paragraph 8.36).

8.21.16. Draw the design in appropriate coded colors (paragraph 8.37).

8.21.17. Protect the design from smudging (paragraph 8.38).

8.22. Evaluate the Relationship Between the Maxillary and Mandibular Casts in Centric Occlusion. A patient might require only one RPD, but a treatment plan should never be initiated without access to the opposing cast. When maxillary and mandibular casts are oriented in centric occlusion, the technician will:

8.22.1. Observe how much vertical space is available in the tissue and tooth replacement areas. If opposing ridges contact (the maxillary tuberosity touches the retromolar pad in distal extension cases) or natural teeth touch an opposing ridge, an RPD cannot be made until the dentist corrects the problem. If vertical space is limited, tissue and tooth replacements should be chosen accordingly.

8.22.2. When designing a maxillary RPD, indicate the amount of vertical overlap between upper and lower anterior teeth by drawing a black line on the lingual surfaces of the maxillary anterior teeth where the mandibular teeth contact. This pencil line helps make the decision for or against maxillary major connectors with lingual plating. The line also shows the dentist which surfaces to avoid when cutting the rest seats.

8.22.3. Make a mental note of those areas where the stamp cusps do not contact the opposing teeth. These areas best accommodate rests and clasp bodies that transverse occlusal embrasures.

8.23. Decide Which Artificial Tooth and Tissue Replacements Are Best Suited to the Case:

8.23.1. **Criteria.** The criteria for choice among the common denture base and artificial tooth combinations are as follows:

8.23.1.1. The amount of space present between the crest of the residual ridge and the opposing arch—a very important factor.

8.23.1.2. Esthetic values.

8.23.1.3. The presence of soft tissue undercuts.

8.23.1.4. The length of the edentulous span.

8.23.1.5. The general condition of the residual ridge in terms of soft tissue health and anticipated rates of bone resorption. A ridge probably resorbs most during the first year after extractions are performed. An RPD made at this time will probably require relining sooner than usual.

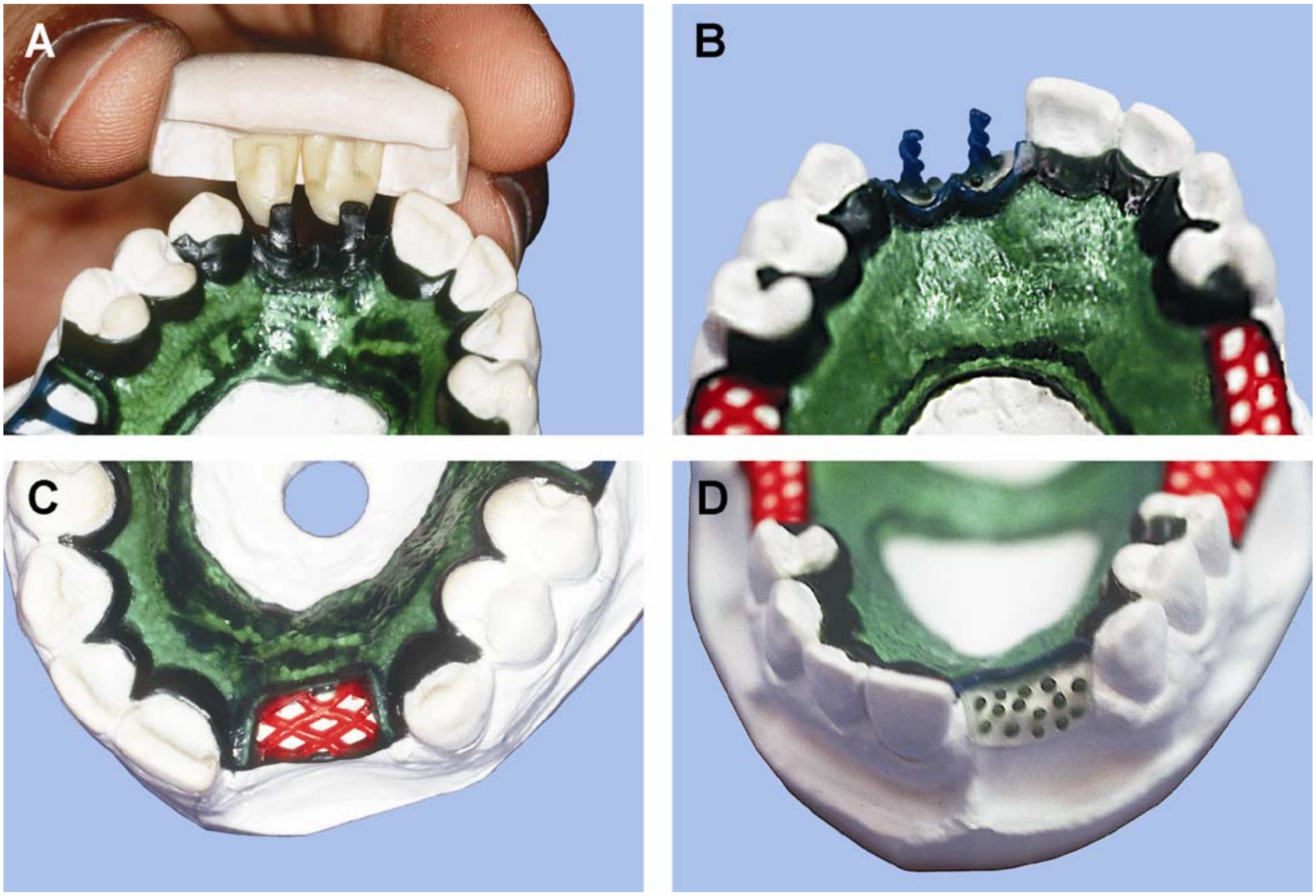
8.23.2. **Anterior Area Tooth and Tissue Replacements (Figure 8.43).** A primary factor in selecting anterior replacements is esthetic acceptability.

8.23.2.1. **RAP Retained on a Metal Base (Figure 8.43-A):**

8.23.2.1.1. This system uses denture teeth that are ground to fit the edentulous space. They are then attached to the metal frame with tooth-colored resin.

8.23.2.1.2. RAPs look very natural, and there is a great variety of denture tooth molds and shades to choose from. Good three-dimensional effects, such as overlapping the teeth, are possible. Repairs or additions with identical replacements are possible because stock denture teeth are used. The presence of facial soft tissue undercuts does not prohibit their use.

Figure 8.43. Anterior Area Tooth and Tissue Replacement.



8.23.2.1.3. RAPs can be used when space between the residual ridge and opposing natural teeth is limited; however, they are not indicated in cases where the residual ridge is significantly resorbed or severely damaged. RAPs should not be used in long spans where they tend to get more support from underlying tissue than from abutment teeth. Because RAPs have limited reline potential, residual ridges should be well healed when RAPs are proposed.

8.23.2.1.4. RAPs require more preparation before the RPD framework is made. The teeth must be selected, carefully ground to fit, and set on the master cast. The dentist may desire to try the teeth in the patient's mouth so they can be previewed before the framework is made. A matrix must be prepared to relate the teeth to the master cast, refractory cast, and framework. Despite the extra work, RAPs are often the preferred anterior tooth replacement because of their strength, esthetics, and versatility.

8.23.2.2. **Processed Tooth-Colored Resin Attached to a Metal Base:**

8.23.2.2.1. One method is to first carve replacement teeth in white, nonstaining wax on the metal frame as part of the denture base wax-up procedure. These teeth are subsequently processed in suitably shaded resin.

8.23.2.2.2. In another technique, the replacement tooth form is waxed up with the framework. A window is carved out of the facial surface and small beads or loops are placed. After the framework is cast, a tooth colored resin veneer is processed into the window.

8.23.2.2.3. A third method is to process light cured composite resin around a braided post (Figure 8.43-B). This gives the technician great versatility as far as staining and contours are concerned.

8.23.2.2.4. As is true for RAPs, processed resin teeth can be used if undesirable soft tissue undercuts are present or when space is limited; they cannot be used in cases where the residual ridge has become flabby or reduced in size. A major drawback to this procedure is that carving and color characterizing the teeth is difficult. The processed resin is not as strong, wear resistant or stain resistant as stock plastic denture teeth; but unusual situations sometimes require this technique be used. All things considered, RAPs are better solutions.

8.23.2.3. **Plastic Denture Teeth Plus Denture Resin Attached by Using an Open Cast Metal Retention Grid (Figure 8.43-C):**

8.23.2.3.1. **Uses:**

8.23.2.3.1.1. This type of artificial substitute is used because it is an excellent way to compensate for grossly resorbed or misshapen residual ridges. The tissue surface of the denture resin saddle can be relined. The coverage provided by a resin base serves support and bracing functions in long span edentulous areas.

8.23.2.3.1.2. Denture teeth embedded in resin denture bases have their limitations. The combination requires a lot of space between the residual ridge and opposing teeth. The denture base's labial flange should extend to the sulcus. This requirement cannot be met when deep facial soft tissue undercuts are present.

8.23.2.3.1.3. Denture teeth embedded in resin bases are not as esthetic as RAPs or facings. If the vertical junction line between the border of the denture base and the gingiva falls near the midline of the arch, the junction will be visible. The only possibilities for concealing the junction line are to thin out the lateral borders of the flange without creating a knife edge and to match, as closely as possible, the color of the denture base to the adjacent tissue.

8.23.2.3.2. **Types of Open Retention Grid:**

8.23.2.3.2.1. Ladder retention is made of struts that cross the edentulous ridge. It is the strongest open retention, very versatile, easily constructed, and the most commonly used.

8.23.2.3.2.2. Mesh retention is made from commercially prefabricated plastic patterns. These patterns can be applied quickly during the wax-up process. Mesh is useful when less vertical space is available than is ideal for ladder retention. When denture teeth are being set on the framework, some of the mesh may be cut away without significantly affecting the strength of the retention grid. Mesh does not retain the acrylic resin denture base as well as ladder retention.

8.23.2.4. **Plastic Denture Teeth Plus Denture Resin Retained by Metal Beads on a Metal Base (Figure 8.43-D).** This option is used when space is at a premium. Metal beads on a thin metal base take up less room than resin retention grids. Metal beads do not retain the resin to the framework as well as open retention or RAPs. A braided or "spiral" post is sometimes used to increase retention of the denture teeth to the metal base.

8.23.2.5. **Commercial Facings Retained on a Metal Backing With a Cementing Medium:**

8.23.2.5.1. Facings are prefabricated in many molds and colors. One advantage of facings is that repairs with identical replacements are relatively simple. The presence of facial soft tissue undercuts does not prohibit their use.

8.23.2.5.2. Facings can be used when space between the residual ridge and opposing natural teeth is extremely limited. Facings cannot be used where the residual ridge is significantly resorbed or severely damaged. They should not be used in long spans where they tend to get more support from underlying tissue than from abutment teeth.

8.23.2.5.3. Because facings have no reline potential, residual ridges should be well healed when facings are proposed. ***NOTE:*** Facings are becoming difficult to find because of the popularity of simpler methods, such as RAPs.

8.23.3. **Posterior Area Tooth and Tissue Replacements (Figure 8.44).** Space is almost always at a premium in posterior areas. The selection of substitutes for missing posterior teeth and tissue is usually driven by a lack of space. Following are several options for posterior replacements:

8.23.3.1. **Plastic Denture Teeth Plus Denture Resin Attached to an Open Cast Metal Retention Grid (Figure 8.44-A).** Overall, this is the most commonly used replacement combination for long-span defects. It requires a fair amount of vertical height between opposing arches for proper fabrication and is popular because:

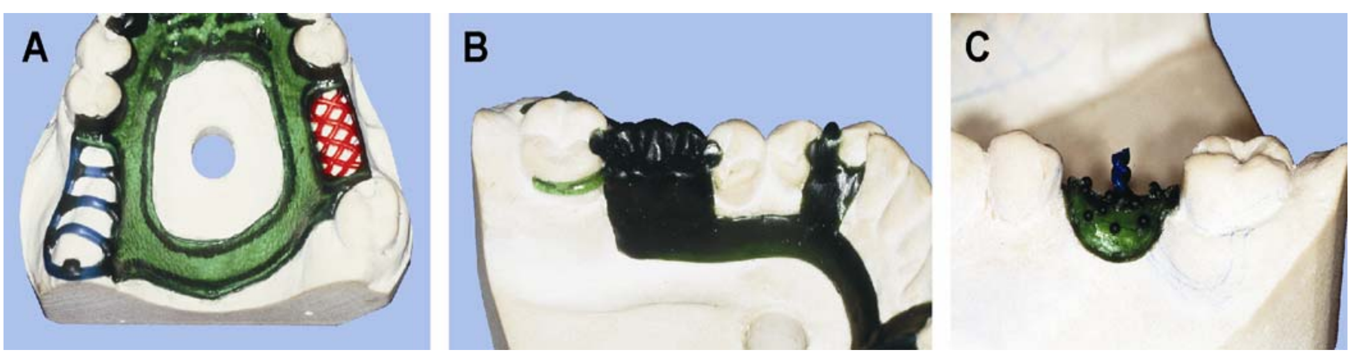
8.23.3.1.1. The denture base is relinable, easy to adjust, and simple to repair.

8.23.3.1.2. The combination of denture teeth and tissue colored plastic is moderately esthetic.

8.23.3.1.3. The retention grid may be ladder or mesh. Ladder retention grid takes up more vertical room than mesh. However, ladder retention is favored when space permits because there are fewer technical problems with its use.

8.23.3.2. **Metal Teeth and a Metal Base Carved and Cast as a Unit with the Rest of the Frame (Figure 8.44-B).** Cast metal bases fit against underlying tissue more accurately than processed plastic. In addition, this replacement combination needs the least amount of room between opposing arches and is by far the strongest tooth replacement. Conversely, the tissue surface of the base cannot be relined, and the overwhelming display of metal is often objectionable. Space permitting, metal posterior teeth can be cast as hollowed-out shells and tooth-colored resin used to form the facial surfaces.

Figure 8.44. Posterior Area Tooth and Tissue Replacements.



8.23.3.3. **Processed Tooth-Colored Resin With Loop or Braided (Spiral) Post Retention on a Metal Base (Figure 8.44-C).** This combination is ordinarily used in short span situations as a substitute for tube teeth. A possible advantage of the processed resin replacement is that it requires slightly less interarch space than a tube tooth for proper fabrication and is much easier to make.

8.24. Classify the Case According to the Word Picture System. According to paragraph 8.6 and Figure 8.2-A through -H, decide whether the case is classified as posterior unilateral toothborne, posterior bilateral toothborne, anterior toothborne, combination toothborne, unilateral distal extension, bilateral distal extension, anterior extension, or combination extension.

8.25. Determine the Need for Indirect Retention. Indirect retention should be part of the design whenever there is an extension base. Decide whether indirect retention is necessary and tentatively determine how to achieve it. An RPD rest can serve as indirect retention whether it is an auxiliary rest or part of a clasp assembly. Lingual plating generally does not provide adequate indirect retention because it rests on an inclined plane, unless rest seats are included in the plated anterior teeth.

8.25.1. **Distal Extension Cases:**

8.25.1.1. In the maxillary arch, the auxiliary rest seats most often cut for indirect retention in distal extension cases are the cingulum of a canine; the mesial fossa of a first premolar; and, possibly, the cingulum of a central incisor. In the mandibular arch, they are the mesial fossa of a first premolar; the mesio-incisal edge of a canine; the mesio-incisal edge of an incisor; and, occasionally, the cingulum of the canine.

8.25.1.2. Incisal rests are not usually placed on maxillary anterior teeth. The rests are unsightly; and, in most cases, there is not enough room for the minor connector of a maxillary incisal rest in centric occlusion.

8.25.1.3. In the mandibular arch, the mesial fossa of the first premolar takes precedence over the cingulum of a canine as a desirable rest seat because the cingulum enamel of a lower canine is relatively thin. The dentist runs a high risk of cutting through enamel into the decay prone dentinal layer when preparing a rest seat. This is not the case in the maxillary arch because the cingulum enamel of a canine is much thicker. Sometimes the dentist adds a cingulum rest to a canine or incisor, using composite resin or other type of restoration.

8.25.2. **Anterior Extension Cases.** The rest seats most commonly used for indirect retention in anterior extension cases are bilateral occlusal rest seats. They are placed as far posteriorly in the quadrants as possible. In these cases, the rests will almost always be part of a clasp assembly.

8.25.3. **Extension Combination Cases.** It is difficult to achieve any indirect retention for the anterior extension-distal extension combination situation. Because many natural teeth are missing anterior and posterior to the axis of rotation in extension combination cases, access to adequate indirect retention is severely limited. Minimal indirect retention is derived from broad coverage of displacement resistant tissue under denture bases and palatal major connectors.

8.25.3.1. **Maxillary Arch.** Anterior and posterior denture bases (saddles) should cover the maximum area tolerable. (A full palatal major connector is suggested.) If a closed horseshoe is used, the anterior part must cover the rugae and the posterior strap should be as broad as possible.

8.25.3.2. **Mandibular Arch.** The “teeter-totter” effect is more severe here than in the maxillary arch because no palatal strap is present to offset the movement of the anterior extension incisally. Also, there are no firm rugae to help resist occlusal displacement of the distal extension. The only recourse available is maximum coverage of anterior and posterior ridge areas, including as much of the buccal shelves and retromolar pads as possible. There is nothing special about these measures; such coverage is required as good dental practice in many kinds of RPD cases.

8.26. Tentatively Pick a Major Connector:

8.26.1. **Major Connector Choices in the Maxillary Arch:**

8.26.1.1. **Case Classification:**

8.26.1.1.1. The anterior toothborne classification is probably the category that represents the least number of missing teeth, and the combination extension is the category that represents the most missing teeth. The edentulous spaces of cases in an RPD classification vary in length. Generally speaking, larger and sturdier connectors are required as the number of missing teeth increases.

8.26.1.1.2. While only a rough guide, the chart in Figure 8.45 shows as many as three different major connectors that might be proper for a maxillary RPD case. The size of the edentulous spaces could be a factor that eliminates one of the choices. There are at least five more factors that would help an RPD designer "zero-in" on a single choice.

Figure 8.45. Case Classification as a Factor in Choosing a Maxillary RPD Major Connector.

CASE CLASSIFICATION	MAJOR CONNECTOR: PALATAL STRAP	HORSESHOE	ANT-POST PALATAL STRAP	CLOSED HORSESHOE	FULL PALATAL PLATE
ANTERIOR TOOTHBORNE	X	X			
POSTERIOR TOOTHBORNE	X		X		
COMBINATION TOOTHBORNE		X	X	X	
UNILATERAL DIST EXT		X	X	X	
BILATERAL DIST EXT			X	X	X
ANTERIOR EXTENSION		X	X	X	
COMBINATION EXTENSION			X	X	X

8.26.1.2. **The Need for Indirect Retention in Distal Extension Cases.** Such retention can be achieved by using an auxiliary rest suspended from the anterior edge of a strap or bar. Another method is to use the rests that are an integral part of the standard lingual plate design as indirect retainers.

8.26.1.3. **Occlusion.** A lingual plate classically extends one-third of the way up the lingual surfaces of the maxillary anterior teeth. Using the vertical overlap line drawn on the lingual of the anteriors as a reference, any part of a lingual plate that is positioned incisal to that line will probably interfere with normal contacts between upper and lower natural teeth.

8.26.1.4. **Health of the Remaining Teeth.** There are instances where some of the remaining anterior teeth are loose, but not loose enough to justify extraction. A lingual plate with its associated rests can act to stabilize loose teeth in their sockets. If one or more of the questionable teeth under the plate are subsequently extracted, the RPD does not have to be remade. Instead, an artificial tooth can be attached to the plate.

8.26.1.5. **Length of the Dental Arch.** There is a large group of cases where a choice must be made between U-shaped major connectors and major connectors having a closed "U" configuration. A long distance between an incisive papilla and the vibrating line favors selection of connectors having the additional rigidity made possible by a posterior palatal bar segment.

8.26.1.6. **Maxillary Torus.** Avoid the torus by using horseshoe, anteroposterior palatal bar, or closed horseshoe connectors. Palatal straps and full palatal plates are contraindicated.

8.26.2. **Major Connector Choices in the Mandibular Arch.** The choices are the lingual bar, lingual plating, and labial bar.

8.26.2.1. The basis for choosing is as follows:

8.26.2.1.1. The amount of space between the sulcus and the gingival crests on the lingual aspect of the ridge. The conditions for use of a lingual bar are (1) the superior border should clear the gingival margins by 4 mm, and (2) the inferior border should not restrict the floor of the mouth's normal mobility. If these conditions cannot be satisfied, select a lingual plate.

8.26.2.1.2. A need for indirect retention. The *rests* that normally support the ends of a lingual plate can act as *indirect retainers* in distal extension cases.

8.26.2.2. Specific indicators for selecting a labial bar are:

8.26.2.2.1. Severe lingual inclination of mandibular incisors,

8.26.2.2.2. Severe, bilateral, lingual inclination of mandibular posterior teeth,

8.26.2.2.3. Lingual soft tissue contours that create unacceptably deep undercuts, or

8.26.2.2.4. The presence of very large mandibular tori that cannot be removed for one reason or another.

8.27. Determine How Many Clasp Assemblies Are Needed and Make a Preliminary Judgment About Their Placement:

8.27.1. **General Clasp Assembly Guidelines:**

8.27.1.1. **Number of Clasp Assemblies.** Use as few assemblies as necessary to produce acceptable retention. Rarely use more than two clasp assemblies per quadrant; one clasp assembly per quadrant is usually sufficient.

8.27.1.2. **Location of Clasp Assemblies.** The preferred sites for clasp assemblies are teeth adjacent to edentulous spaces. Incisor teeth are a notable exception because they are weaker than posterior teeth and clasps placed on them tend to be visible. Incisors next to an edentulous space almost always have auxiliary rests placed on them, but are rarely clasped.

8.27.1.3. **Esthetics of Clasp Assemblies.** Patients do not like clasp assemblies that show. Sometimes, special clasp assemblies such as twin flex clasps can be used to hide clasps. Canines can sometimes be clasped with a clasp that engages a distobuccal undercut to hide the clasp from direct view.

8.27.1.4. **Separation of Clasp Assemblies.** If two clasp assemblies are indicated for use in a quadrant, use single clasps, separated by a distance of at least one tooth, to stabilize the frame more effectively. (An embrasure clasp counts as two clasps.)

8.27.1.5. **Opposition of Retentive Undercuts.** Undercuts used for retention should oppose each other properly. Generally, buccal retention on one side of the arch should be opposed by buccal retention on the other side. The same concept applies to lingual retention.

8.27.1.6. **Coverage of Tooth and Gingival Tissues.** Bar clasps contact less tooth area than circumferential clasps and may be a better choice if a patient has a high incidence of decay. Circumferential clasps cross the free gingival margin fewer times than bar clasps and may create less food and plaque trap areas than bar clasps.

8.27.1.7. **Periodontal Support.** Circumferential clasps are stiffer than bar clasps or wrought wire clasps. Therefore, if the tooth has been weakened from periodontal disease, a clasp that is less stiff may be desirable.

8.27.2. **Clasp Assemblies Specifically Related to the Classification of the Case:**

8.27.2.1. **Toothborne RPD.** A toothborne RPD allows a great deal of flexibility in choosing the number and type of clasps.

8.27.2.1.1. **Anterior Toothborne RPD.** The first premolar and first molar in each quadrant are often clasped. Spreading the clasp assemblies as much as possible provides the best stability.

8.27.2.1.2. **Unilateral Posterior, Bilateral Posterior, and Combination Toothborne RPD:**

8.27.2.1.2.1. In a quadrant where no posterior teeth are missing, a clasp assembly is placed on each of two posterior teeth and the assemblies are separated by a distance of at least one tooth. If a quadrant contains one posterior edentulous space, the teeth mesial and distal to the space are clasped.

8.27.2.1.2.2. If there are two posterior edentulous spaces on a side, the tooth mesial to the anterior space, and distal to the posterior space are normally clasped. The tooth in between *(intermediate abutment)* is not clasped with a clasp that engages a retentive undercut. This is because this tooth is the fulcrum around which the RPD may rotate and is subject to additional stress. The intermediate abutment may be clasped if the arms of the clasp are both constructed as reciprocal arms.

8.27.2.2. **Extension RPD:**

8.27.2.2.1. **Unilateral Distal Extension RPD.** For unilateral distal extension cases, one clasp assembly is placed in the distal extension quadrant and one or two clasp assemblies are placed on the toothborne side. On the side with the distal extension defect, a clasp assembly is placed on the most distal tooth present. On the toothborne side, follow rules already given for posterior toothborne RPDs (paragraph 8.27.2.1.2).

8.27.2.2.2. **Bilateral Distal Extension RPD.** One clasp assembly is placed on the most distal tooth present in each quadrant.

8.27.2.2.3. **Anterior Extension RPD.** The first premolars and second molars are clasped bilaterally.

8.27.2.2.4. **Combination Extension RPD.** With the canine tooth as the anterior limit, locate one clasp assembly as far anteriorly and another as far posteriorly as possible on each side. Obviously, only one clasp assembly can be used in a quadrant if just one tooth remains.

8.28. Identify Surfaces To Use as Guide Planes. Generally, all tooth surfaces next to edentulous spaces and in areas where reciprocal elements of the RPD will be placed should be used for guide planes. This may include proximal areas, distal surfaces of distal abutments, and lingual surfaces. The exception is anterior teeth, because esthetics will usually not allow the change in contour. Guide planes are generally broad occlusogingivally and flat buccolingually, removing much of the gingival undercut.

8.29. Choose a Path of Insertion To Confirm an Occlusal Plane Tilt:

8.29.1. **Tentative Design.** When receiving a diagnostic cast, examine it for a possible path of insertion that minimizes undesirable undercuts, gives desirable undercuts where needed, and makes maximum use of guide planes. Then decide on a tentative design before beginning to draw a design on the cast. Next place the cast on an adjustable tilt table to determine if the design is possible. If that is not possible, a change to the tentative design may be needed.

8.29.2. **Path of Insertion:**

8.29.2.1. The path of insertion (or path of placement) is the direction of travel an RPD takes from the instant its rigid parts contact abutment teeth to the time all rests are fully seated. All RPD components effect the path of insertion, but guide planes have the most influence.

8.29.2.2. Different RPDs, each with a different route for going to place, can probably be used for the same case. The RPDs might not even look alike. RPD design depends in part on the depth and location of tooth and soft tissue undercuts, both of which change as the proposed path of insertion changes. Because some RPD designs are better for certain situations than others, it follows that there is a path of placement that is better suited to a case than others.

8.29.3. **Definition of Tilt:**

8.29.3.1. When a cast is mounted on an adjustable tilt table in a surveyor, tilt is defined as the orientation of the cast's occlusal plane to the long axis of the surveyor's spindle. The angle that the spindle makes with the occlusal plane is a representation of one possible path of insertion. By tilting the survey table at various angles, the tooth and soft tissue undercuts along all reasonable paths of insertion and can be evaluated and the best path can be chosen.

8.29.3.2. Undercut can be shifted from one area to another by tilting the cast. The cast is tilted to increase undercut in desirable areas and decrease undercut in undesirable areas, but the sum total undercut of all the structures of the dental arch cannot be increased or decreased by tilting the cast, only rearranged. The tilt of an occlusal plane is a combination of its lateral and anteroposterior orientations to the spindle.

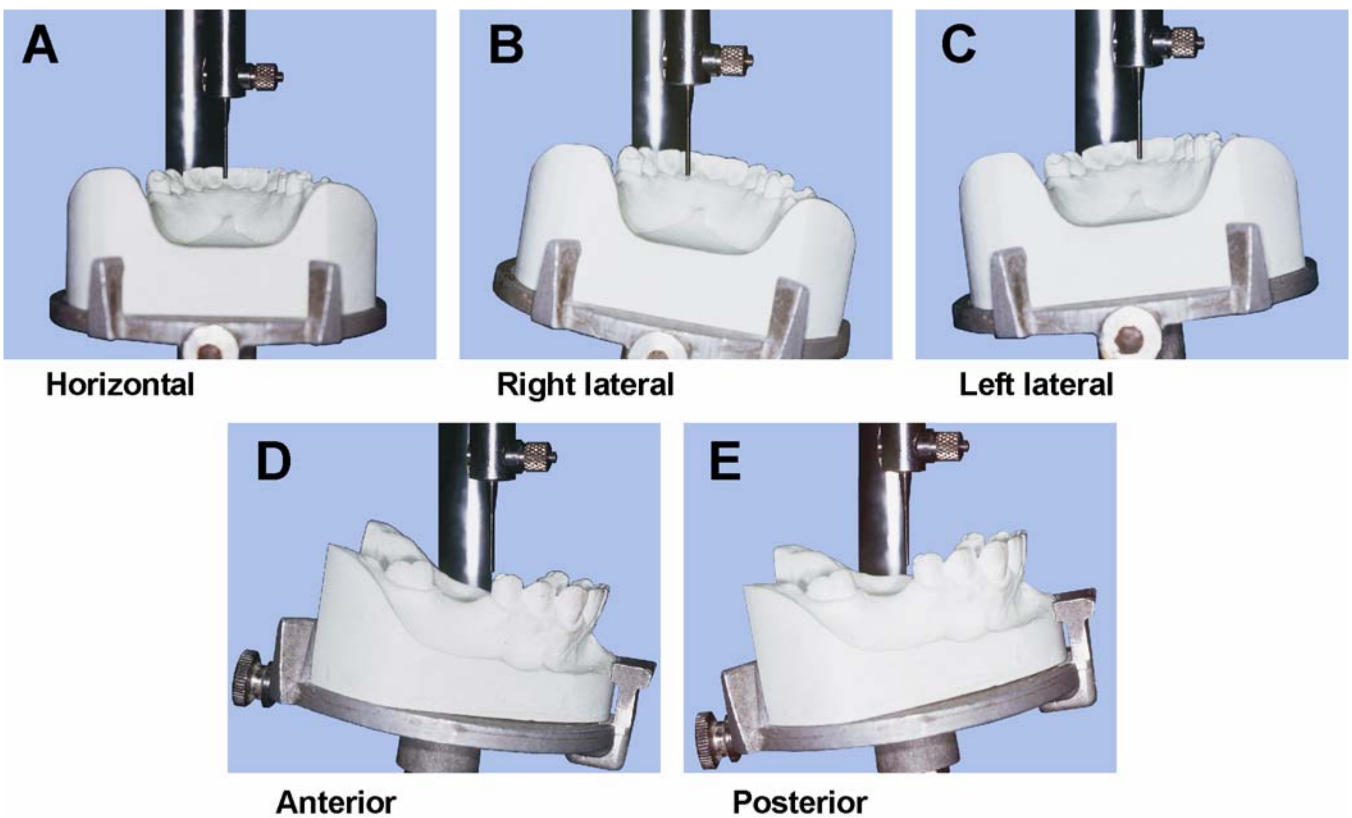
8.29.3.3. Five basic tilts are shown in Figure 8.46. Look at the cast on the tilt table from the posterior aspect. (This point of reference holds true for either a maxillary or mandibular casts.) The positions (or tilts) are (A) horizontal (flat or neutral), (B) right lateral, (C) left lateral, (D) anterior, and (E) posterior. There are an infinite number of orientations possible between these basic tilts. One path of insertion (occlusal plane tilt) must be chosen as best.

8.29.4. **Conditions for an Acceptable Tilt:**

8.29.4.1. The more a tilt meets the following three conditions, the more acceptable it becomes:

8.29.4.1.1. Guide planes should be identified and be made parallel to the path of insertion. The existence of natural guide planes at a tilt where desirable undercuts exist is a matter of chance. The dentist approaches this problem by first picking a tilt for the most advantageous location of tooth undercuts. He or she goes back to the patient's mouth and creates opposing flat surfaces that parallel the proposed path of insertion. The cuts are made on abutment teeth in areas that will contact bracing or reciprocal components. The dentist makes new impressions and performs another survey. Guide planes should now exist along the path of insertion where tooth undercuts are advantageously located.

Figure 8.46. Basic Occlusal Plane Tilts.



8.29.4.1.2. Desirable undercuts can be found on teeth already identified as potential abutments.

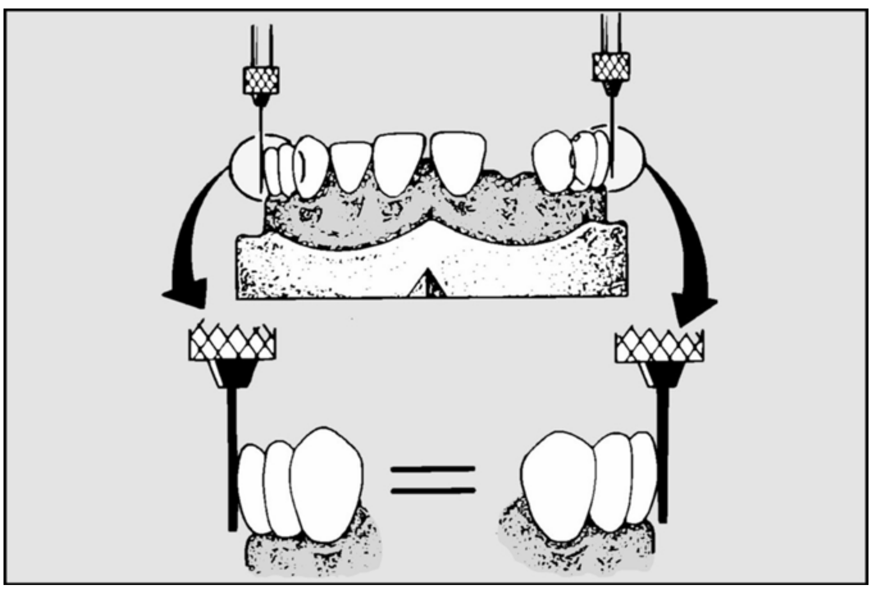
8.29.4.1.3. The chosen tilt minimizes undesirable tooth and soft tissue undercuts. Gross tissue or tooth undercuts that cause the superior or inferior border of the major connector or plating to stand away from tooth or tissue will create food traps.

8.29.5. **Locating an Acceptable Tilt.** Of the three conditions for tilt acceptability (paragraph 8.29.4), the dominant criterion is *finding guide planes on teeth already identified as potential abutments.* Because locating an acceptable table tilt (path of insertion) is best performed in an organized manner, following is a suggested series of steps for accomplishing that purpose:

8.29.5.1. Set the cast to a horizontal tilt; that is, set the occlusal plane parallel to the horizon. Except for a few specialized designs, such as rotational path RPDs, virtually all paths of insertion will be very close to this tilt. The remaining adjustments will be slight adjustments to this basic tilt to optimize the placement of the undercut. The analyzing rod placed in the spindle of the surveyor indicates the path of insertion. Any surface parallel to the analyzing rod is parallel to the proposed path of insertion.

8.29.5.2. Set the lateral component of tilt (Figure 8.47). The guideline for determining the lateral tilt is common to almost all cases, regardless of classification. Align as many of the lingual guide planes with the path of insertion as possible. Distribute available undercut equally between the midfacial infrabulge zones on bilaterally opposing abutment teeth. It is necessary to adjust the tilt to balance among the three conditions: guide planes parallel to the path of insertion, adequate retentive undercuts and minimal undesirable undercuts.

Figure 8.47. Set the Lateral Component of Tilt.



8.29.5.3. Determine the anteroposterior component of tilt. The infrabulge area of a tooth can be divided into the following zones of undercut: mesiofacial, midfacial, distofacial, mesiolingual, midlingual, and distolingual.

8.29.5.3.1. The facial zones are most frequently used for developing retention in RPD cases. Consider the example of a posterior bilateral toothborne case. Such a case usually has two abutment teeth on each side of the dental arch. With three facial zones per abutment, there are nine combinations of facial zones possible in one quadrant alone. For example, the mesiofacial zone or an anterior abutment might be used together with the distofacial zone on the posterior abutment. In another example, the midfacial zones might be used on both abutments in the quadrants. The possibilities increase substantially when both sides of the arch are being considered.

8.29.5.3.2. After the lateral component of tilt has been set, the next task is to find the anteroposterior occlusal plane orientation that provides the best combination of zones on abutments suited to the classification of the case (paragraph 8.29.4).

8.29.5.4. Evaluate a zone of undercut or combination of zones (undercut desirability) as follows:

8.29.5.4.1. Check to see if undercuts are present on the abutments suited to the classification of the case. Remember, an intermediate abutment is clasped for bracing and encirclement purposes only; the tooth's undercuts are not ordinarily engaged. An intermediate abutment is a single natural tooth isolated between two edentulous spaces in a quadrant; other natural teeth remain mesial to the anterior space and distal to the posterior space.

8.29.5.4.2. Make sure the zones of undercut are reasonably accessible. If the retentive tip of a clasp cannot get to them, do not use the zone.

8.29.5.4.3. Make sure the undercut in the zone is deep enough (0.010 inch for a chrome clasp). Ideally, the distance between the height of contour and depth of retentive undercut should be between 1.5 mm and 2.5 mm when 0.010 inch retentive undercut is used. This distance will be less for 0.005 and more for 0.020 inch retention. When the tooth shape does not allow this, consider changing the path of insertion (or ask the dentist to consider modifying the tooth).

8.29.5.4.4. Ensure the undercuts are located in zones where the flexing action of the clasps do not cause harm. For example, using midfacial or distofacial undercuts on a distal abutment in a distal extension situation is <u>almost</u> <u>mandatory</u>. The same can be said for using midfacial or mesiofacial undercuts on mesially located abutments in anterior extension cases.

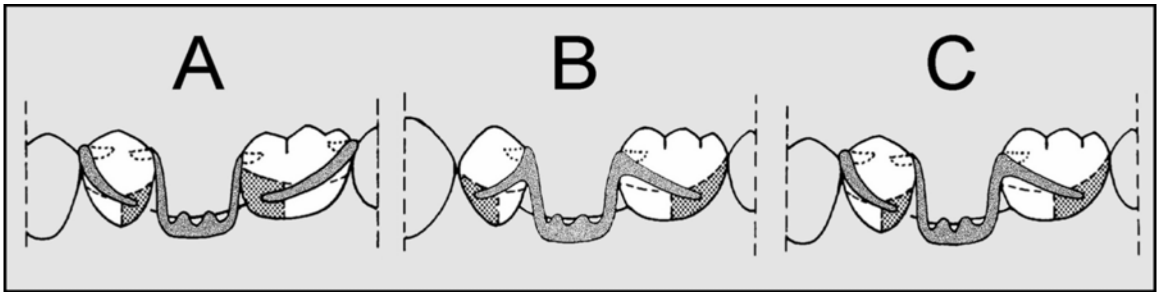
8.29.5.4.5. Avoid the display of metal on anterior abutments. To do this, choose zones of undercut that can be engaged by the less noticeable clasp types (simple circumferential and I-bar clasps).

8.29.5.4.6. As shown in Figure 8.48, when the retentive arms of two clasps in a quadrant converge (A) or diverge (B), the overall retentive effect is somewhat better than having the arms run in the same direction (C).

8.29.5.5. Make a preliminary estimate of the anteroposterior component of tilt. Depending on the classification of the case, desirable undercuts are most likely found within a predictable range of anteroposterior tilt. With the lateral tilt of the case already determined, a zero degree (or horizontal anteroposterior orientation) is the place to start.

8.29.5.5.1. **Unilateral and Bilateral Posterior Toothborne RPD.** Set the tilt from zero to a few degrees either side of zero.

Figure 8.48. Use Zones of Undercut That Enable Clasp Arms To Converge or Diverge.



8.29.5.5.2. **Anterior Toothborne and Toothborne Combination RPD.** Set the tilt from zero degrees to a slight posterior tilt. Posterior tilting tends to minimize undesirable soft tissue undercuts in anterior residual ridge areas, and it may gain natural guide planes on the mesial surfaces of the anterior abutments.

8.29.5.5.3. **Distal Extension RPD.** Set the tilt from zero degrees to a slight posterior tilt. Finding an appropriate distal undercut on the extension side's terminal abutment is a critical requirement. Again, it may be possible to gain a natural guide plane on the distal surfaces of the distal abutments.

8.29.5.5.4. **Anterior Extension RPD.** Set the tilt at the horizontal (neutral) position.

8.29.5.5.5. **Extension Combination RPD.** Set the tilt from zero degrees to a slight tilt toward the extension defect that is most serious.

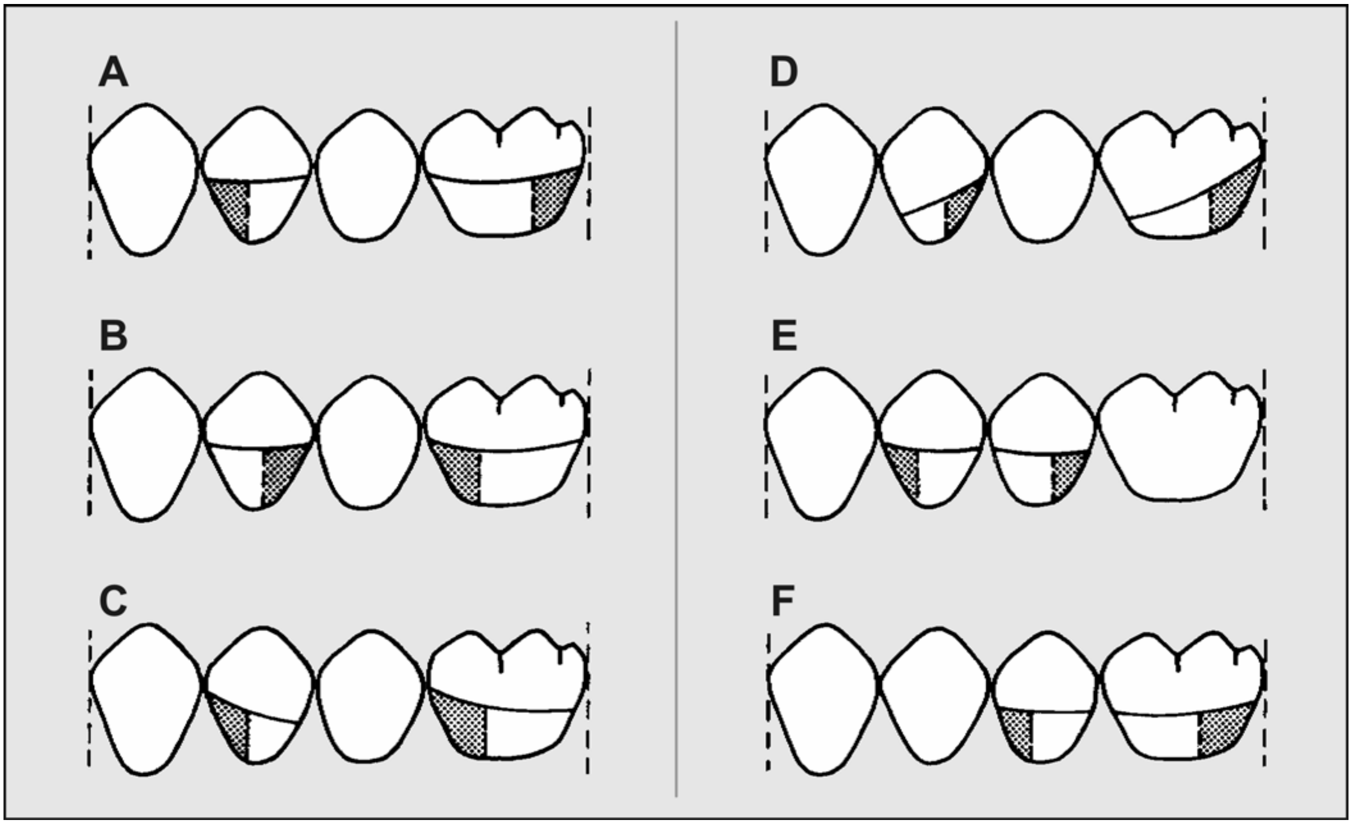
8.29.5.6. Identify the abutment teeth and zone combinations most appropriate for the classification of the case. The lateral orientation of the occlusal plane to the spindle has previously been established. Successful location of the final tilt now means finding an acceptable zone or combination of zones in both quadrants at the anteroposterior orientation common to both quadrants. In the following examples, abutment and zone combinations are suggested for *one side of an arch at a time.* Suggestions are based on the RPD's classification. To use the examples effectively, find two quadrant examples within the proper classification that most closely apply to the case being designed. By no means are all of the possibilities listed. The examples are supposed to represent principles rather than the full range of conceivable situations. All of the following illustrations show the use of facial infrabulge zones:

8.29.5.6.1. **Posterior Unilateral Toothborne RPD:**

8.29.5.6.1.1. **Quadrant With No Teeth Missing.** Abutment tooth and zone combinations in order of decreasing acceptability are shown in Figure 8.49.

8.29.5.6.1.2. **Quadrant Containing the Edentulous Area.** Different patterns of tooth loss are possible. Esthetics may or may not be the dominant factor. When esthetics is not the dominant factor, zone combinations (shown in Figure 8.50) are in order of decreasing acceptability. When esthetics is the dominant consideration, zone combinations (shown in Figure 8.51) are in order of decreasing acceptability.

Figure 8.49. Quadrant Examples for Posterior Unilateral Toothborne RPD Dentulous Side.



8.29.5.6.2. **Posterior Bilateral Toothborne RPD.** The considerations are the same as the ones listed in paragraph 8.29.5.6.1.

8.29.5.6.3. **Anterior Toothborne RPD.** Anterior toothborne RPDs favor the use of a mesiofacial undercut on the most anterior clasp assembly in each quadrant. When designing an RPD, try to separate the clasp assemblies in a quadrant by a span of one or more teeth. Avoid clasping anterior teeth. Abutment tooth and zone combinations shown in Figure 8.52 are in order of decreasing acceptability.

8.29.5.6.4. **Combination Toothborne RPD:**

8.29.5.6.4.1. **Quadrant Has No Posterior Teeth Missing.** The considerations are the same as those listed in paragraph 8.29.5.6.3.

8.29.5.6.4.2. **Quadrant Contains a Posterior Edentulous Area.** The use of a mesiofacial or a midfacial undercut is favored for anteriorly positioned clasp assemblies in a quadrant. Different patterns of tooth loss are possible. Esthetics may or may not be the dominant consideration. When esthetics is not the dominant consideration, the zone combinations (shown in Figure 8.53) are in order of decreasing acceptability. When esthetics is a dominant factor, the zone combinations (shown in Figure 8.54) are in order of decreasing acceptability.

Figure 8.50. Quadrant Examples for Posterior Unilateral Toothborne RPD Edentulous Side—Esthetics Not Dominant.

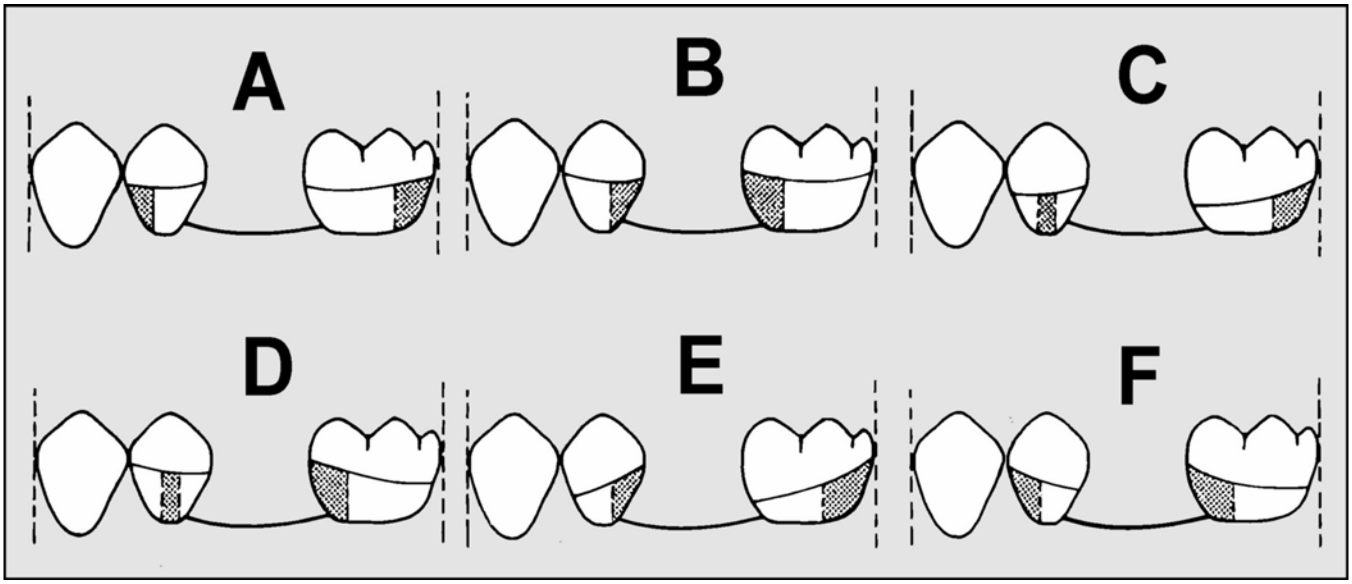
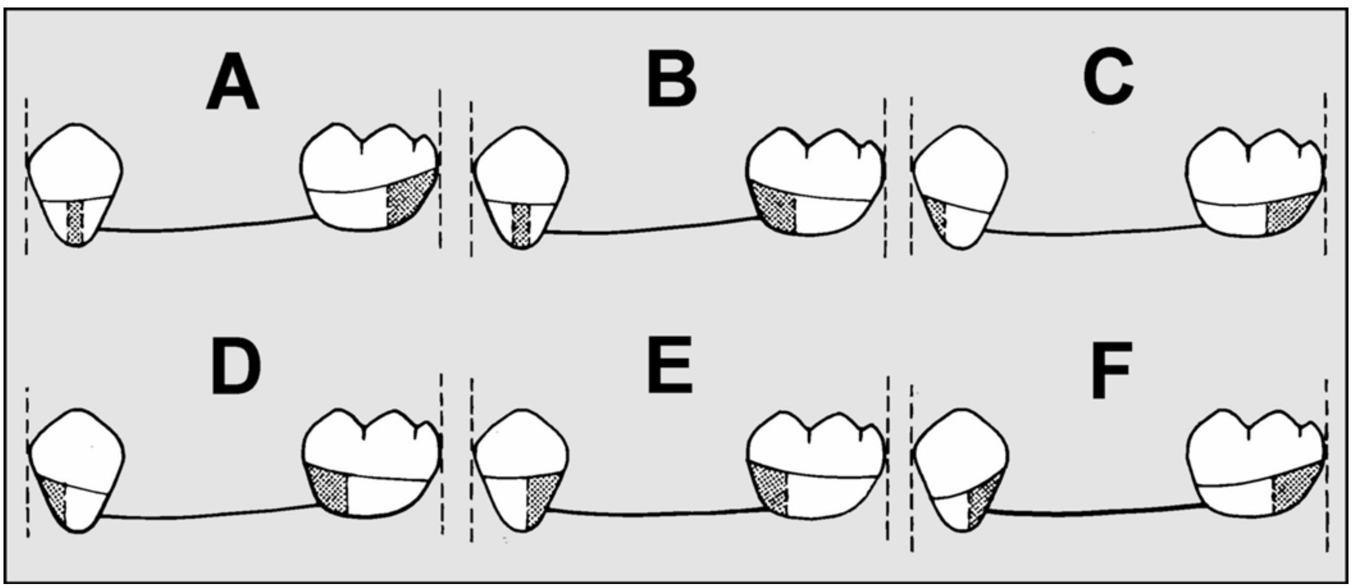


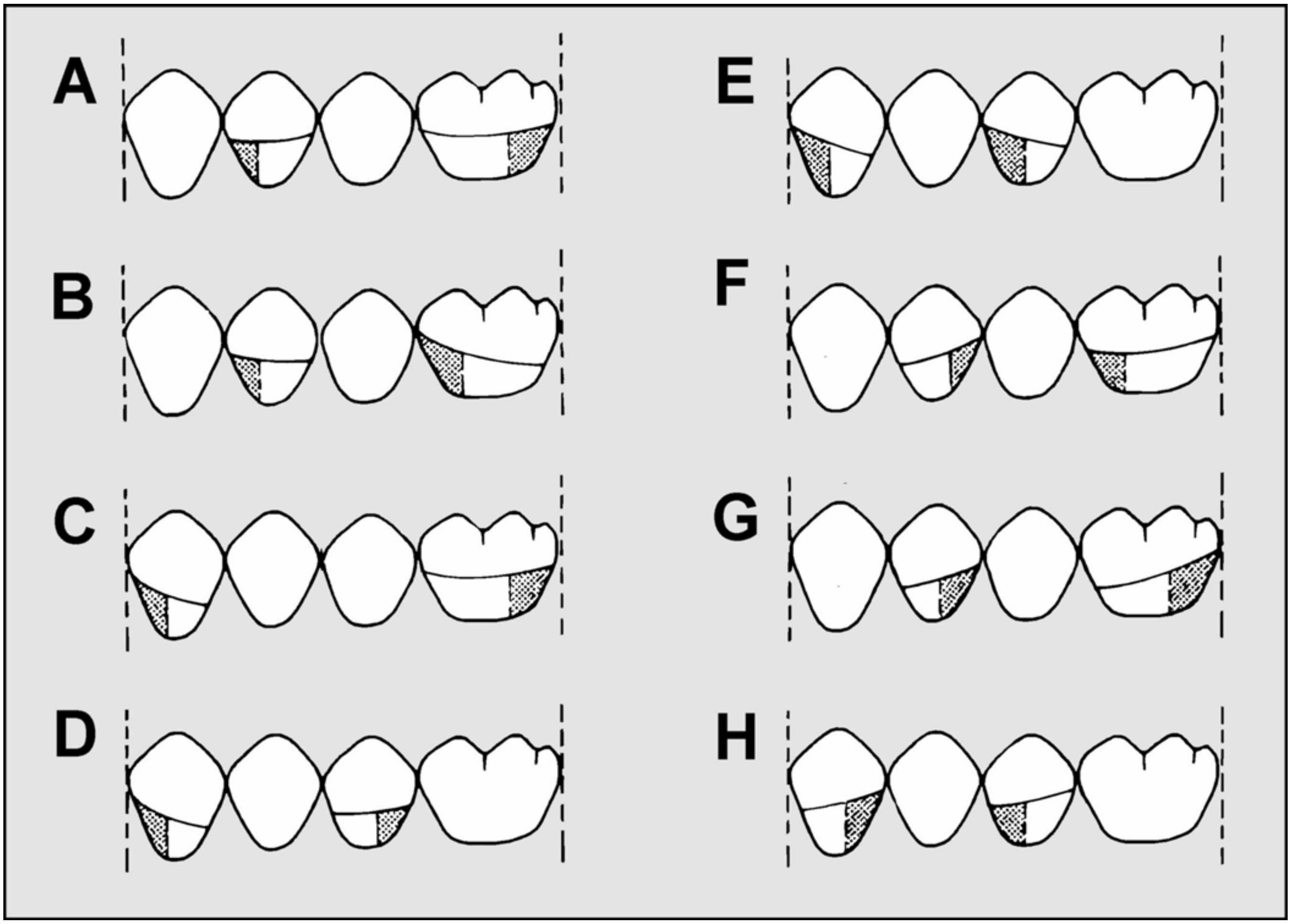
Figure 8.51. Quadrant Examples for Posterior Unilateral Toothborne RPD Edentulous Side—Esthetics Dominant.



8.29.5.6.5. **Unilateral Distal Extension RPD:**

8.29.5.6.5.1. **Dentulous Quadrant Has No Posterior Teeth Missing.** The two clasp assemblies in this quadrant should be separated by a span of at least one tooth. The axis of rotation of such an RPD runs through the distal abutment, and placing a clasp assembly on a more anterior abutment that is at least one tooth away improves indirect retention. ***NOTE:*** Engaging the undercut of the anterior abutment may create a harmful lever arm when pressure is placed on the opposing distal extension. The design should ensure adequate lingual bracing. The abutment tooth and zone combinations (shown in Figure 8.55) are acceptable.

Figure 8.52. Quadrant Examples for Anterior Toothborne RPD.



8.29.5.6.5.2. **Dentulous Quadrant Contains a Toothborne Edentulous Area.** The considerations are the same as those listed in paragraph 8.29.5.6.1.2.

8.29.5.6.5.3. **Quadrant Contains the Distal Extension Defect.** The rule here is very plain—the midfacial and distofacial infrabulge zones are the undercut areas of choice in distal extension cases. A mesiofacial zone may be used as a last resort. Retentive tips of clasps placed in mesiofacial infrabulge zones are only minimally effective in keeping a distal extension base down, and they tend to do irreversible damage to abutment teeth (Figure 8.56). Adequate lingual bracing is required and the mesial clasp tip may need to be placed at or above the height of contour.

8.29.5.6.6. **Bilateral Distal Extension RPD.** Considerations are the same as those listed in paragraph 8.29.5.6.5.3.

8.29.5.6.7. **Anterior Extension RPD.** Use mesiofacial zones on anteriorly positioned abutments. (Retentive tips of cast clasps placed in distofacial zones can cause damage.) Anterior and posterior abutments within a quadrant should be separated by a span of at least one tooth to increase the effectiveness of indirect retention as follows:

Figure 8.53. Quadrant Examples for Combination Toothborne RPD With a Posterior Edentulous Area—Esthetics Not Dominant.

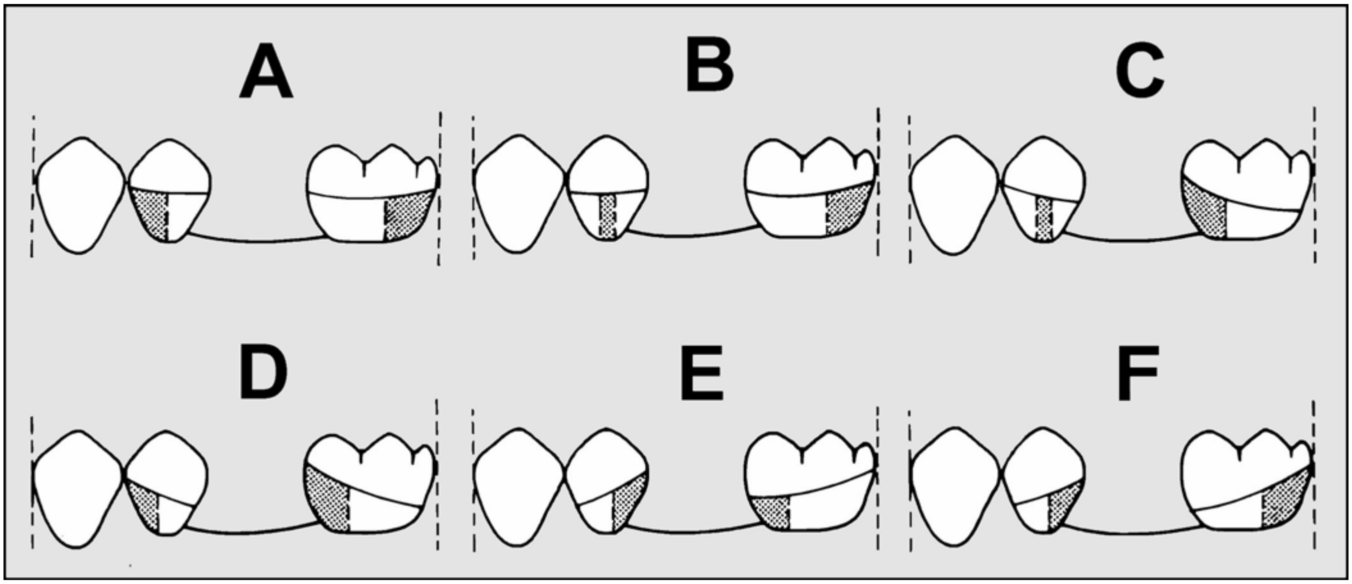
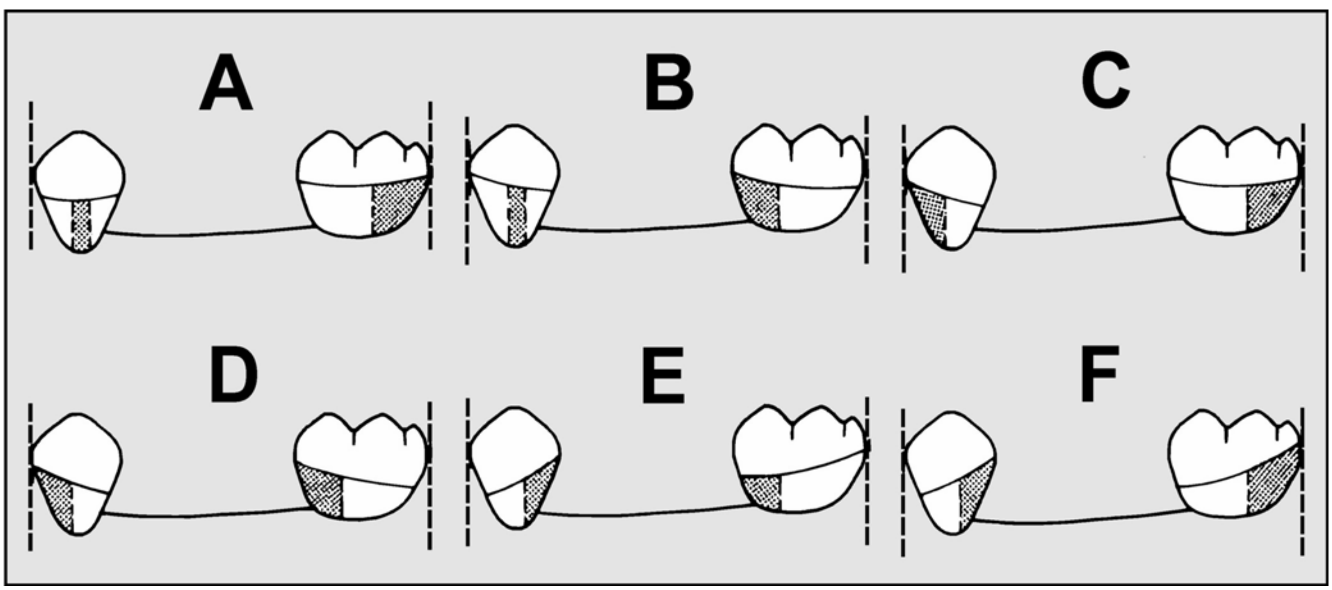


Figure 8.54. Quadrant Examples for Combination Toothborne RPD With a Posterior Edentulous Area—Esthetics Dominant.



8.29.5.6.7.1. **Quadrant Has No Teeth Missing Posterior to the Anterior Extension Defect.** A number of tooth loss patterns are possible. (Two patterns are shown.) In Loss Pattern #1, the zone combinations shown in Figure 8.57-A through -C are acceptable. In Loss Pattern #2, the zone combinations shown in Figure 8.58-A and -B are acceptable.

8.29.5.6.7.2. **Quadrant Contains a Toothborne Edentulous Area Posterior to the Anterior Extension Defect.** A number of tooth patterns are possible. (Two patterns are shown.) In Loss Pattern #1, the zone combinations shown in Figure 8.59-A through -D are acceptable. In Loss Pattern #2, the zone combinations shown in Figure 8.60-A through -D are acceptable.

Figure 8.55. Quadrant Examples for a Unilateral Distal Extension RPD With No Teeth Missing on the Dentulous Side.

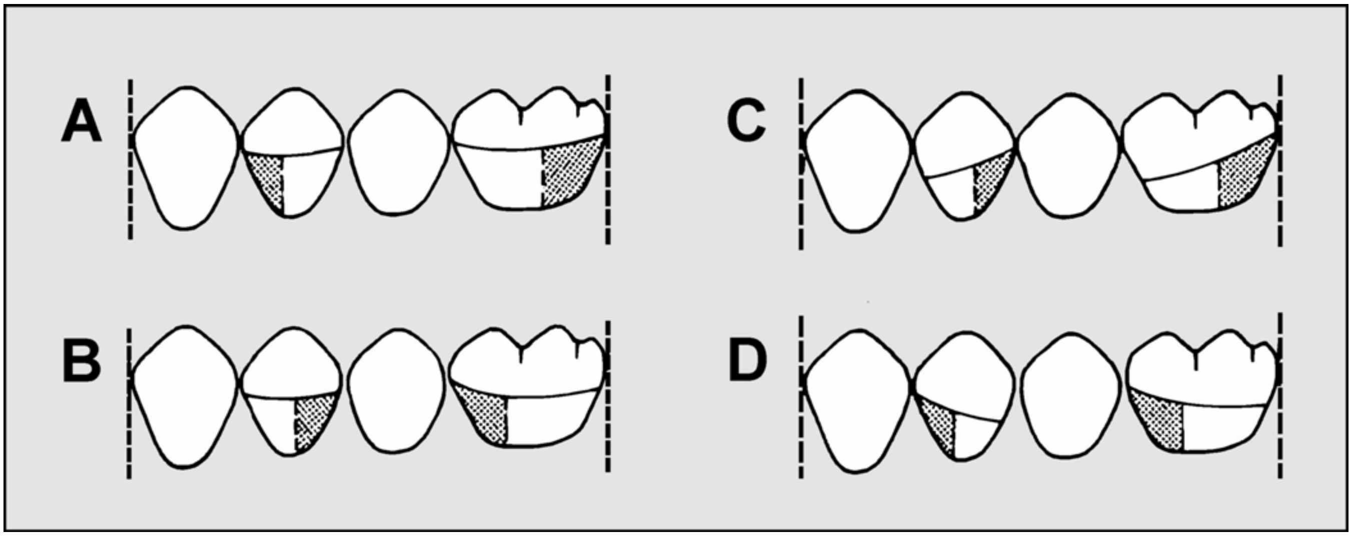


Figure 8.56. Quadrant Examples of Unilateral and Bilateral Extension Defects.

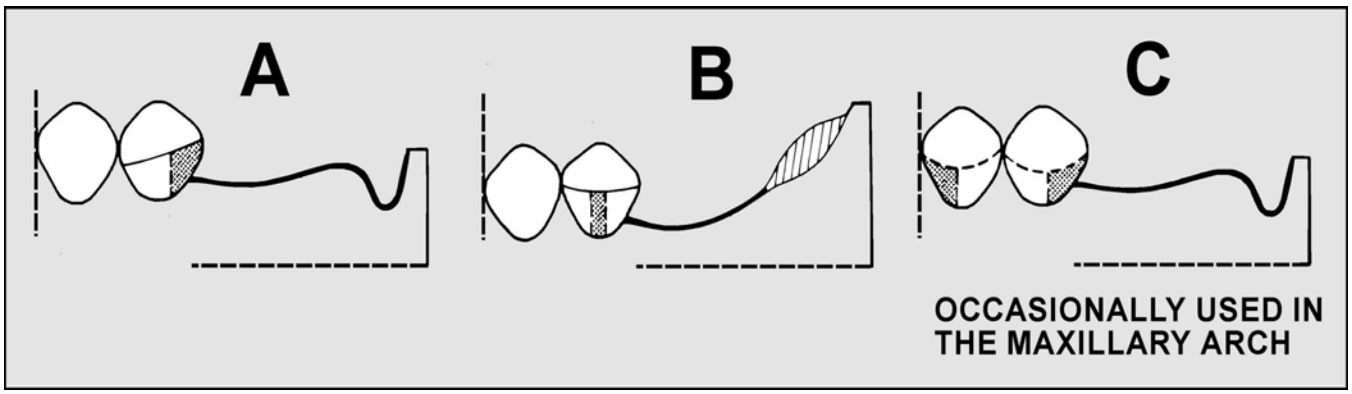
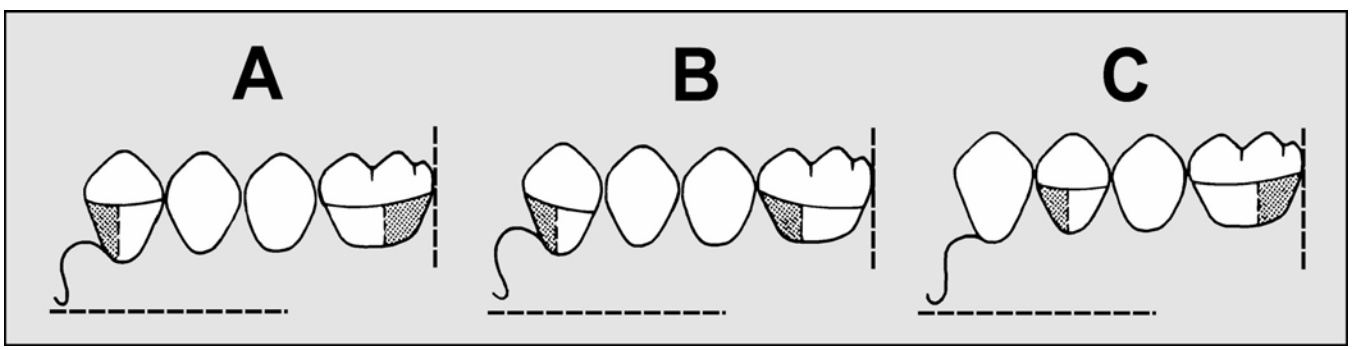


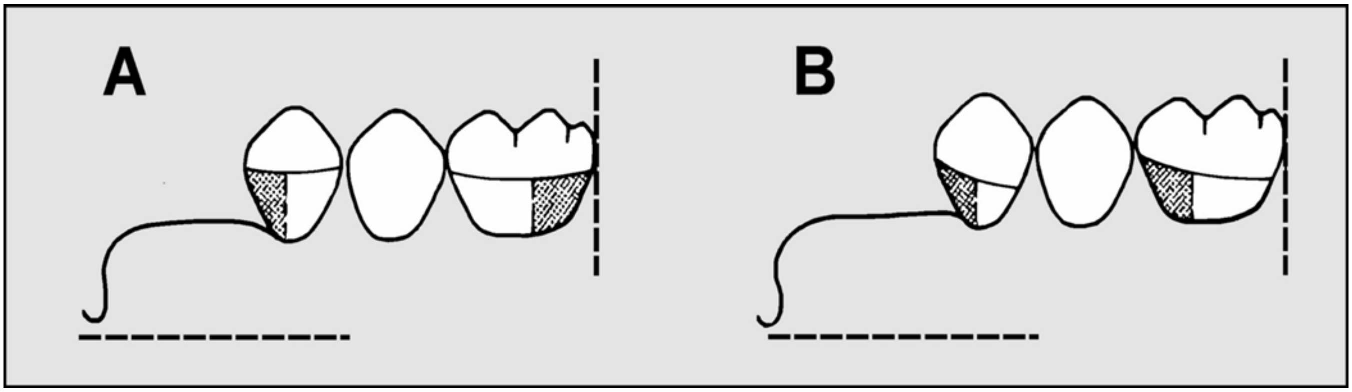
Figure 8.57. Quadrant Examples for Loss Pattern #1—No Missing Posterior Teeth.



8.29.5.6.8. **Extension Combination RPD:**

8.29.5.6.8.1. **Quadrant With No Teeth Missing Posterior to the Anterior Extension Defect.** The considerations are the same as the ones listed in paragraph 8.29.5.6.7.1.

Figure 8.58. Quadrant Examples for Loss Pattern #2—No Missing Posterior Teeth.



8.29.5.6.8.2. **Quadrant Contains Toothborne Edentulous Spaces Posterior to the Anterior Extension Defect.** The considerations are the same as the ones listed in paragraph 8.29.5.6.7.2.

8.29.5.6.8.3. **Quadrant Contains a Distal Extension Defect.** A number of tooth loss patterns are possible. (Four patterns are shown.) In Loss Pattern #1, the zone combinations shown in Figure 8.61-A and -B are acceptable. In Loss Pattern #2, the zone combinations shown in Figure 8.62-A and -B are acceptable. In Loss Pattern #3, the zone combinations shown in Figure 8.63-A and -B are acceptable. In Loss Pattern #4, the combination shown in Figure 8.64 is acceptable.

Figure 8.59. Quadrant Examples for Loss Pattern #1 With a Toothborne Edentulous Posterior Area.

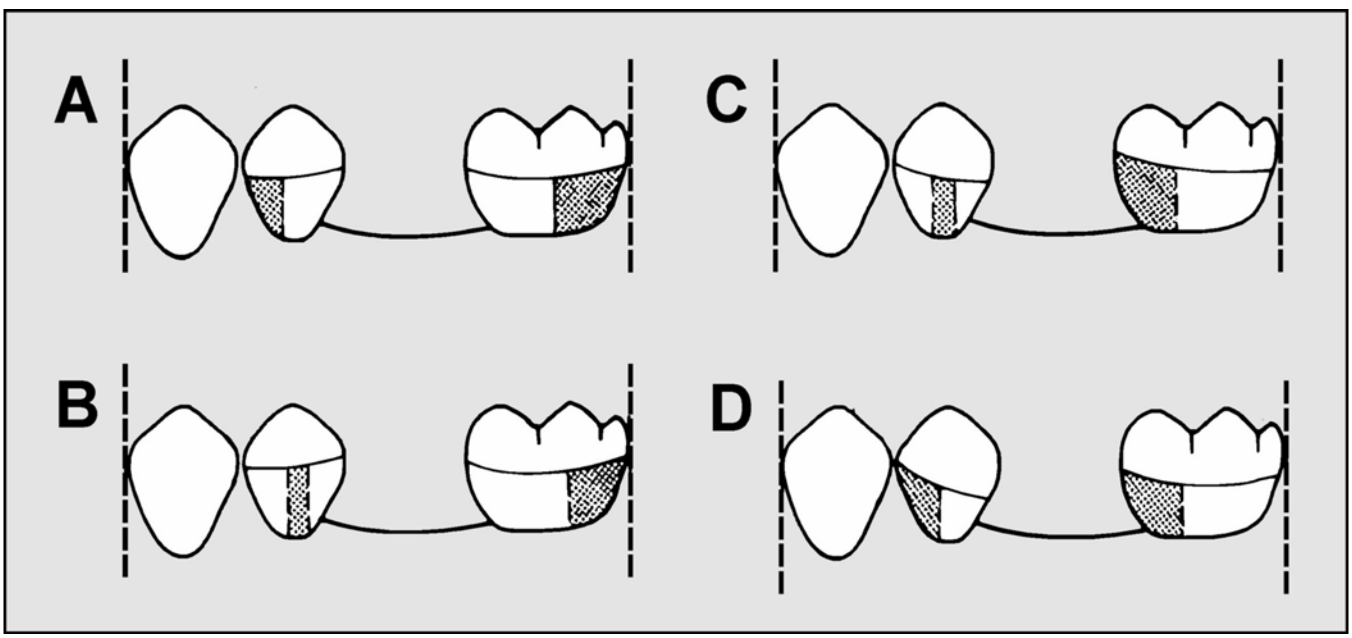


Figure 8.60. Quadrant Examples for Loss Pattern #2 With a Toothborne Edentulous Posterior Area.

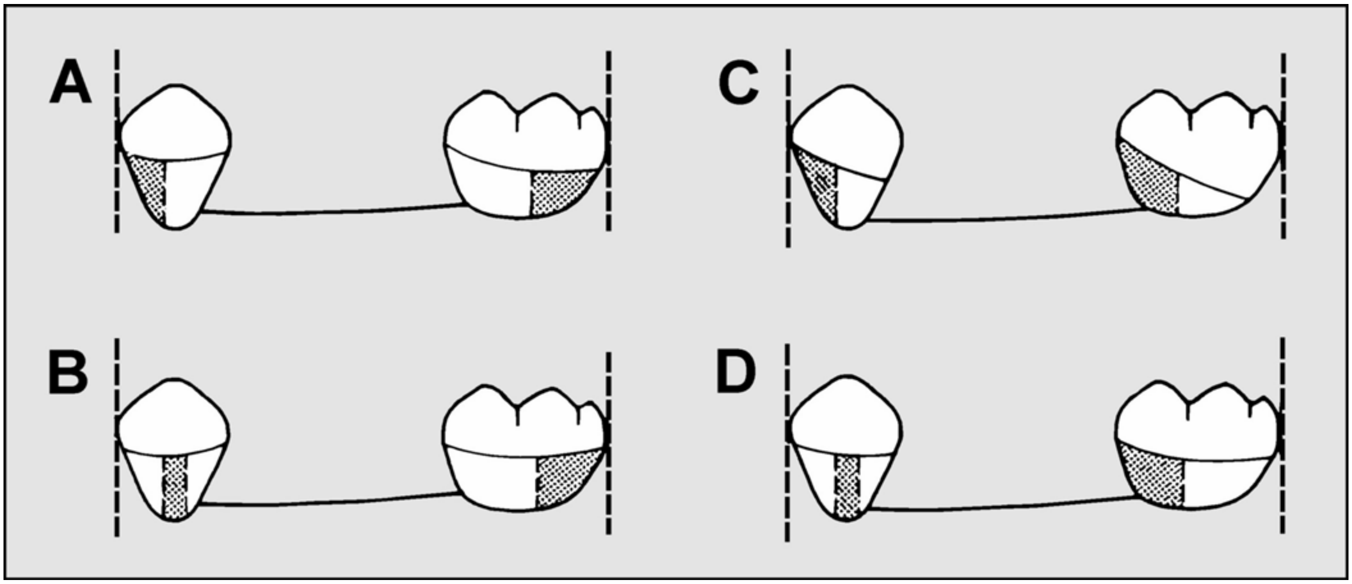


Figure 8.61. Quadrant Examples for Loss Pattern #1 of a Distal Extension Defect.

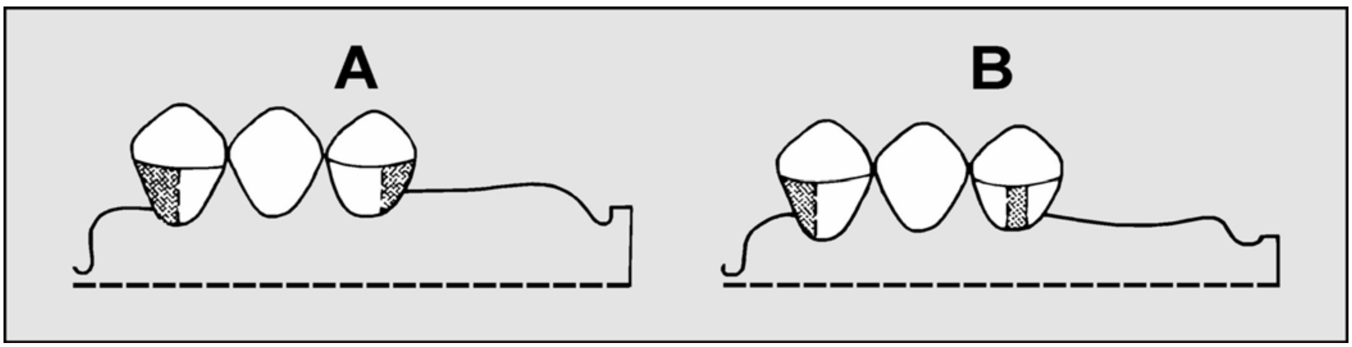


Figure 8.62. Quadrant Examples for Loss Pattern #2 of a Distal Extension Defect.

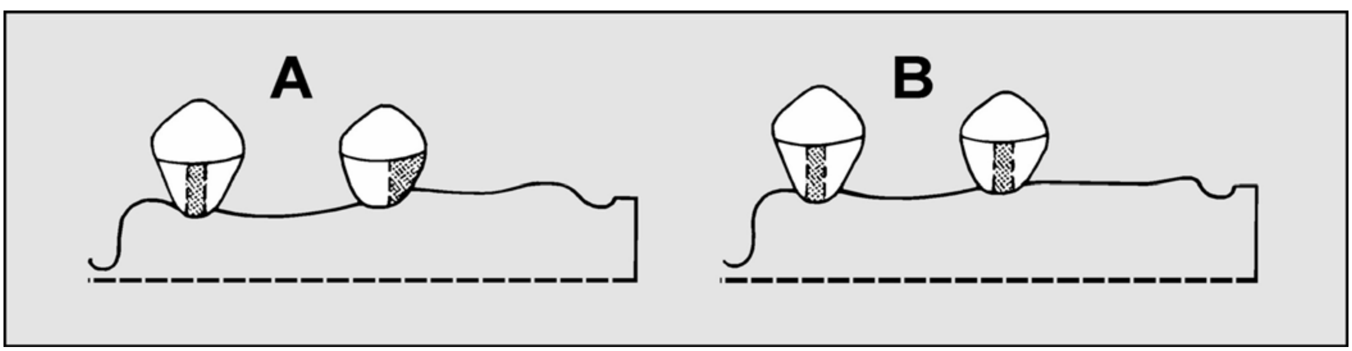


Figure 8.63. Quadrant Examples for Loss Pattern #3 of a Distal Extension Defect.

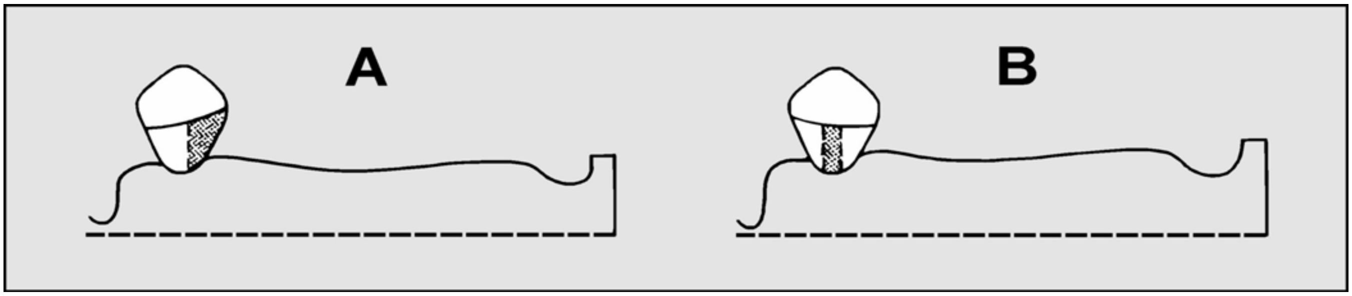
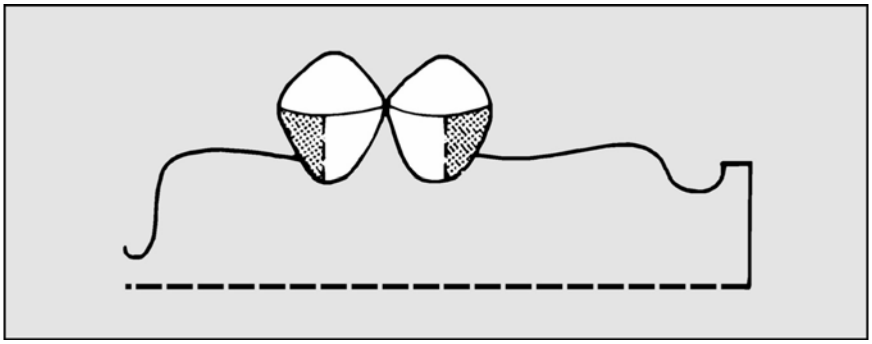


Figure 8.64. Quadrant Example for Loss Pattern #4 of a Distal Extension Defect.



8.30. Limit and Improve the Tilt:

8.30.1. **Limit of Tilt.** An occlusal plane can be tilted too far laterally or anteroposteriorly with reference to the surveyor spindle as follows:

8.30.1.1. **Lateral Limit of Tilt.** Given a cast mounted on a surveyor table, a lateral orientation is found where cross arch opposing undercuts are present on abutment teeth. If the tilt is changed so the cross arch opposing undercuts are no longer observable, the cast has been tilted too far laterally.

8.30.1.2. **Anteroposterior Limit of Tilt:**

8.30.1.2.1. Given a cast mounted on a surveyor table, an anteroposterior orientation is found where mesial and distal zone undercuts are present on the proposed abutments, but the undercuts are not deep enough. If the case is tilted posteriorly until the abutments show adequate distal zone undercuts, minimal mesial zone undercuts must still be observable or the case has been tilted too far posteriorly. The reverse situation is true for anterior tilts in toothborne quadrants.

8.20.1.2.2. Given a cast mounted on a surveyor table, a distofacial undercut on the terminal abutment is found, but the undercut is not deep enough when measured at a neutral tilt. Paralleling the mesiolingual aspect of the terminal abutment with an analyzing rod demonstrates the quadrant's distal limit of tilt.

8.30.1.2.3. The limits of anteroposterior tilt for the two quadrants of a case are almost always different. Therefore, the quadrant that tolerates the least amount of tilting before exceeding its limit dictates the anteroposterior orientation for the whole case.

8.30.2. **Improving a Tilt.** A tentatively acceptable tilt (desirable undercuts present on teeth proposed as abutments) may be modified for the following reasons: to make the RPD look better in the patient's mouth, to increase the amount of soft tissue contact area under denture bases (saddles) for support and bracing purposes, and to lessen the chances of food impaction between rigid RPD components and oral structures. (This usually means trying to reduce the amount of excess space between the RPD's rigid parts and the oral structures beneath them.) Three examples of tilt modification are as follows:

8.30.2.1. **Example #1, Anterior Extension RPD.** In this example, the zone combinations exist as shown in Figure 8.65 with the surveyor table set at 0 degrees lateral and 0 degrees anteroposterior tilt. Undercuts of sufficient depth are present within the zones. Due to pronounced ridge resorption, denture teeth embedded in a resin denture base are the replacement of choice. Observe the tissue height of contour in the anterior area and the depth of the undesirable undercut beneath it. Remember, the framework's path of insertion controls the route the denture base travels to place. A resin denture base processed on the cast to fit into the sulcus would be prevented from seating in the patient's mouth by the tissue height of contour. There are two unattractive options open to the dentist under these circumstances. The dentist may:

8.30.2.1.1. Cut the flange back to the tissue height of contour. With this option, the junction line between the plastic and the skin of the mouth would probably become exposed to view, and the anteroposterior bracing effectiveness is definitely reduced.

8.30.2.1.2. Maintain the length of the flange by grinding enough plastic from the tissue surface of the flange to let the denture base (saddle) slip by the height of contour. This option has the serious disadvantage of creating an unacceptable space between the ridge and the tissue surface of the denture base when the RPD is seated. Figure 8.66 shows the same cast tilted posteriorly to minimize the undesirable soft tissue undercut. At this tilt, the flange of the saddle extends into the sulcus without any modification. The border would be concealed and food traps not created. The results of modifying the original tilt seem to be justified. Whether an acceptable framework design can be composed to conform to this path remains to be decided. Notice how all the zones of undercut have changed in size and shape. The mesiofacial zones are considerably smaller. Determine whether undercuts of adequate depth are still present in the original zones. If reevaluation of the case shows the mesiofacial zones are not deep enough, try to find another suitable combination of undercuts with the required depth. The example in Figure 8.67 shows an acceptable alternative. In this figure, midfacial undercuts have been substituted on the anterior abutments.

8.30.2.2. **Example #2, Relationship of a Lingual Bar to the Lingual Aspect of the Mandibular Ridge:**

8.30.2.2.1. The relationship shown in Figure 8.68 between the lingual bar and the ridge is unacceptable. The lingual bar should closely follow the contour of the mandibular lingual surface just barely short of contact with the mucosa.

8.30.2.2.2. The lingual bar-to-ridge relationship in Figure 8.69 is satisfactory.

8.30.2.3. **Example #3, Equalizing the Proximal Areas Between an Artificial Replacement and the Natural Tooth Next to it:**

Figure 8.65. Undesirable Soft Tissue Undercut.

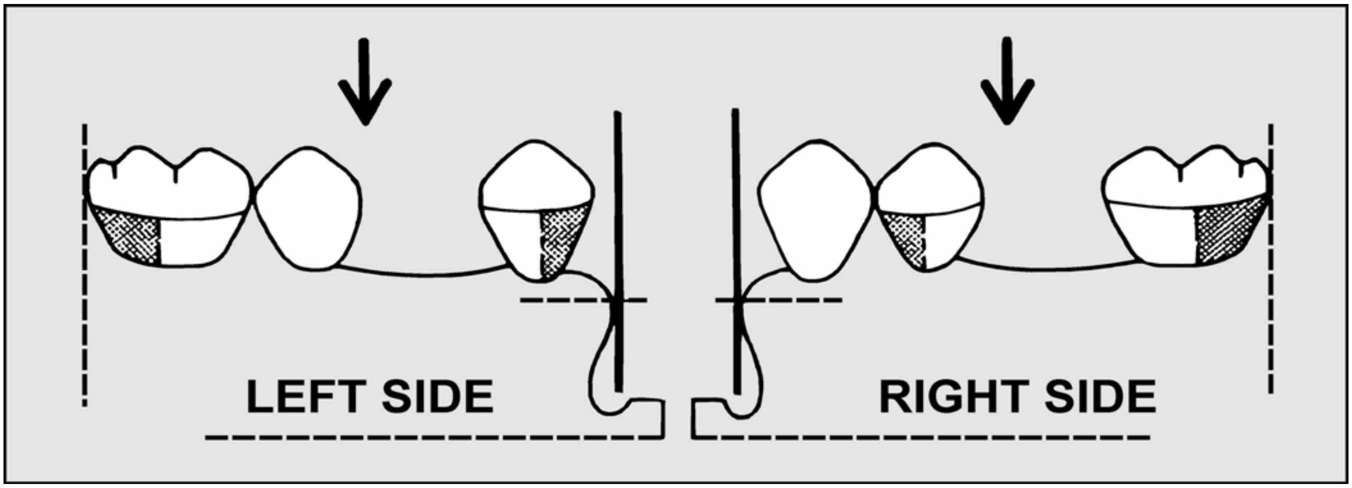


Figure 8.66. Soft Tissue Undercut Minimized.

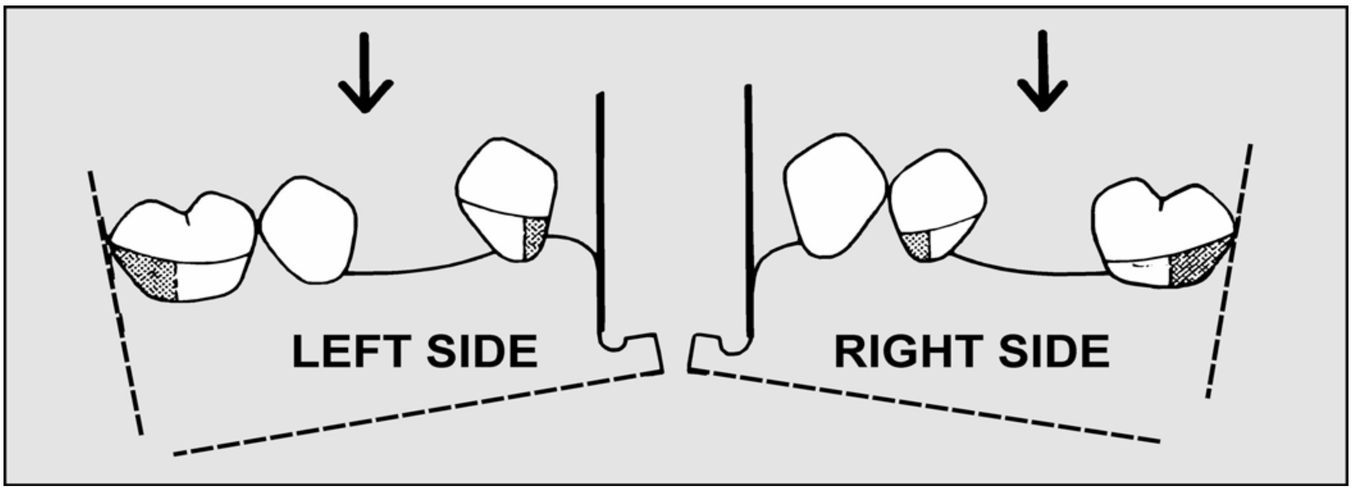


Figure 8.67. Undercut Substitution.

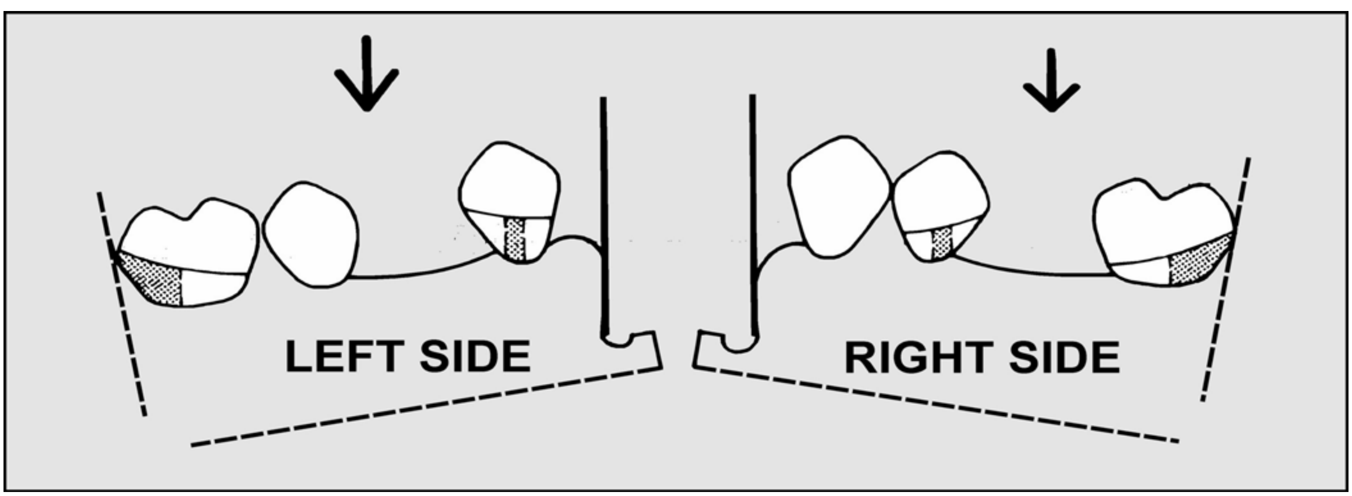


Figure 8.68. Incorrect Bar Position.

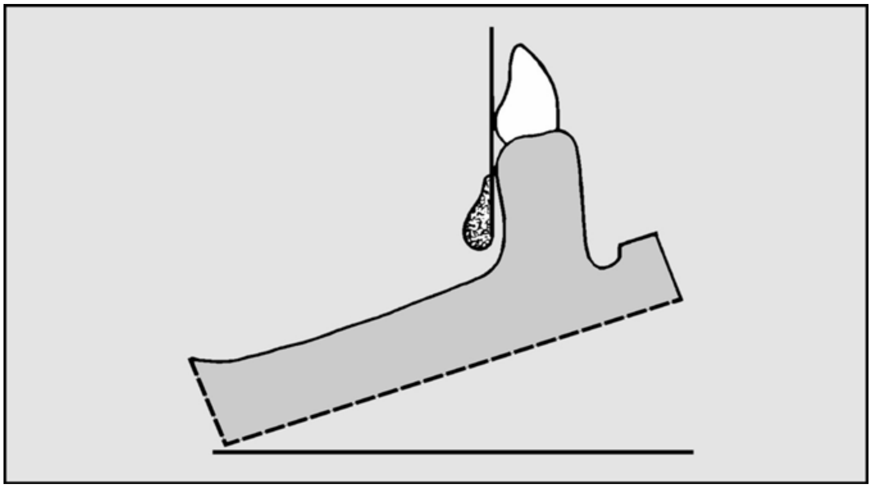


Figure 8.69. Correct Lingual Bar Position.

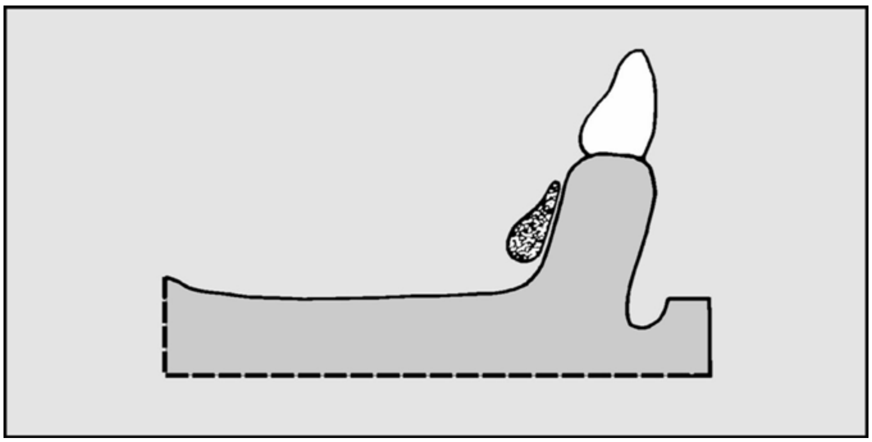
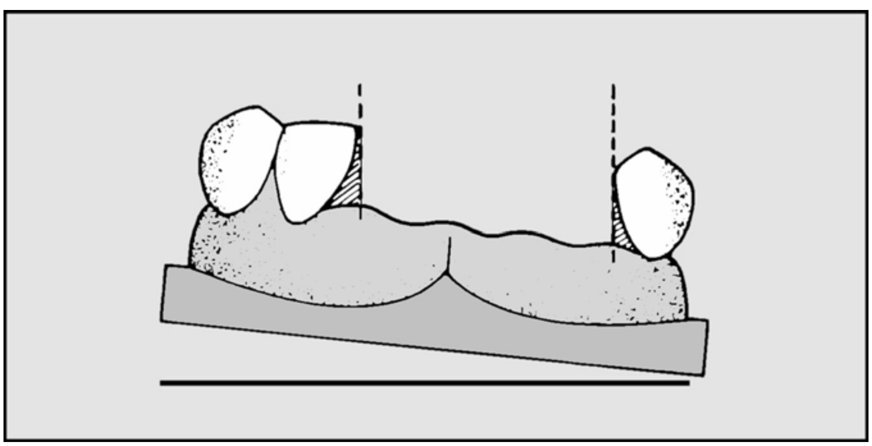


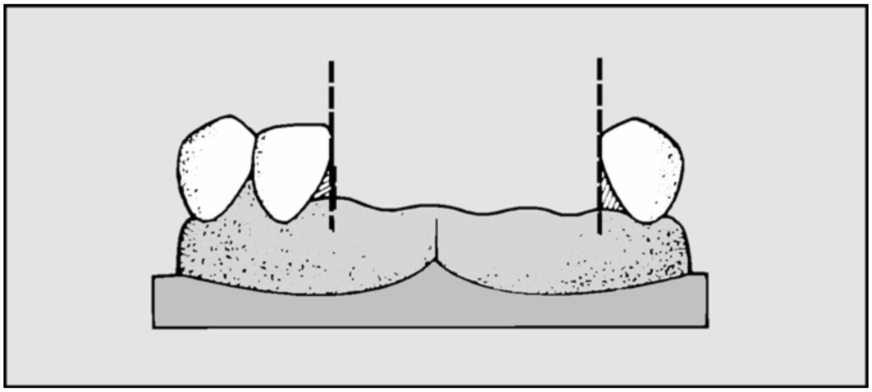
Figure 8.70. Size of a Proximal Undercut Can Affect Esthetics and Hygiene.



8.30.2.3.1. In Figure 8.70, the artificial replacement for the anterior edentulous area cannot extend distal to the two dotted lines or the RPD will not go to place. The space at the mesial of the lateral incisor is too large and represents a potential food trap. The size of the space in the patient's mouth might be obvious to the casual observer. The more exaggerated versions of this problem can seriously limit the ability to produce artificial teeth that are properly shaped.

8.30.2.3.2. In Figure 8.71, the proximal spaces distal to the dotted lines are roughly equal. If desirable undercuts are available for use, this tilt is more acceptable than the one in Figure 8.70. A tilt having adequate undercuts in the right places can be an elusive thing because it does not take much of a change to ruin its distinctive features. When undesirable undercuts are extremely deep, slight tilt modifications of the kind described do not help much. Ask the dentist to resolve the problem in some other way.

Figure 8.71. Increased Potential for an Esthetic, Hygienic Adaptation of an Artificial Tooth.



8.31. Place Tripod Marks on the Cast. *Tripoding* is a method of marking a surveyed cast with three dots so the cast or its duplicate can be repositioned on any survey table at exactly the same tilt. This capability is essential when transferring a design from a diagnostic to a master cast and for subsequent blockout procedures.

8.31.1. **Place Tripod Marks as Part of the Initial Survey** (Figure 8.72). After finding an acceptable tilt, lock the surveying table in that position. Insert a carbon marker into the surveyor spindle. Bring the tip of the carbon into contact with a feature on the cast, lock the vertical spindle, and mark the surface with a short horizontal line by moving the surveying table on the surveyor base. After the first mark is made, make a mark on two other cast features at the identical spindle height used to place the first dot by sliding the surveying table to bring the carbon marker in contact with two additional areas on the cast. Make a short vertical line through the horizontal carbon mark, using a red pencil to form a cross. Circle the cross with a blue pencil. When placing the marks:

8.31.1.1. Make sure they are widely separated. If imaginary lines connected the marks, they would make the shape of a triangle. The larger the triangle, the more accurately the cast can be re-tripoded.

8.31.1.2. Place dots on those surfaces of the cast that represent immobile features of the patient's mouth. Do not place marks in sulci or on frenums.

8.31.1.3. Place dots on spots that are certain to appear in every impression made. Do not place dots on the land areas of the cast.

8.31.1.4. Try to avoid areas of the cast where the dots might obscure framework design drawings and vice versa.

Figure 8.72. Tripod Marks.

8.31.1.5. Try to choose features that are oriented more vertically than horizontally. Tripod marks cannot be placed in undercut areas.

8.31.2. **Use Tripod Marks To Find the Tilt They Represent:**

8.31.2.1. Take a long, critical look at the cast with the tripod marks. Using cast landmarks, calipers, and a millimeter ruler as guides, place tripod marks in the identical spots on the master cast.

8.31.2.2. Place the duplicate cast on a surveying table. Lock down the surveying table at a position where the cast is neutrally tilted.

8.31.2.3. Bring the tip of an analyzing rod into contact with one of the marks and lock the vertical spindle.

8.31.2.4. Without changing the tilt of the table, check to see if the tip of the analyzing rod can contact the other two marks. (It probably cannot.)

8.31.2.5. Choose one of the two remaining two marks and tilt the cast until the analyzing rod can contact both marks. It may be necessary to raise or lower the spindle. Be sure to relock the spindle. Once two marks are level, tilt the cast around an imaginary axis through these two marks until the third mark comes into alignment, again making adjustments in the height of the spindle as necessary.

8.31.2.6. Continue to make slight adjustments to the tilt of the table and the vertical setting of the spindle refining the positions of the marks until the rod can contact all three marks without changing the height of the spindle or the tilt of the table. ***NOTE***: The objective is to find the single tilt where all three dots can be brought into contact with the tip of an analyzing rod that is locked down at one constant vertical height.

8.32. Mark the Tooth and Soft Tissue Survey Lines With a Carbon Marker:

8.32.1. After choosing a path of insertion and tripoding the cast, the next step is to make a “contour map” of the height of contour of tooth and tissue structures (Figure 8.73). Place a carbon marker in the vertical spindle of the surveyor. Move the cast and carbon marker, one against the other, by sliding the table around on the base of the surveyor.

Figure 8.73. Mark Heights of Contour With a Carbon Marker.

8.32.2. To properly survey a cast, first trace survey lines at the heights of contour of the teeth by placing the side of the carbon marker against the height of contour of the tooth and the tip of the marker against the bottom of the undercut. Outline the entire undercut area.

8.32.3. Next, simultaneously mark the soft tissue heights of contour with the side of a carbon marker and the lower limit of the undercut with the tip of the marker.

8.32.4. Survey lines have value for determining the proper location of clasp arms, minor connectors, and major connectors in the overall design; choosing suitable substitutes for missing teeth and soft tissue; and blocking out undesirable undercuts before duplicating the master cast in refractory material. Survey lines also are a guide to the dentist to show where tooth contours must be altered to eliminate or reduce undesirable undercuts or to establish guide plane prior to the final impression.

8.33. Decide Where Tooth Modifications Will Enhance RPD Function. Four components of the RPD usually require modification of tooth surfaces by the dentist prior to making the final impression. These components should be marked in red on the diagnostic cast.

8.33.1. **Rests.** Rest seats almost always require preparation. Embrasure clasp assemblies with their associated rests often require significant tooth reduction.

8.33.2. **Guide Planes**. Guide planes should be as long and flat as possible. When the guide plane is next to an extension base, it is also kept flat in a buccolingual plane.

8.33.3. **Clasps.** Normally, the height of contour of the tooth is high at the line angle of the tooth where the shoulder of the clasp contacts the tooth. In order for a suprabulge clasp to drop down toward the gingival of the tooth without crossing the undercut, the dentist must reshape the tooth to lower the survey line. Abnormally high survey lines are most pronounced on mandibular molars that are the distal abutment in a tooth-borne RPD. These areas must be adjusted for proper clasp placement, especially on the mesiolingual.

8.33.4. **Plating**. Sometimes tooth undercuts will interfere with plating. This is particularly prevalent with crowded or rotated lower anterior teeth. These undercuts should be removed by the dentist, if possible.

8.34. Mark the Location of Retentive Tips. Now that the cast has been tripoded and surveyed and a design decided upon, locate the depth of desired undercut using a suitable undercut gauge. Mark the proper depth of undercut with a discreet red dot. This dot is the definitive location of the lower edge of the retentive clasp tip.

8.35. Select a Clasp Assembly for Each Abutment Tooth. Paragraphs 8.29.4 and 8.29.5 deal with finding an acceptable tilt and make suggestions for zones of undercut in specific combinations for the different case classifications. The problem is to select clasp shapes that are best able to get to those zones. The ability of a clasp to engage an undercut located in a particular spot on a tooth's surface is limited by occlusion, esthetic considerations, presence of soft tissue undercuts, classification of the case, location of the undercut, incidence of decay associated with the clasp form, and periodontal integrity of abutment teeth as follows:

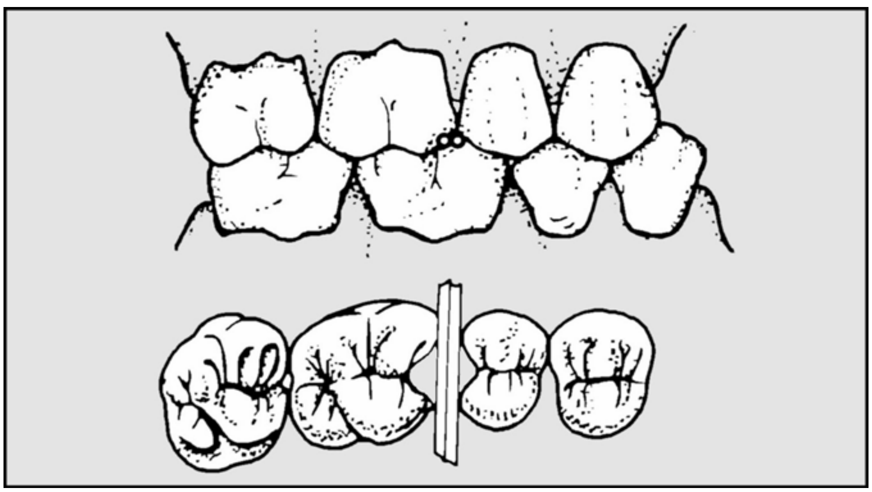
8.35.1. **Factors Influencing Choice of a Clasp Assembly:**

8.35.1.1. **Occlusion:**

8.35.1.1.1. **Circumferential Clasp Assemblies:**

8.35.1.1.1.1. When upper and lower teeth are in centric occlusion, a simple circumferential clasp requires a passage space 1.25 mm wide and 1 mm high through an embrasure area. Embrasure clasps need a channel 2 mm wide and 1 mm high. If the space does not exist naturally, it is up to the dentist to adequately open up embrasure channels to accommodate clasp parts (body and arms). An 18-gauge round wire is about 1 mm in diameter. Dentists sometimes use one or two of these wires to test if enough room exist (Figure 8.74).

Figure 8.74. Embrasure Clasp Clearance.



8.35.1.1.1.2. Another important consideration is that a high survey line on an abutment tooth can approach the shearing cusp of an opposing tooth so closely that there is no room for a clasp arm. When centric occlusion is very "tight" (opposing teeth contact solidly and cusps overlap steeply), start thinking about infrabulge alternatives to circumferential clasping.

8.35.1.1.2. **Bar Clasp Assemblies.** A bar clasp cannot be used in posterior segments where no teeth are missing. The design features of a bar clasp require that the approach arm originate from a denture base area. In areas where edentulous spaces exist, a bar clasp interferes with occlusion less than circumferential clasps because a bar clasp does not penetrate through embrasures completely.

8.35.1.2. **Esthetic Considerations:**

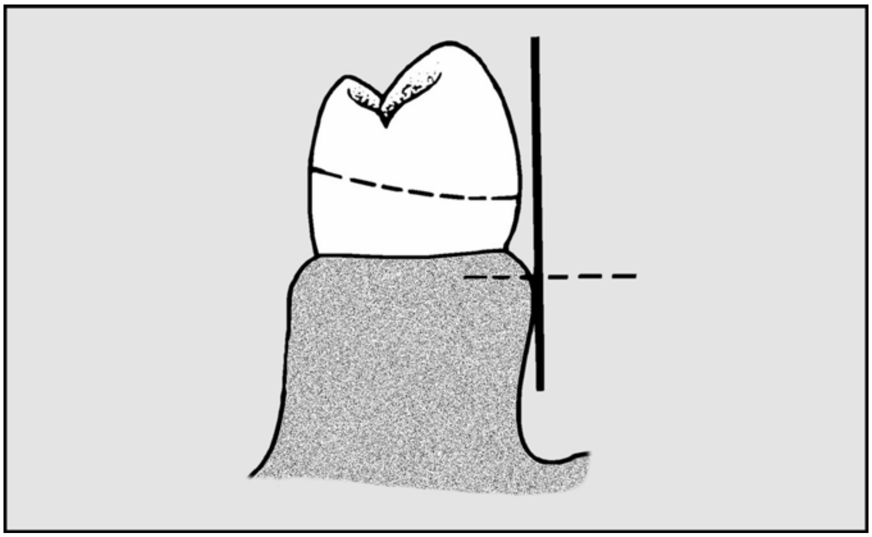
8.35.1.2.1. **Circumferential Clasp.** A circumferential clasp is less visible on teeth with low survey lines. If the retentive arm is made to approach a mesiofacial undercut from the distal aspect of an abutment tooth and the clasp arm travels as close to the gingival margin as the survey line permits, the metal does not show as much.

8.35.1.2.2. **Bar Clasp.** A bar clasp's approach arm crosses gingival surfaces on the way to a zone of undercut. To the extent that most people do not expose gum tissue when they talk or smile, I-bar clasps can be less conspicuous than many circumferential types.

8.35.1.3. **Presence of Soft Tissue Undercuts.** This consideration affects the use of bar clasps as follows:

8.35.1.3.1. The approach arm of a bar clasp should contact tissue between its point of origin and place where the arm crosses the gingival margin. *The presence of an undesirable soft tissue undercut in the path of a bar clasp's approach arm is one of the most serious contraindications to its use.* Figure 8.75 shows a high, deep, soft tissue undercut.

Figure 8.75. Soft Tissue Undercut.



8.35.1.3.2. Given the condition illustrated in Figure 8.75, the only option for positioning a bar clasp's approach arm is shown in Figure 8.76. This option is unacceptable. Given the conditions shown in Figure 8.77, a proper relationship can be developed between an approach arm and underlying tissue (Figure 8.78).

8.35.1.3.3. There are instances where a tooth leans out so far into the vestibule the facial surface blocks satisfactory placement of an approach arm. The problem most frequently occurs in the canine area (Figure 8.79).

8.35.1.4. **Classification of the Case:**

8.35.1.4.1. Extension cases require special attention. Clasp assemblies that use a mesial rest in conjunction with a distal undercut for distal extension case abutments produce fewer tilting forces on the teeth.

Figure 8.76. Incorrect Approach Arm Relationship.

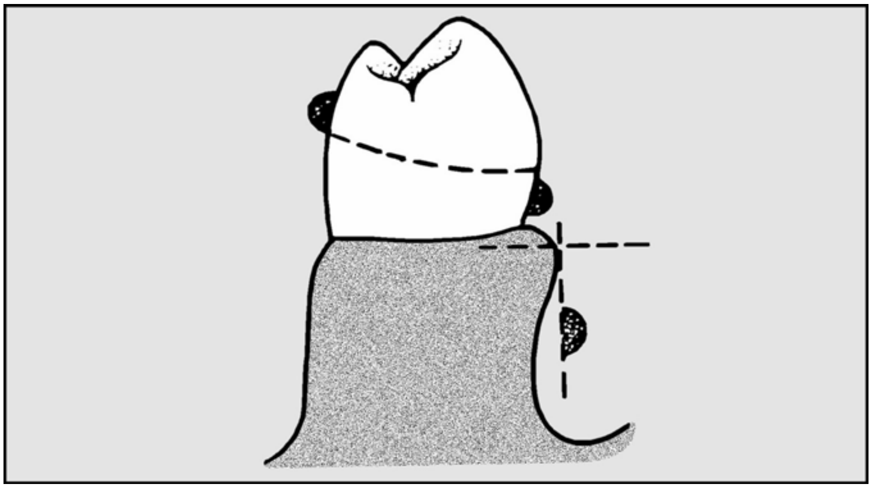


Figure 8.77. No Soft Tissue Undercut.

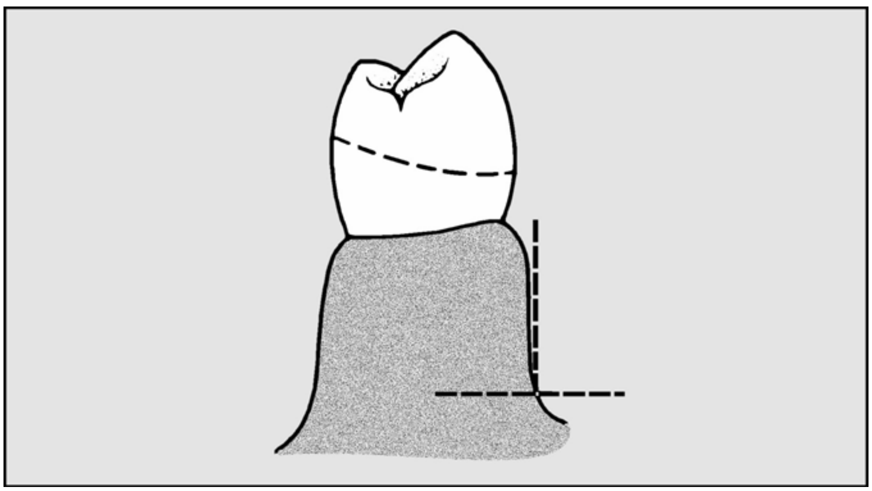


Figure 8.78. Acceptable Approach Arm Relationship.

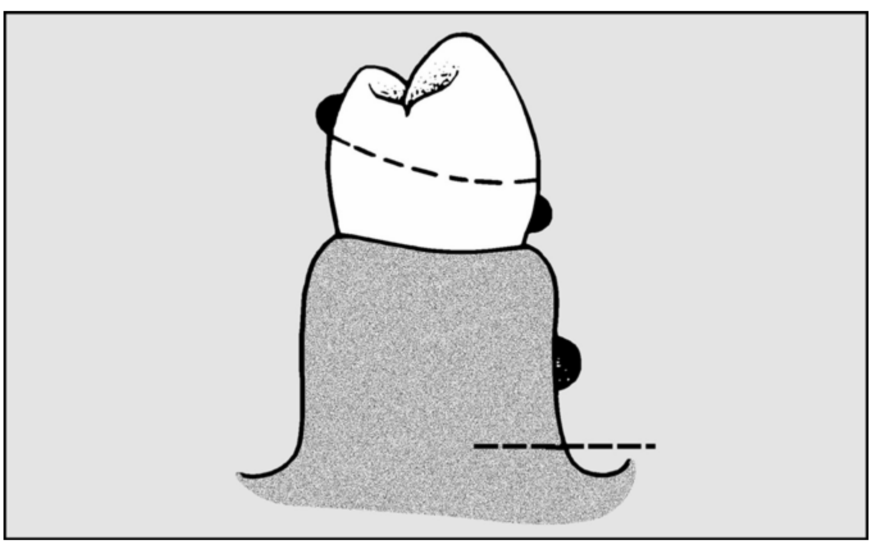
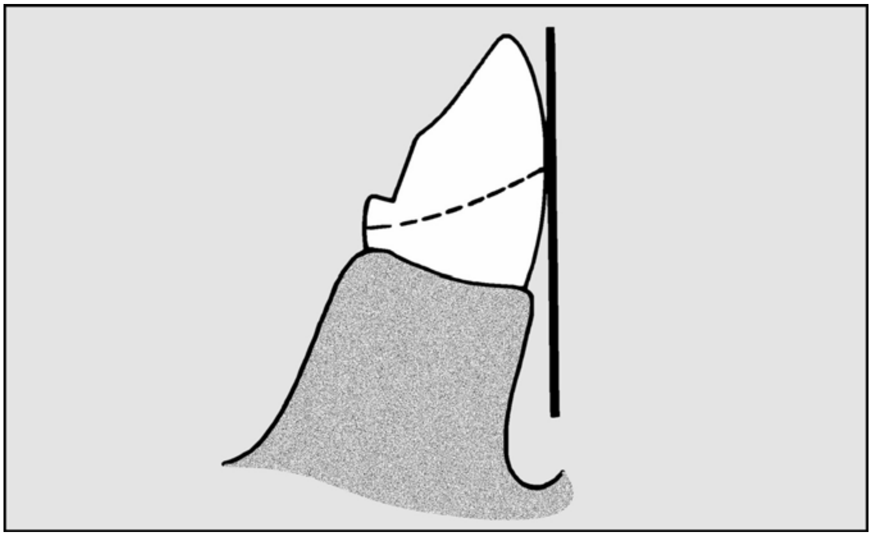


Figure 8.79. Bar Clasp Use Is Blocked.



8.35.1.4.2. The same is true when using a distal rest together with a mesial zone of undercut for anterior extension situations. Extension RPDs must be thought of in a different way than toothborne RPDs because part of the support of the RPD comes from compressible tissues. As a result, the RPD moves much more when the patient chews. The clasp assemblies must be chosen to consider this movement. There are three primary concepts for dealing with this movement; *stress-breaking, stress-releasing, and stress-distribution.*

8.35.1.5. **Location of the Undercut.** Most forms of circumferential and bar clasps are best suited to engaging undercuts in mesial or distal zones. The I-bar is an exception. It is specifically designed to engage midfacial or midlingual undercuts.

8.35.1.6. **Incidence of Decay Associated With a Clasp Form.** There are dental patients who are unusually prone to developing cavities. Because bar clasps generally contact less tooth surface than circumferential clasps, the chances for decay should be somewhat reduced.

8.35.1.7. **Periodontal Integrity of Abutment Teeth:**

8.35.1.7.1. **Circumferential Clasps.** Circumferential clasps are stiffer than bar varieties and have more potential to do damage while the RPD is being inserted or removed. Clasp arms placed close to the occlusal surface of a tooth because of high survey lines act to widen the chewing table. This increases the load an abutment must bear. The additional burden could be too much for the tooth's supporting structures to tolerate.

8.35.1.7.2. **Combination Clasps.** There is an authoritative body of opinion that believes combination clasps are less abusive to teeth than cast clasps because the wire retentive arm of a combination clasp has a round cross-section and can flex in many planes instead of just one.

8.35.2. **Common Clasp Assembly Applications.** Observe how the common clasp forms relate to survey lines and zones of undercut in the following examples. Although it is impossible to show every conceivable situation, these limited number of examples are supposed to represent principles that can be applied to a much larger range of possibilities:

8.35.2.1. **Circumferential Clasp Assemblies:**

8.35.2.1.1. **Simple Circumferential:**

8.35.2.1.1.1. Two arms project from the clasp's body and terminate on the sides of the tooth opposite from the clasp assembly's rest. A simple circumferential clasp is versatile, easily adjusted, and can be relatively inconspicuous. Limiting factors permitting, this is the circumferential clasp of choice.

8.35.2.1.1.2. The undercuts used are the mesial or distal zones on facial or lingual surfaces. Example #1 shows a toothborne quadrant and the clasp arms are convergent (Figure 8.80). Example #2 shows a toothborne quadrant and the clasp arms are divergent (Figure 8.81). Example #3 shows a distal extension quadrant, distal abutment, mesial rest, and distofacial zone (Figure 8.82). Example #4 shows an anterior extension case, anterior abutment, distal rest, and mesiofacial zone (Figure 8.83).

Figure 8.80. Simple Circumferential Clasp Assemblies With Convergent Retentive Arms (Example #1).

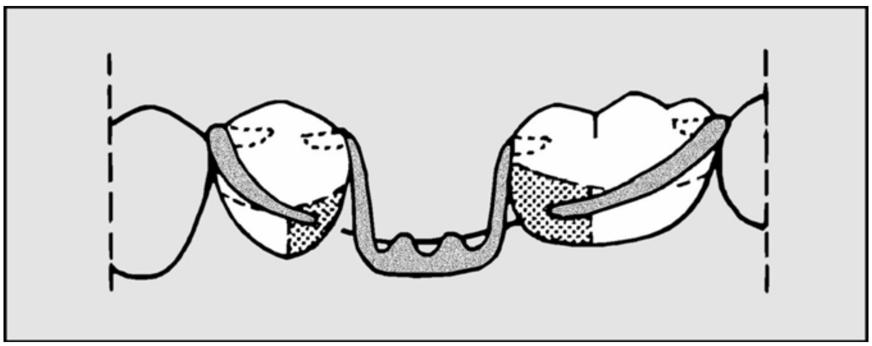
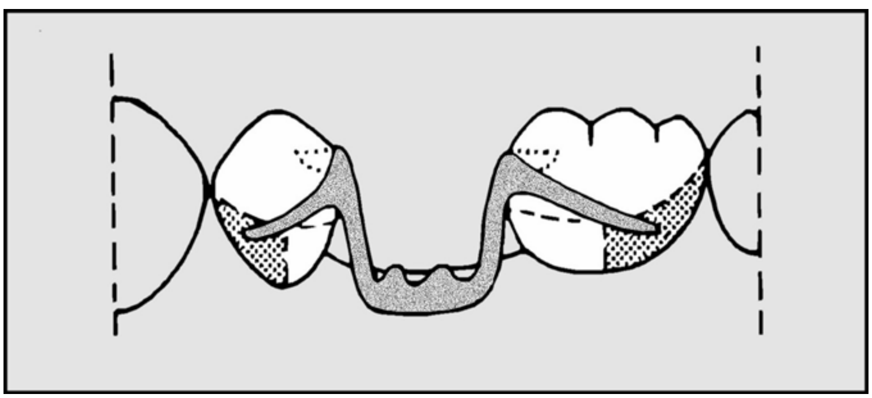


Figure 8.81. Simple Circumferential Clasp Assemblies With Divergent Retentive Arms (Example #2).



8.35.2.1.2. **Embrasure (Crib).** This clasp assembly consists of two circumferential clasps joined at their bodies, and a single minor connector. The assembly passes between two adjacent natural teeth. One retentive arm engages the mesial zone of undercut on the anterior abutment, and the other retentive arm uses a distal undercut on the posterior abutment (Figure 8.84).

Figure 8.82. Simple Circumferential Clasp Assembly With Distal Extension Situation (Example #3).

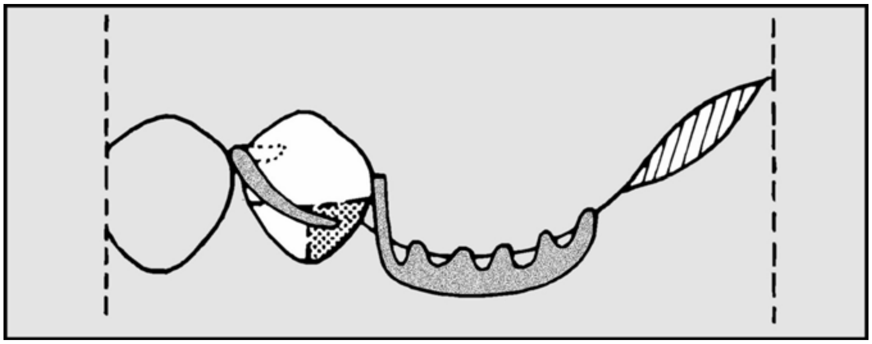


Figure 8.83. Simple Circumferential Clasp Assembly With Anterior Extension Situation (Example #4).

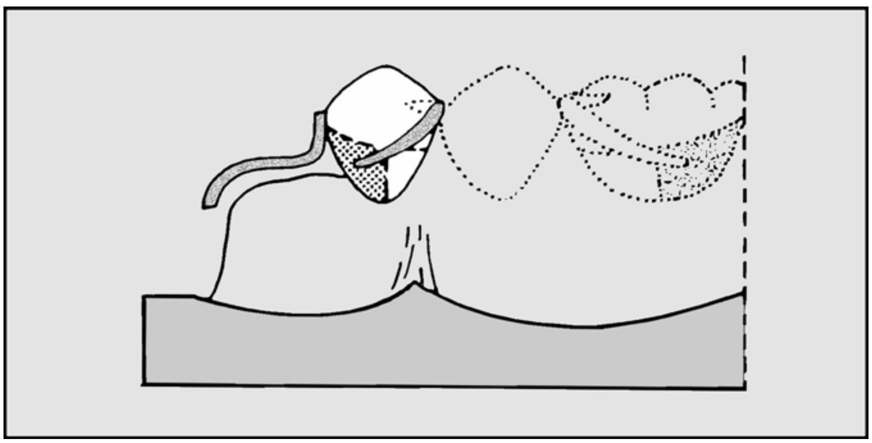
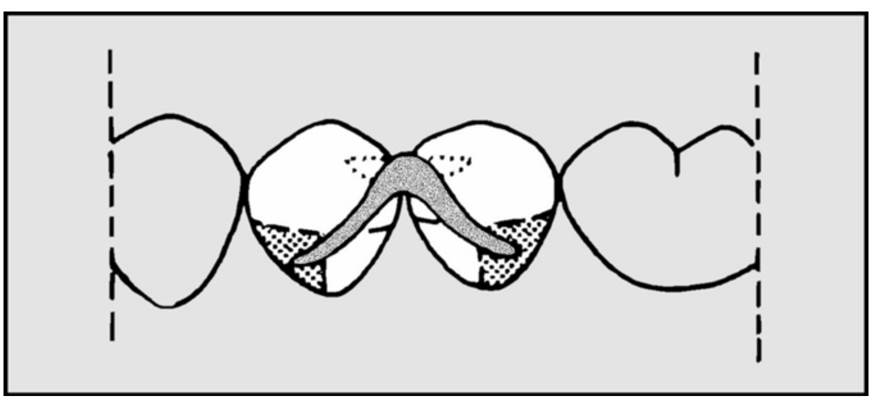


Figure 8.84. Embrasure Clasp Assembly.



8.35.2.1.3. **Ring Clasp With Strut Assembly:**

8.35.2.1.3.1. Instead of two arms, this circumferential clasp has a single arm that almost completely encircles the tooth. The ring clasp assembly uses two rests, and a supplemental strut braces the arm. An unbraced ring clasp is highly susceptible to accidental bending. The strut leaves a major connector or a denture base area, crosses over soft tissue surfaces, and intersects with the clasp arm halfway between the retentive tip and the minor connector. The strut should remain in light contact with the soft tissue it traverses.

8.35.2.1.3.2. It logically follows that a properly braced ring clasp is contraindicated when there is an undesirable soft tissue undercut in the path of the strut. Mesial zone undercuts on molars can be difficult to get to. Braced ring clasps are a design compromise that can fulfill that purpose. The undercuts most frequently involved are mesiolingual on mandibular molars and mesiofacial on maxillary molar teeth. Example #1 shows the ring clasp used to enter a mesiolingual zone on a mandibular molar; Figure 8.85 represents a lingual and buccal view. Example #2 shows the ring clasp used to enter a mesiofacial zone on a maxillary molar; Figure 8.86 represents a buccal and a lingual view.

Figure 8.85. Ring Clasp Assembly, Mandibular Arch (Example #1).

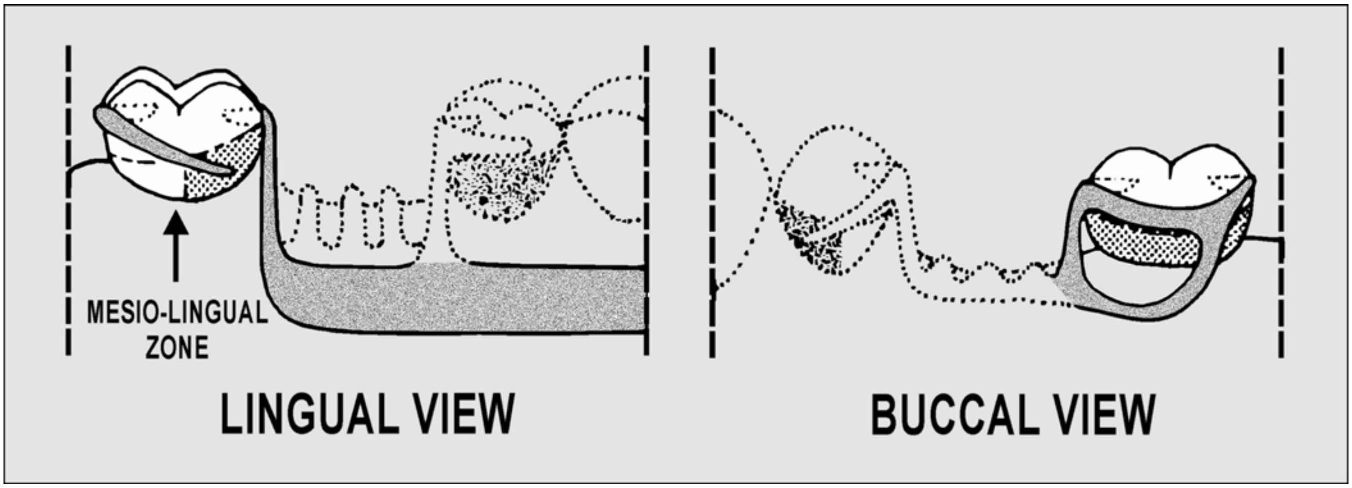
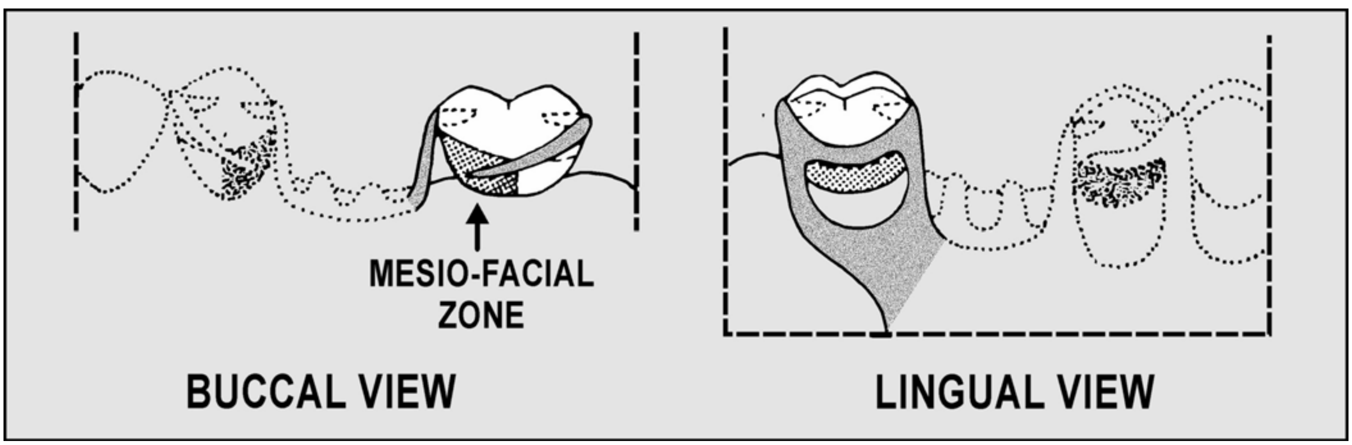


Figure 8.86. Ring Clasp Assembly, Maxillary Arch (Example #2).

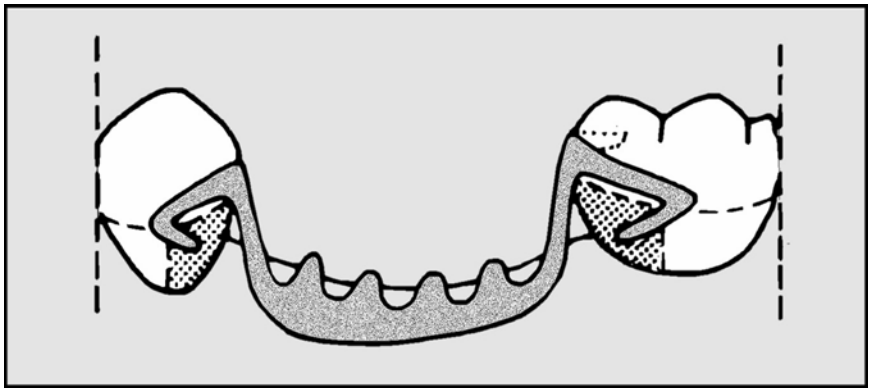


8.35.2.1.4. **Reverse Action (Hairpin):**

8.35.2.1.4.1. The distinctive feature of this circumferential clasp is that the retentive arm reverses itself on the face of the tooth (Figure 8.87). The retentive tip of a hairpin clasp enters a zone of undercut immediately gingival to the retentive arm's shoulder.

8.35.2.1.4.2. One problem associated with hairpin clasps is that they cover a great deal of tooth surface. They are highly visible and can not be used on teeth having short clinical crowns.

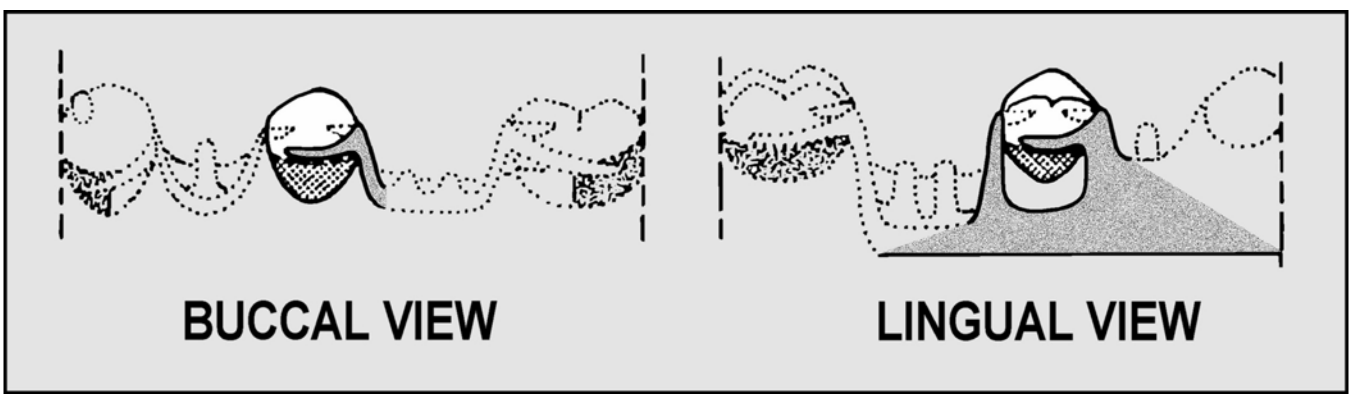
Figure 8.87. Hairpin Clasp Assemblies.



8.35.2.1.4.3. Perhaps the most serious shortcoming of the hairpin clasp is its susceptibility to breakage. It is very difficult for the dental laboratory technician to shape and polish this retentive arm without destroying its taper. As a result, this clasp usually flexes at the weakest point (the angle of the hairpin) and fractures. However, it may be used to enter distofacial undercuts on canines, distofacial undercuts on premolars, and mesiofacial infrabulge zones of molars when soft tissue undercuts prevent the use of bar approach arms.

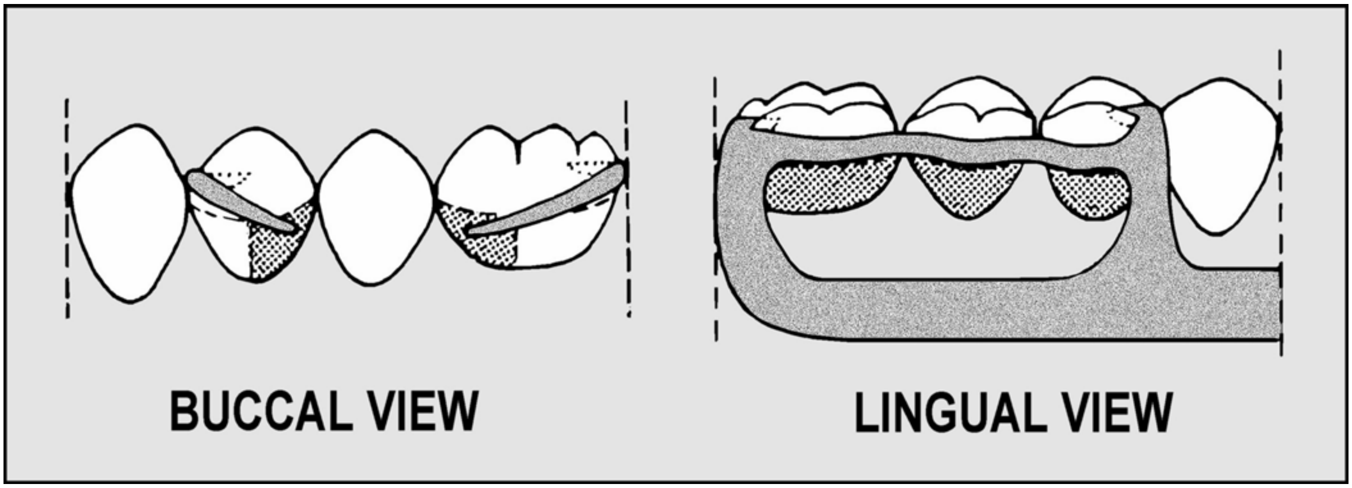
8.35.2.1.5. **Half-and-Half (Split).** This clasp assembly consists of mesial and distal minor connectors, each of which bears a rest and an arm. The split clasp can engage most mesial or distal zone undercuts on the buccal or lingual. Figure 8.88 represents buccal and lingual views of a split clasp used in this manner.

Figure 8.88. Half-and-Half (Split) Clasp Assembly.



8.35.2.1.6. **Multiple Circumferential.** This clasp assembly consists of two opposing circumferential clasps joined at the terminal end of the two reciprocal arms. A separate minor connector attaches each of the joined clasps to the framework. The reciprocal arms are united to provide increased support for two or three weak or isolated teeth. Buccal and lingual views of the multiple circumferential clasp assembly are presented in Figure 8.89.

Figure 8.89. Multiple Circumferential Clasp Assembly.



8.35.2.1.7. **Combination Circumferential:**

8.35.2.1.7.1. The combination clasp consists of a wrought wire retentive arm and a cast reciprocal arm. The wrought wire arm may be embedded in the framework during the waxing and casting procedures, the wire may be soldered to the framework after the framework is cast, or the wire may be embedded in the acrylic resin denture base during processing.

8.35.2.1.7.2. Some authorities maintain that a wrought wire arm is detrimentally altered by high temperature. Therefore it is advisable to solder the wrought wire to the framework at a point well away from the flexible retentive end of the wire.

8.35.2.1.7.3. The combination clasp is believed to exert less destructive force on an abutment because of its high flexibility. By the same token, a wrought wire arm is easily bent out of shape.

8.35.2.1.7.4. The most common uses of the combination clasp are on an abutment tooth adjacent to a distal extension base where the only undercut available lies in the mesiofacial zone (Figure 8.90) and on periodontally weak abutments. The combination clasp may also be used to engage a midfacial undercut with the mid-body portion of the clasp. In this case, both the shoulder and tip of the clasp would be above the survey line. The depth of undercut required is usually .010 or .015 and rarely .020 inch. The wrought wire used may be either 18-gauge round platinum-gold-palladium (PGP) wire or Ticonium wire.

8.35.2.1.8. **Twin Flex.** A special variety of wrought wire clasps is the twin flex. It is used in interproximal retentive undercuts, usually in the anterior where there is a desire to avoid display of metal. The clasp extends underneath the major connector, where it is soldered, into the proximal undercut (Figure 8.91). It requires significant vertical space and is difficult to construct.

Figure 8.90. Buccal View of Combination Circumferential Clasp Assembly.

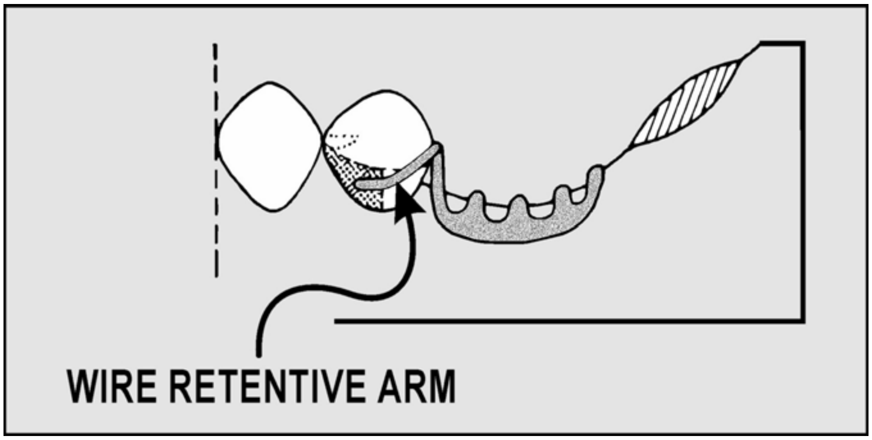


Figure 8.91. Lingual View of Twin Flex Clasp Beneath Lingual Major Connector.

8.35.2.2. **Bar Clasp Assemblies:**

8.35.2.2.1. **T-Bar Clasp.** This clasp ordinarily uses undercuts located in facial or lingual zones adjacent to an edentulous space. If such a clasp had a long approach arm and was cast in chrome, it should engage .015 inch undercut. When the retentive tip of a T-bar clasp engages a distofacial undercut, the bracing tip falls on the tooth's highly visible mesial surface. However, this component provides a valuable bracing function. The T-bar clasp is not indicated on canines and first premolars. Two examples of T-bar clasp assembly use are in Figures 8.92 and 8.93.

8.35.2.2.2. **Modified T-Bar.** When esthetics is most important, the bracing tip of a T-bar clasp can be omitted. When the bracing tip off a T-bar clasp is omitted, the result is called a modified T or 1/2 T. Because the modified T is somewhat more esthetic than a T-bar clasp, the modified T may be used on anteriorly positioned abutments. Two examples of modified T bar clasp assemblies are shown in Figures 8.94 and 8.95.

Figure 8.92. T-Bar Clasp Assemblies—Toothborne Quadrant.

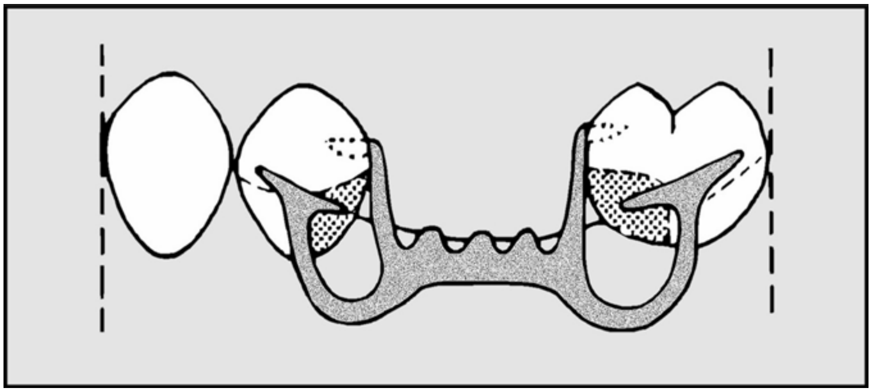


Figure 8.93. T-Bar Clasp Assembly—Distal Extension Situation.

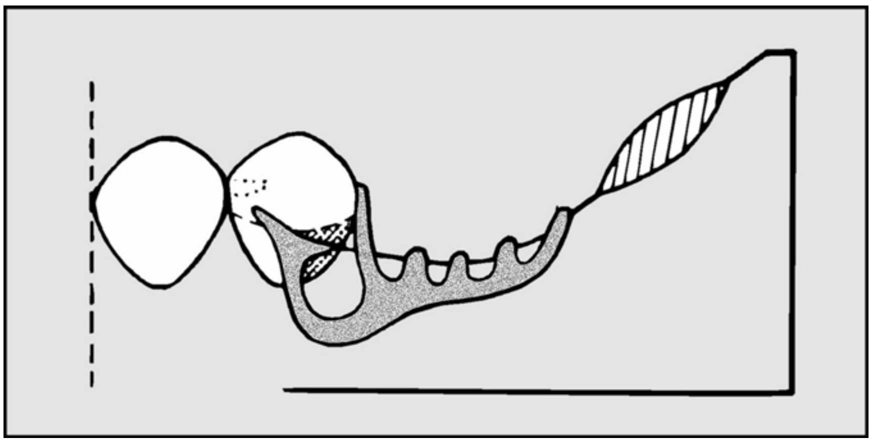


Figure 8.94. Modified T-Bar Clasp Assemblies—Toothborne Quadrant.

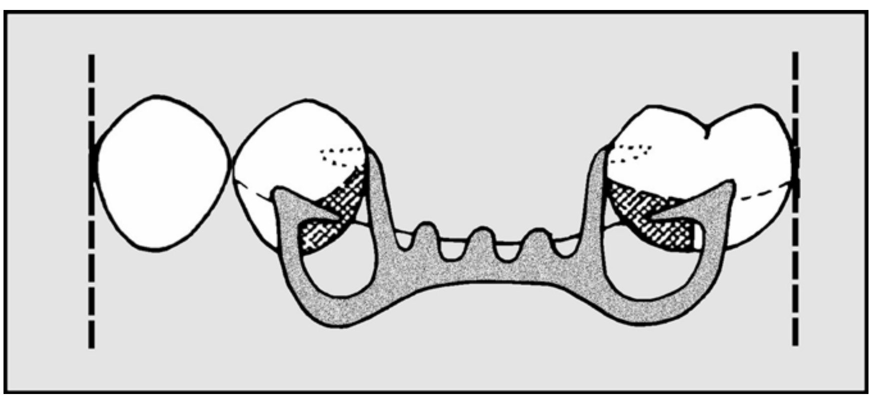
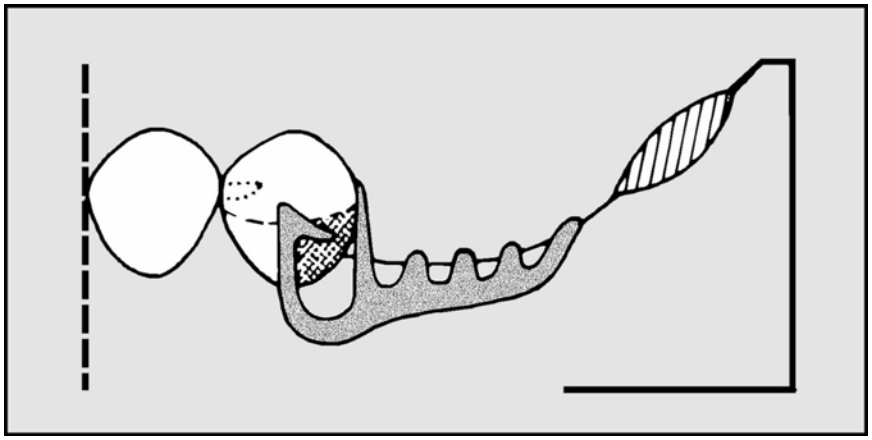
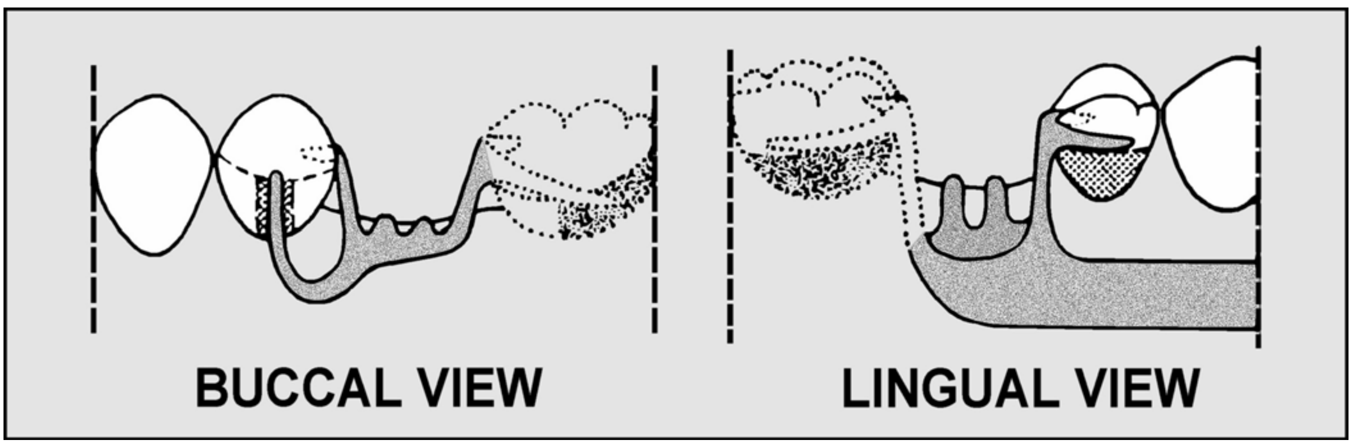


Figure 8.95. Modified T-Bar Clasp Assembly—Distal Extension Situation.



8.35.2.2.3. **I-Bar.** In contrast to other forms of the bar clasp, there are no bracing or retentive tips diverging from the approach arm of an I-bar clasp. Instead, the end of the approach arm acts as a retentive tip. The original I-bar configuration was devised to reduce bar clasp visibility, and it is still used for that purpose. I-bar clasps cast in chrome-alloy usually use .010 inch mesiofacial or mesiolingual undercut. An example of a I-bar clasp assembly is shown in Figure 8.96.

Figure 8.96. I-Bar Clasp Assembly—Toothborne Quadrant.

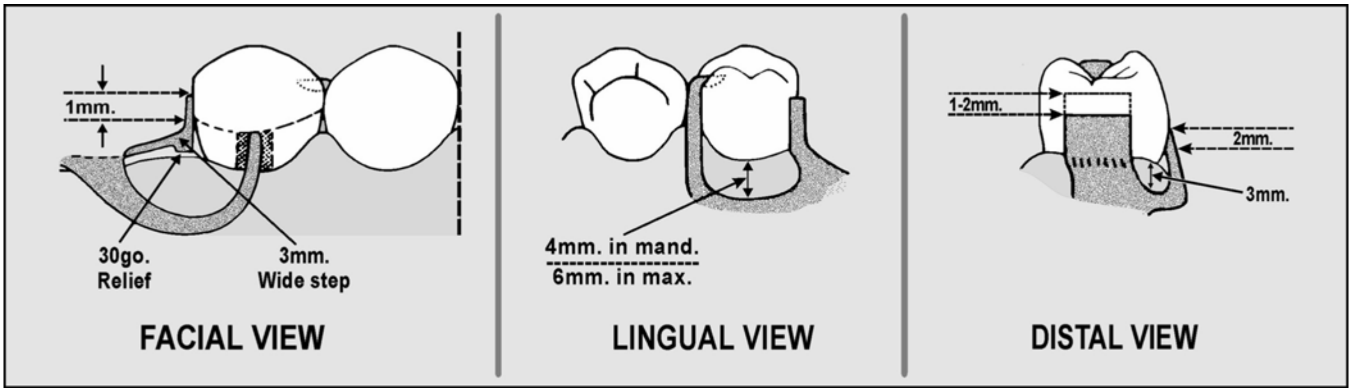


8.35.2.3. **Stress-Releasing Clasp Assembly Applications.** The stress-releasing concept is very popular with some dentists. It uses various specialized clasp assemblies in an attempt to minimize torquing forces on the terminal abutments of distal extension RPDs. These include the I-bar, RPI, modified T-bar, and RPA concepts. While each of these techniques has its own peculiarities, they all have in common a mesial rest on the terminal abutment and distal guide plane, and they use a midbuccal, mesial-midbuccal, or distobuccal retentive undercut. The major connector on the lingual is kept at least 5 mm below the gingival margin.

8.35.2.3.1. **I-Bar Clasp.** This technique, originally described by Dr. Kratochvil, uses a long flat guide plane on the distal of the abutment that contacts the tooth from 1 to 2mm on the tissue up to the occlusal surface. There is no relief under this metal except for blockout in undercut areas. The guide plane may wrap slightly around the distolingual line angle. A distal rest accompanies the mesial rest on the next anterior tooth. The I-bar clasp engages a midbuccal undercut.

8.35.2.3.2. **RPI Clasp.** Developed by Dr. Krol, RPI stands for rest, proximal plate, and I-Bar (Figure 8.97).

Figure 8.97. RPI Clasp Assembly.



8.35.2.3.2.1. **Rest.** The abutment tooth contains a mesio-occlusal rest. A minor connector is attached to this rest in the mesiolingual embrasure. The minor connector is constructed to avoid touching the distolingual surface of the adjacent tooth.

8.35.2.3.2.2. **Proximal Plate.** The superior edge of the proximal plate engages about 1 mm of the bottom of the distal guide plane. The lingual margin of the plate follows the curvature of the abutment far enough so the remaining distance to the minor connector is less than the width of the tooth. The proximal plate is 1 mm thick and joins the framework at right angles. At this junction, the portion of the proximal plate adjacent to the gingival tissue is 3 mm wide anteroposteriorly. The tissue under this step is relieved with one thickness of 30-gauge wax.

8.35.2.3.2.3. **I-Bar.** The retentive tip of an I-bar has a 2 mm span of contact with tooth surface, and the bottom of this contact is located at .010 inch undercut. The approach arm of the I-bar should be located at least 3 mm away from the gingival margin.

8.35.2.3.2.4. **Guide Planes.** Before a final impression is made, the dentist prepares a guide plane at the occlusal 1/3 of the abutment's distal surface. The distal guide plane is about 2 to 3 mm in height. An undercut must be present below the guide plane. This lets the proximal plate disengage from the tooth when the distal extension part of the RPD is loaded. The dentist has the option of preparing another 2 to 3 mm guide plane at the occlusal 1/3 of the abutment's mesiolingual surface. This acts to increase the reciprocating and bracing effectiveness of the minor connector.

8.35.2.3.3. **RPA.** When an infrabulge clasp cannot be used, but the dentist wants to use a stress releasing design, an RPA concept may be used. This concept uses a mesial rest, a proximal plate, and a circumferential (Akers) clasp into a distobuccal undercut. The important point to remember in this technique is the superior edge of the circumferential clasp must contact the abutment tooth only at the survey line until the retentive tip engages the tooth in the retentive undercut. The rest of the clasp does not contact the tooth at all. The rest and proximal plate is the same as the RPI concept.

8.35.2.3.4. **Modified T-Bar.** When a stress-relieving concept is used, but only distobuccal undercut is available, a modified T-bar may be used. The clasp assembly is made the same as an RPI, except a modified T-bar instead of an I-bar is used.

8.36. Decide If All Requirements for Rests Have Been Met. Some general guidelines for placing rests are:

8.36.1. Rests are almost always placed on teeth adjacent to edentulous spaces because that is where support requirements are greatest. Common exceptions include when a specialized clasping system is used such as a stress-releasing concept and when opposing cusps make it very difficult for the dentist to create room for a rest.

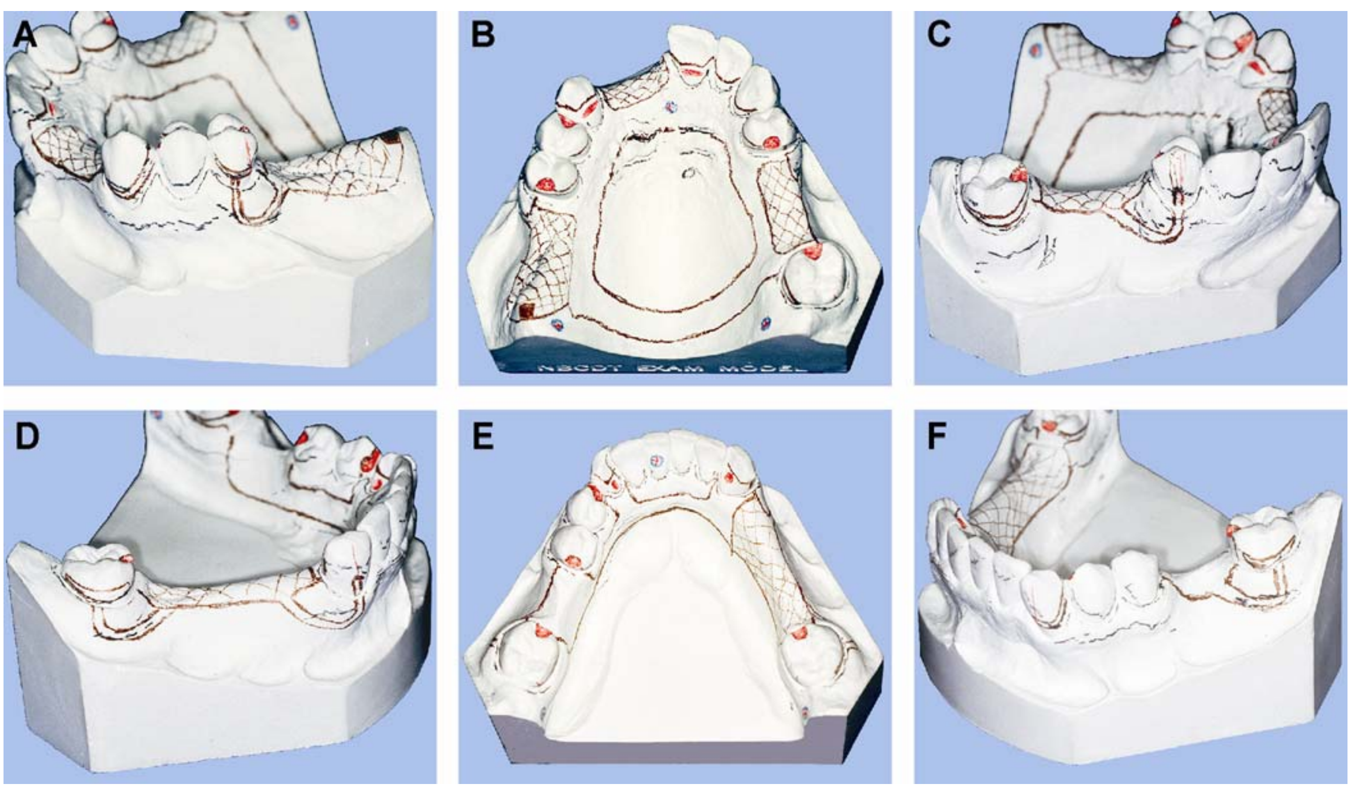
8.36.2. A clasp assembly almost always has a rest associated with it.

8.36.3. Rests are used to provide indirect retention in extension cases.

8.36.4. There is a commonly occurring, special situation where auxiliary rests are an excellent idea. In mandibular posterior toothborne RPDs that use a lingual bar major connector, the anterior part of the bar should be supported with auxiliary rests in the mesial fossa of the first premolar teeth.

8.37. Draw the Design in Appropriate Coded Colors. (***NOTE:*** This is the last step in the survey and design procedure.) The choices among RPD components have been made as the survey procedure has progressed. All that remains is to draw an accurate representation of the RPD on the cast. Per Figure 8.98, the primary guides for the drawing are the survey lines, points of undercut marked in red pencil, vertical overlap line drawn on the lingual surfaces of the upper anterior teeth, and anatomical features of the cast as follows:

Figure 8.98. Surveyed and Designed Casts.



8.37.1. **RPD Design Color Code.** Standard colors are reserved for drawing particular parts of an RPD design on a cast. These colors help to delineate components clearly and improve the quality of communication between the dentist and the technician as follows:

8.37.1.1. **Red:**

8.37.1.1.1. **Diagnostic Casts.** The color *red* is used to indicate areas in the patient's mouth that require preparation or recontouring such as rest seats, interfering cusps in the opposing arch, and guide planes. Red is used to mark the point where the retentive tip of a clasp will be positioned. Tissue relief is also marked in red.

8.37.1.1.2. **Master Casts.** The use of the color *red* on a master cast is limited to marking points of undercut for positioning clasp retentive tips, and tissue relief areas.

8.37.1.2. **Blue.** The color *blue* is used to outline the extent of acrylic resin denture base coverage.

8.37.1.3. **Brown.** The color *brown* is reserved for outlining metal parts of the RPD.

8.37.1.4. **Black.** Tooth and soft tissue survey lines are represented on the cast in the color *black.* Special instructions may also be written in black.

8.37.2. **Sequence and Method of Drawing the Design.** The suggested order for the steps in drawing the design on a diagnostic cast are:

8.37.2.1. **Rests.** The rest seats are colored.

8.37.2.2. **Clasps.** No matter what kind of clasp is drawn, the full assembly must take in more than 180 degrees of the tooth's circumference.

8.37.2.2.1. **Circumferential Clasp:**

8.37.2.2.1.1. **Retentive Arm.** The shoulder (proximal one-third) of a retentive arm is located above the survey line. The retentive tip (terminal one-third) ends on the undercut previously marked in red.

8.37.2.2.1.2. **Reciprocal Arm.** The gingival edge of the reciprocal arm conforms to the survey line. If the survey line approaches the occlusal surface of a posterior abutment or the clinical crown is very short, consider using reciprocal plating. The occlusal edge of reciprocal plating terminates about 0.5 mm occlusal to the survey line.

8.37.2.2.2. **T-Bar and Modified T-Bar Clasps:**

8.37.2.2.2.1. **Approach Arm.** As the approach arm leaves the denture base, the gingival edge of the arm is located at least 3 mm from the abutment's gingival crest. The edge of the arm nearest the sulcus must not dip below any soft tissue survey lines that might be present. The arm must not interfere with normal sulcus mobility. When the approach arm curves to make contact with the tooth surface, it is drawn so it intersects the gingival crest line at 90 degrees. The approach arms of T-bar and modified T-bar clasps make first contact with the tooth at the survey line.

8.37.2.2.2.2. **Bracing Tip.** *(T-bar clasps only)* The gingival edge of an approach arm's bracing tip falls on, or very close to, the survey line.

8.37.2.2.2.3. **Retentive Tip.** The retentive tip extends from the approach arm's contact with the survey line to the point of undercut on the tooth's surface previously marked in red.

8.37.2.2.2.4. **Reciprocal Arm.** The considerations are the same as those for circumferential clasp reciprocal arms (paragraph 8.37.2.2.1.2).

8.37.2.2.3. **I-Bar Clasps That Use Reciprocal Arms:**

8.37.2.2.3.1. **Approach Arm.** The considerations for an I-bar approach arm's soft tissue relationship are the same as the T-bar and modified T-bar clasps (paragraph 8.37.2.2.2.1).

8.37.2.2.3.2. **Retentive Tip.** The I-bar's retentive tip is the end of its approach arm. The tip makes first contact with the tooth at the .010 inch undercut mark and extends occlusally or incisally for 2 mm.

8.37.2.2.3.3. **Reciprocal Arm.** The considerations are the same as for the circumferential clasp reciprocal arms (paragraph 8.37.2.2.1.2).

8.37.2.2.4. **RPI Bar Clasp Assemblies (Figure 8.97):**

8.37.2.2.4.1. **Approach Arm and Retentive Tip.** The considerations are the same as for I-bar clasps that use conventional reciprocal arms (paragraph 8.37.2.2.3).

8.37.2.2.4.2. **Minor Connector.** The minor connector is drawn so it does not touch an adjacent tooth.

8.37.2.2.4.3. **Distal Plate.** The plate is supposed to contact the cervical 1 mm of the pre-prepared distal surface guiding plane. In clasps that engage midfacial undercuts, the assembly plating starts at the abutment's distofacial corner. It extends around the distolingual corner enough so the resultant space between the plate and the minor connector is less than the width of the tooth (encirclement).

8.37.2.3. **Major Connectors:**

8.37.2.3.1. **Defining the Borders of Major and Minor Connectors:**

8.37.2.3.1.1. Avoid adding to the prominence of natural convexities by covering their crests with metal.

8.37.2.3.1.2. Cover gingival margin tissue completely by an adequately relieved part of the RPD, or position the component at least 4 to 6 mm from the gingiva.

8.37.2.3.1.3. Cross gingival crest tissue at right angles to the gingival margin.

8.37.2.3.2. **Maxillary Major Connectors:**

8.37.2.3.2.1. **Anterior Borders of Straps.** Anterior borders of *straps* should follow the valleys between rugae as much as possible. When crossing over rugae, do it at 90 degrees to their crests. Stay 6 mm from gingival margins where possible. When utilizing *lingual plating,* be aware of where the line of impact between upper and lower incisors is drawn; do not extend lingual plating incisal to that line. The leading edge of a lingual plate is scalloped. The plate covers the lingual gingival one-third of the tooth in the cingulum area and rises to cover interproximal spaces up to the contact points. An exception is made when large diastemas are present. Cingulums are covered, but interproximal spaces are not. Make sure a rest supports each end of the plate.

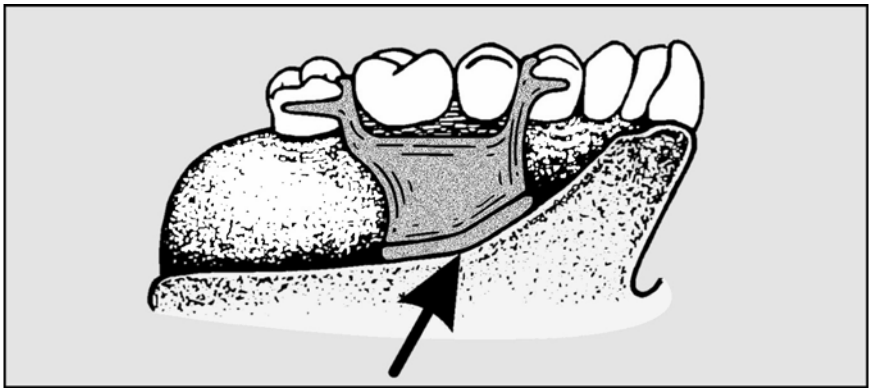
8.37.2.3.2.2. **Lateral Borders of a Maxillary Major Connector.** Either plate the lingual surface of a tooth or stay 6 mm from the gingival border.

8.37.2.3.2.3. **Posterior Border of a Maxillary Major Connector.** A strap should traverse the palatal vault anterior to the vibrating line. Full palatal coverage ends on the vibrating line in a manner similar to complete dentures.

8.37.2.3.2.4. **Width of Straps.** Maxillary strap major connectors should be made as wide as the combined width of the maxillary second premolar and first molar.

8.37.2.3.2.5. **Placement of Straps and Horseshoes Relative to the Palatal Vault (Figure 8.99).** The hard palate makes an ascent from the incisive papilla to the height of the vault. Then it proceeds more or less straight back to the vibrating line. Try to draw a strap or a horseshoe so at least part of the major connector straddles the place where the palatal angle changes. A strap gets additional strength from the "angle iron" effect.

Figure 8.99. Placement of Strap and Horseshoe Major Connectors Relative to Palatal Vault Shape.



8.37.2.3.3. **Mandibular Major Connectors:**

8.37.2.3.3.1. **Lingual Bar.** The superior edge of a mandibular lingual bar should clear the crests of the gingiva by 4 mm. The inferior edge should be placed high enough that it does not interfere with the normal mobility of the floor of the mouth. In distal extension cases, lingual bars end cleanly on a vertical line with the distal surface of the terminal abutment.

8.37.2.3.3.2. **Lingual Plates.** Mandibular lingual plates are outlined in the same manner as their maxillary counterparts (paragraph 8.37.2.3.2.1).

8.37.2.4. **Minor Connectors:**

8.37.2.4.1. **Minor Connectors That Join Clasp Assemblies and Auxiliary Rests to Major Connectors.** These types of minor connectors should be sturdy enough for rigidity, but sufficiently streamlined so patients can tolerate their presence. Minor connectors leading to clasp assemblies and auxiliary rests must cross a gingival margin at 90 degrees to the gingival line.

8.37.2.4.2. **Denture Resin Open Retention Grids.** Retention grids should always extend over the crest of the ridge to prevent midline fractures of the denture base. Grids are constructed to avoid the retromolar pads in the mandibular arch. Adequate bulk and strength in the metal at the junction of the grid and the major connector is essential as follows:

8.37.2.4.2.1. **Mesh.** Because mesh holes can be obliterated during the casting process, use prefabricated mesh patterns with maximum size openings.

8.37.2.4.2.2. **Ladder-Type Grid Retention.** This ladder-like configuration is formed from round and half-round wax shapes that extend over a ridge's crest onto its facial surface. The ends of the bars are connected for strength. It is also common to place reinforcing elements lingual to the crest of the ridge. Longitudinal reinforcing struts are never placed on top of a residual ridge. Struts located in this manner reduce the amount of room available for setting denture teeth and act as a wedge on the resin to cause breakage. The struts should be about 6 mm apart.

8.37.2.5. **Resin and Metal Denture Base Borders:**

8.37.2.5.1. **Anterior and Lateral Extent.** Anteriorly and laterally, denture base borders are determined by soft tissue survey lines. Survey lines permitting, denture base borders should extend into the sulci.

8.37.2.5.2. **Posterior Extent.** The following rules for the posterior extension of an RPD are not subject to compromise: (1) The maxillary arch full palatal coverage ends on or anterior to the vibrating line, (2) a maxillary arch distal extension denture base must extend into the hamular notch, and (3) a mandibular arch distal extension denture base must cover at least half of the retromolar pad.

8.37.2.6. **Finish Lines.** Finish lines show where there will be a 90-degree butt joint between acrylic resin and metal. When the tissue surface of the denture base will be made of resin, there will be an internal and external finish line. With metal bases, there will only be an external finish line. Internal and external finish lines cannot line up over each other because the retentive grid could be seriously weakened. Normally, the external finish line is placed toward the center of the arch from the internal finish line.

8.37.2.6.1. Internal finish lines should be placed about 1 to 2 mm from the survey line adjacent to the proximal areas of the edentulous areas. This creates an area of metal next to the gingival margin. Only mesh and ladder-type retention have internal finish lines.

8.37.2.6.2. External finish lines should be drawn, keeping in mind where the denture teeth will be placed. The metal and resin should provide a smooth transition from the major connector to the denture teeth and should create a natural contour.

8.37.2.6.3. Internal and external finish lines merge as they approach the facial or distal of the denture base.

8.37.2.7. **Supplemental Directions.** There are words and symbols used to explain the drawing on a cast more fully. These words and symbols are written in pencil or indelible ink boldly and neatly on the soft tissue portion of the cast adjacent to the appropriate area. Following is a list of words, symbols, and abbreviations for use on casts:

8.37.2.7.1. **Beads.** (Always spelled out.)

8.37.2.7.2. **BP.** Braided post.

8.37.2.7.3. **F.** Facing.

8.37.2.7.4. **GP.** Guide plane.

8.37.2.7.5. **MP.** All-metal pontic.

8.37.2.7.6. **Mesh.** (Always spelled out.)

8.37.2.7.7. **MV.** Metal pontic with an acrylic resin veneer.

8.37.2.7.8. **Onlay.** (Always spelled out.)

8.37.2.7.9. **PGP.** Platinum gold palladium wire.

8.37.2.7.10. **RAP.** Reinforced acrylic pontic.

8.37.2.7.11. **Tube Tooth.**

8.37.2.7.12. **WW.** Wrought wire.

8.37.2.7.13. **Red-Rimmed Circle.** Areas to be relieved or recontoured.

8.38. Protect the Design Against Smudging. To prepare the formula for a paint-on cast sealant, prepare a concentrated solution consisting of 50 gm of cellulose acetate, 12.5 cc of diethylphthalate, and 1 pint of acetone. Mix the ingredients and let the solution set for 24 hours. Then dilute l part of the concentrate to 10 parts of the acetone. Paint this onto a designed cast to protect the lines against smudging. ***NOTE:*** If these ingredients are not available, mix 1 part of shellac with 10 parts of methyl alcohol to make another satisfactory sealant.

Section 8D—Master Casts, Record Bases and Occlusion Rims, Cast-Mounting Procedures, and Design Transfer to the Master Cast

8.39. Final Impressions and Master Casts:

8.39.1. Pouring a final impression to make a master cast is one of the most crucial steps in RPD fabrication. The cast has to be as accurate, dense, and strong as possible. To obtain these qualities, pour an alginate impression within 10 minutes of removing it from the patient's mouth. This also means pouring a rubber base impression within the first hour.

8.39.2. For maximum density and strength, use a vacuum spatulated mix of artificial stone to pour final impressions. Use the two-step method mentioned in Chapter 7, paragraph 7.25, to pour impressions for RPD construction, or box them with a 50:50 mix of plaster and pumice before pouring them according to Chapter 7, paragraphs 7.34 and 7.35. Trim the cast according to directions in Chapter 7, paragraph 7.23.

8.40. Mounting the Master Cast in an Articulator:

8.40.1. **Introduction.** At this time, the need for this procedure is a value judgment. Some situations require it, while others do not. Often, it is not possible to make intelligent survey and design estimates without mounting the casts first. This can be true even if a fully surveyed and designed diagnostic cast is available as a guide. Some reasons for this would be:

8.40.1.1. Attachments for facings, reinforced acrylic pontics, and tube teeth must be cast as part of the framework.

8.40.1.2. A doubt exists about how opposing teeth fit against one another in maximum intercuspation, and this element of doubt affects the design of the RPD.

8.40.1.3. One or more natural teeth are in infraocclusion relative to the opposing teeth. The dentist is incorporating a metal onlay into the framework design to compensate for the problem.

8.40.1.4. The dentist is using the RPD to reestablish a proper occlusal vertical dimension. Master casts are usually mounted after the framework is cast in order to:

8.40.1.4.1. Find and grind away places on the casting that interfere with the patient's natural occlusion,

8.40.1.4.2. Position artificial replacements for missing natural teeth,

8.40.1.4.3. Correct the denture base processing error.

8.40.2. **Maximum Intercuspation (MI) Mounting When No Occlusion Rims Are Being Used (Figure 8.100).** The assumptions are that enough natural teeth remain to fit the casts into the patient's MI and the articulator is a fixed guide instrument (or a semiadjustable instrument used as a fixed guided instrument). The mounting procedures are as follows:

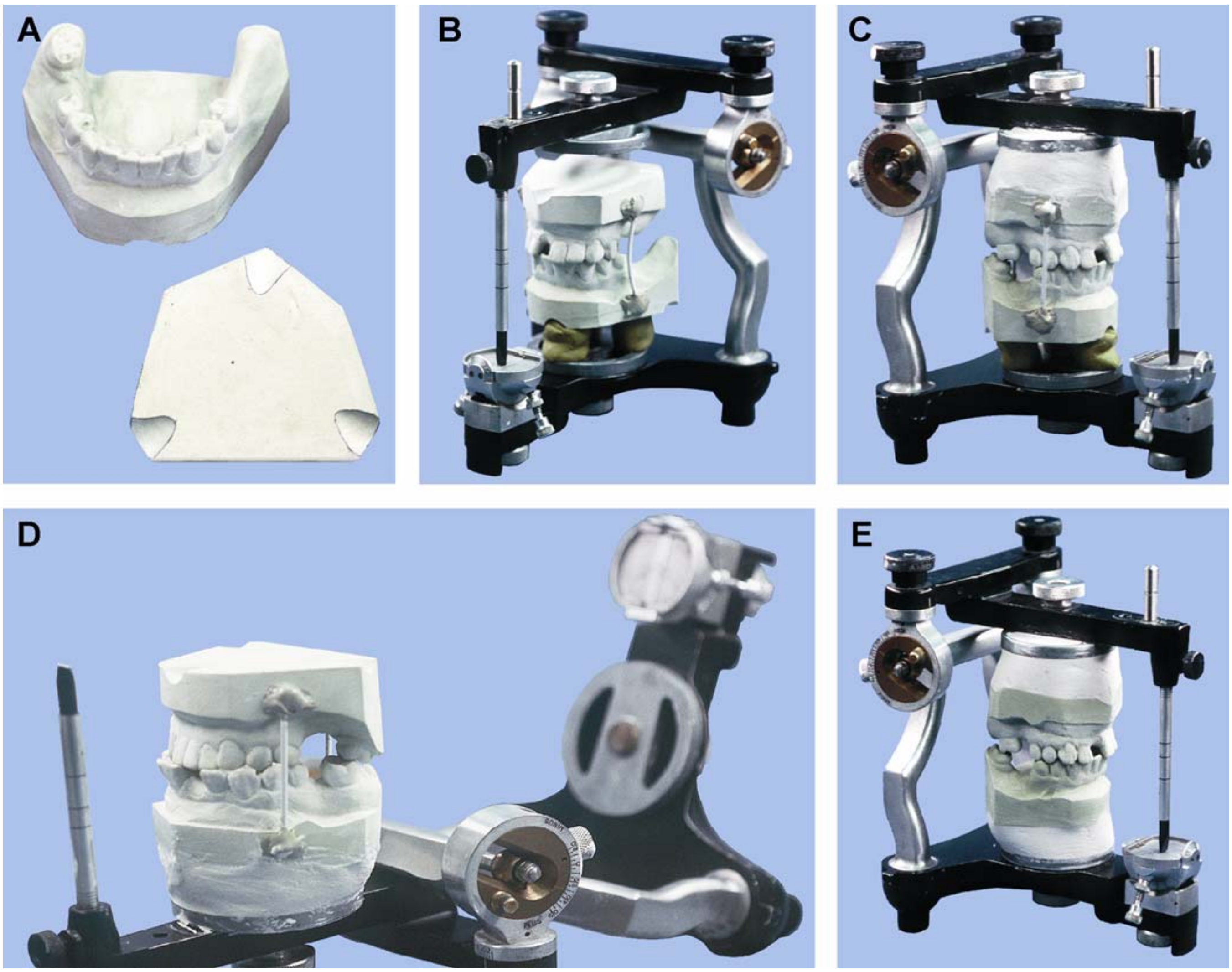
8.40.2.1. Establish proper settings of the Hanau H2 semiadjustable articulator if it is being used as a fixed guided instrument.

8.40.2.1.1. Make the top of the incisal guide pin flush with the top of the maxillary member. Set the incisal guide table at 0 degrees.

8.40.2.1.2. Set the horizontal condylar indications at 30 degrees and the lateral condylar guidance at 15 degrees.

8.40.2.1.3. Lock the condyle elements against the centric stops.

Figure 8.100. MI Mounting.



8.40.2.2. Make sure all plaster nodules and debris have been removed from the occlusal surfaces of the teeth on the cast. Index the base of the cast.

8.40.2.3. Place the casts in maximum intercuspation and stabilize them against shifting with sections of coat hanger wire and stick compound.

8.40.2.4. Mount the maxillary cast in an average manner (Chapter 6, paragraph 6.12).

8.40.2.5. Invert the articulator onto an appropriate stand.

8.40.2.6. Attach the lower cast to the lower member.

8.40.3. **Record Bases and Occlusion Rims Needed To Perform the Mounting**. These are used when not enough opposing natural teeth exist to find the patient's MI:

8.40.3.1. **Record Base and Occlusion Rim Construction (Figure 8.101):**

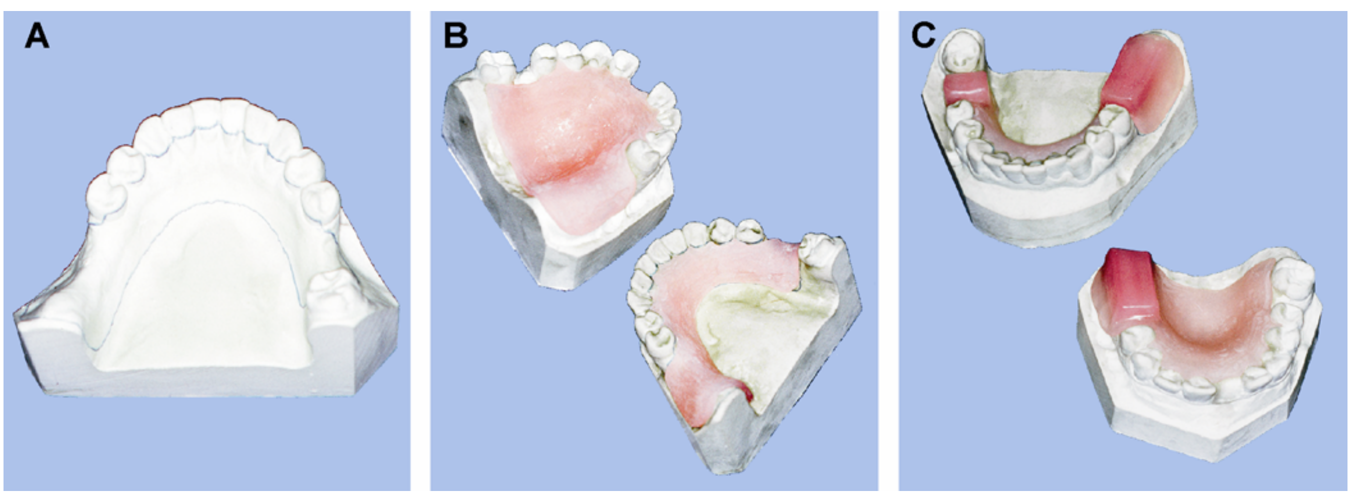
8.40.3.1.1. **Record Bases:**

8.40.3.1.1.1. Self-curing acrylic resin may be used to fabricate record bases on partially edentulous casts just as they are made for complete denture cases, except for the obvious modifications dictated by the presence of teeth on the casts (Chapter 7, paragraphs 7.40 and 7.41).

8.40.3.1.1.2. The three biggest problems associated with record base construction for partially edentulous casts are accidentally locking the record base material into the tooth and tissue undercuts while the record base is being made, distorting and breaking the record base, and carelessly scuffing the master cast.

8.40.3.1.1.3. Before starting record base construction, check for deep, bilaterally opposing undercuts and either avoid them or block them out. *Always* reinforce the anterior lingual area of a mandibular record base with a coat hanger wire. Remember, once the shape of a master cast is changed with a damaging influence (abrasion, erosion, or shipping), the cast cannot be used for RPD fabrication.

Figure 8.101. Record Base and Occlusion Rim Construction.



8.40.3.1.2. **Occlusion Rims.** Make occlusion rims a little wider and higher than adjacent natural teeth.

8.40.3.2. **Maxillary Cast Mounting.** Mount the maxillary cast according to the dentist's wishes by either the average method (Chapter 7, paragraph 7.47.1) or the facebow transfer method (Chapter 7, paragraph 7.47.2).

8.40.3.3. **Mandibular Cast Mounting.** Mount the mandibular cast using procedures described in Chapter 7, paragraph 7.48.

8.41. Transferring the Survey and Design to the Master Cast:

8.41.1. After he or she receives satisfactory diagnostic and master casts, the ADL officer or a qualified technician redraws the survey and design on the master cast.

8.41.2. First, the tripod marks found on the diagnostic cast are transferred to the master cast (paragraph 8.31.2). (The tripod marks allow the master cast to be oriented in the same position within the surveyor the diagnostic cast occupied during its survey.)

8.41.3. When the original tilt of the diagnostic cast has been duplicated, the master cast is surveyed. Then the color coded design is transferred from the diagnostic cast to the master cast (Figure 8.98). ***NOTE:*** The only difference in the code for a master cast is that rest seats are outlined in *brown* rather than being fully colored in *red*.

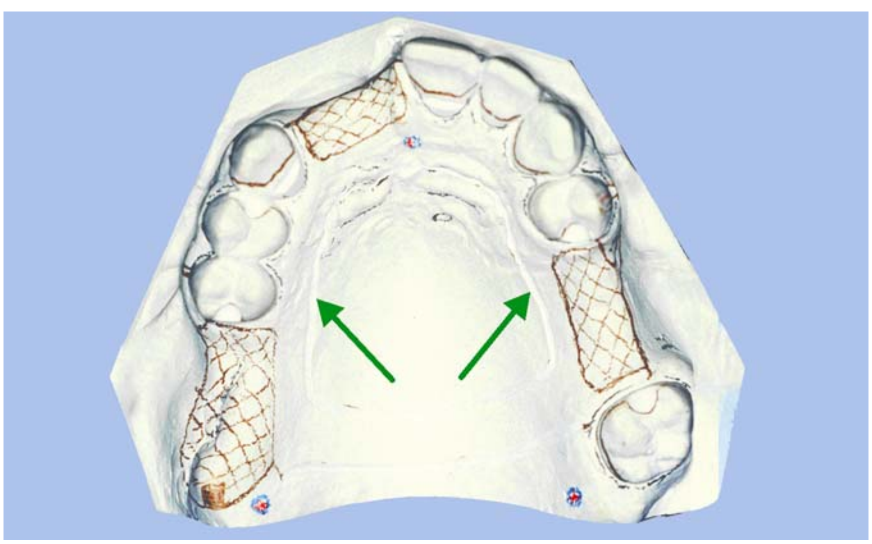
Section 8E—Refractory Cast Production, Design Transfer to the Refractory Cast, and Framework Wax-Up

8.42. Producing a Refractory Cast. A *refractory cast* is a heat-resistant duplicate of a modified (blocked out and relieved) master cast. The refractory cast is made from dental casting investment. It serves as a base for forming the RPD framework in wax and plastic. Subsequently, the refractory cast and attached framework pattern become part of a mold used for casting the framework in metal. The two major steps in producing a refractory cast are:

8.42.1. **Preparing the Master Cast.** Adjustments to the tongue space and base should be done before the master cast is placed on a survey table and tripoded.

8.42.1.1. **Maxillary Arch Major Connectors.** Maxillary arch major connectors should have a prepared seal (beadline) along the portions of the component that border on soft tissue (Figure 8.102). The beadline displaces soft tissue slightly and prevents food impaction under the connector. Create the beadline by scraping a rounded groove, 1 mm wide and 0.5 mm deep, into the surface of the cast. The groove should follow the edges of the connector's design on soft tissue. Be careful not to cut a bead line into the teeth. Feather the line out when it approaches a gingival crest area and stop it about 1.5 mm short of the gingival crevice.

Figure 8.102. Maxillary Major Connector Bead Line.



8.42.1.2. **Mandibular Tongue Spaces.** Trim the tongue space with a pneumatic chisel, as necessary, to prepare a surface for sprue leads. The tongue area should be just below the level of the pattern (bottom edge of the major connector) to allow for a 15-degree incline from the sprue to the pattern. ***CAUTION:*** Be aware of the thickness of the base. If the base will be less than 10 mm after trimming the tongue space, it may be necessary to first add stone to the base first to strengthen it.

8.42.1.3. **Bases:** (***CAUTION:*** When trimming a master cast, be careful to preserve the labial sulcus in areas that will require acrylic flanges.)

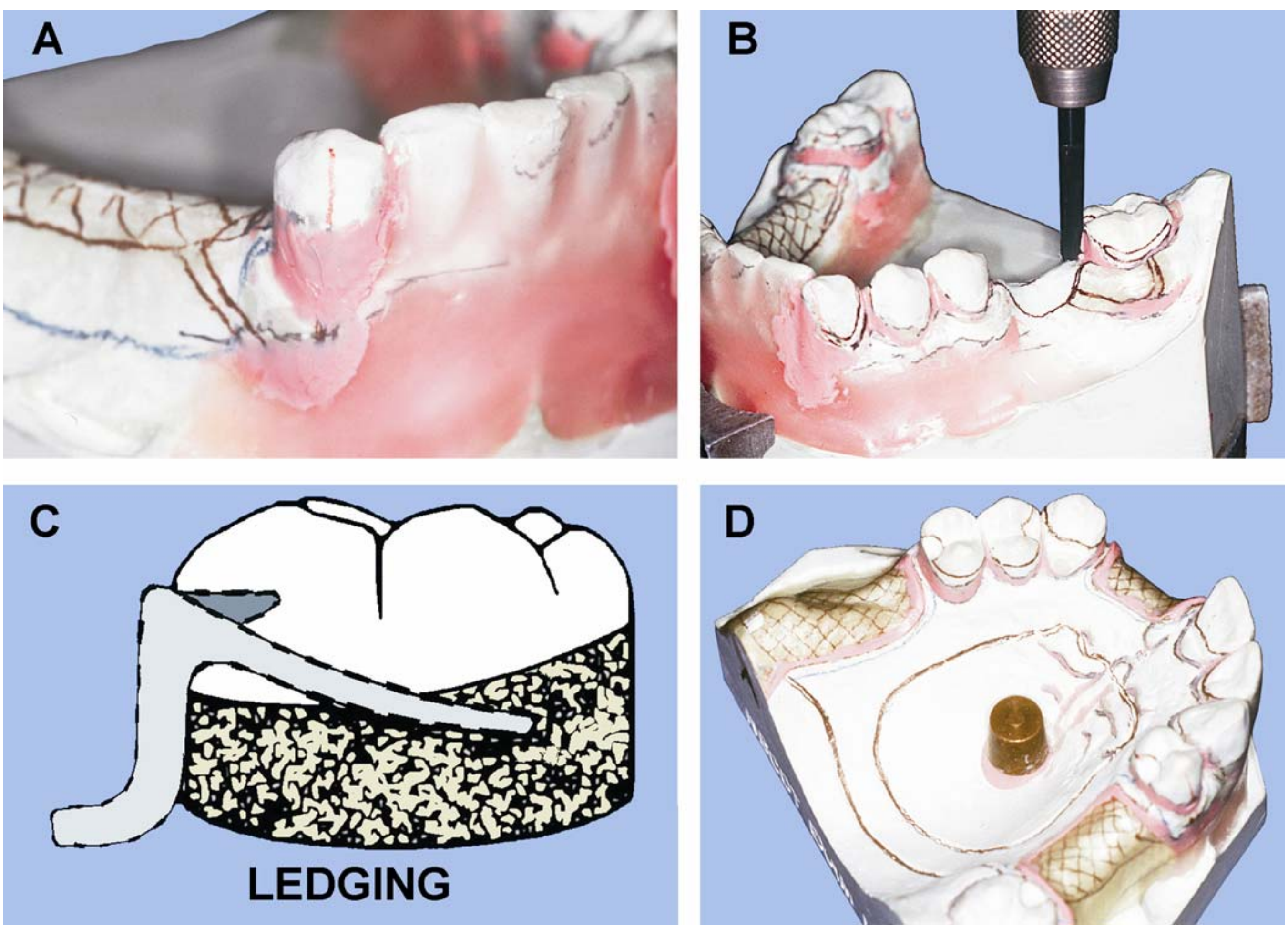
8.42.1.3.1. Ensure the sides of the base are trimmed at a 90-degree angle to the bottom of the cast. An undercut in the base will cause distortion of the duplicating material when the cast is removed from the mold. Trim as necessary. If there is not adequate land area to trim, rebase the cast or block out with baseplate wax.

8.42.1.3.2. Remember, the master cast must fit in the duplicating flask. Trim oversized or thick bases.

8.42.1.3.3. Occlude with the opposing cast. Ensure the excess stone in the posterior regions does not interfere with occlusion. Trim as necessary.

8.42.1.4. **Blockout and Ledging (Figure 8.103).** The procedures to accomplish next are *blockout* and *ledging*. The *blockout* step eliminates all undesirable tooth and soft tissue undercuts; *ledging* is a method of exposing the portion of desirable undercut used for retention.

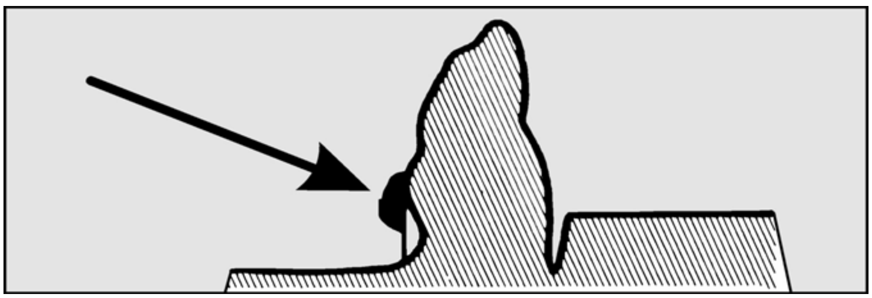
Figure 8.103. Blockout, Ledging, and Relief.



8.42.1.4.1. **Formula for Blockout Wax.** The formula for making blockout wax consist of 9 sheets of baseplate wax, 9 sticks of gutta-percha, 10 sticks of sticky wax, 1 tablespoon of kaolin powder, and a trace of sudan red for color. (One-half a tube of red lipstick can be substituted for sudan red.)

8.42.1.4.2. **Blockout of Gross Undercuts Peripheral to the Design.** Check the tripod marks to be sure the cast is still properly tripoded. Block out deep undercuts with baseplate wax if the undercuts are not directly related to the design. (Figure 8.103-A). These undercuts are most common in anterior facial and mandibular lingual areas (Figure 8.104). Stay at least 4 mm away from pattern areas. Blocking out deep undercuts peripheral to the design allows the cast to be removed from the duplicating material with the least amount of drag and resultant distortion.

Figure 8.104. Blockout for a Proposed Lingual Bar.



8.42.1.4.3. **Application of Blockout Wax.** The framework design drawn on the cast is known as the "pattern." All undercuts in the pattern must be blocked out with blockout wax. The combination of ingredients in blockout wax enables it to withstand the pouring temperature of the duplicating material without melting. Even a slight softening of the wax could cause the tooled area to sag, which could result in undercut. This is why it is important to avoid the undercuts in the pattern with all other waxes. Flow blockout wax into all undercuts within the pattern, including the rugae, rests, and under the tori (Figure 8.103-A). Overbulk the wax slightly.

8.42.1.4.4. **Subduing:**

8.42.1.4.4.1. This procedure fills the small tissue crevices within the framework design, thus smoothing the tissue surface of the framework without creating measurable space between it and the tissue. This results in a more sanitary appliance.

8.42.1.4.4.2. Wax should be hot enough to flow easily when applied. Subdue all rough tissue surfaces including edentulous ridge areas that will not have a relief pad.

8.42.1.4.4.3. Once the wax is applied, remove as much as possible with a dulled instrument. Be very careful not to scrape the cast. The only wax remaining should be filling in the crevices and rough areas. If any large amounts are present, remove that wax and replace it with blockout wax. Flame the wax just enough to smooth it, but not so it soaks into the stone. This would defeat the purpose. (Blockout wax may be used instead of subduing wax, but will not scrape off the cast as easily.)

8.42.1.4.4.4. The formula for making subduing wax is two sheets of base plate wax, two ropes of beading or utility wax, and sudan red to color.

8.42.1.4.5. **Tooling (Figure 8.103-B).** Select a blockout tool and secure it in the spindle of the surveyor to trim the excess wax from around each abutment tooth to create *parallelism*. Heat the tool by lifting a bunsen burner to the surveyor and applying the flame to the tool.

8.42.1.4.5.1. **Step 1—Warming the Wax.** The temperature of the tool is extremely important. Heat the tool just hot enough to melt the wax. With the edge of the tool at a right angle to the tooth, warm the wax with the tool without contacting the tooth.

8.42.1.4.5.2. **Step 2—Carving Off Excess Wax.** Do not reheat the tool. While it is still warm, guide it around the tooth again. This time the edge of the tool should contact the tooth along the survey line. Hold the top of the vertical arm in such a way that it can be moved up and down to follow the contours of the tissue at the base of the wax. At the same time, turn the vertical arm to keep the carving edge of the tool at a right angle to the tooth. The wax will already be warm, and the tool should take off any wax that is not in an undercut. ***CAUTION:*** Be careful not to abrade the cast with the tool.

8.42.1.4.6. **Cleanup.** All wax above the survey line must be removed. Also use a sharp pointed instrument to remove the wax from the proximals contacts upward. This is to make sure the metal interproximal points contact the teeth without a gap.

8.42.1.4.7. **Ledging Procedures:**

8.42.1.4.7.1. Cut a ledge into the wax on each clasped abutment according to the exact position the retentive tip (terminal one-third of the retentive arm) is going to occupy (Figure 8.103-C). Trim the wax at right angles to the abutment tooth. Do not scratch the stone surface.

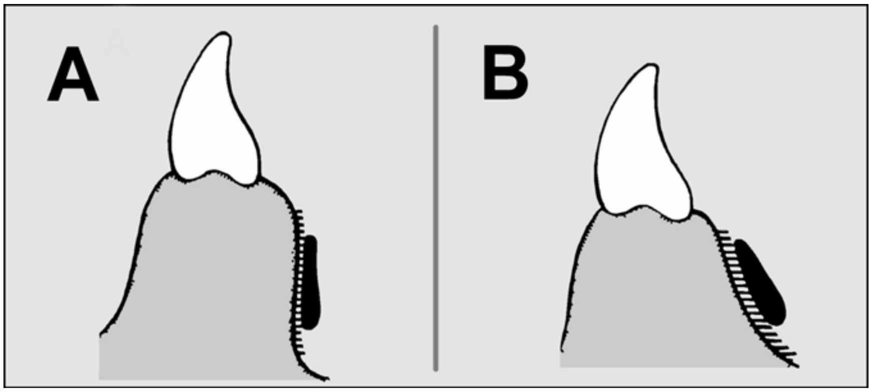
8.42.1.4.7.2. The width of the ledge is an exact representation of how much the clasp must flex when the prosthesis is inserted or removed. After the master cast has been duplicated, the ledges are reproduced in the refractory cast and the clasp patterns are contoured to these guides. Do not leave out a "step" in the wax along the clasp pattern. This will cause weakness at that point in the clasp. If twin-flex wire is to be used, bend it at this time (paragraph 8.47.3.4).

8.42.1.5. **Relief:**

8.42.1.5.1. **Mandibular Arch—Major Connector Relief.** Lingual bars and plates require no relief between the metal and the cast in toothborne RPDs. Relief may be required for distal extension partial dentures. Under the pressures of mastication, the downward movement of the free end of the denture base causes the lower part of the lingual bar or plate to rotate toward the ridge. If the connector hits soft tissue as the denture rotates, the tissue may become sore and could ulcerate. The amount of major connector relief is directly proportional to the estimated amount of denture base rotation. The potential for rotation increases as the length of the distal extension defect increases. Rotation is greater in cases where the soft tissue in the distal extension area is very mobile. (There is no way to evaluate this factor.) The amount of relief required is also directly proportional to the slope of the tissue under the major connector. As the lingual surface of the ridge approaches vertical, the need for relief lessens. Two examples of distal extension cases showing differing conditions are as follows:

8.42.1.5.1.1. **Case #1.** The distal extension defect is short; it is covered with firm tissue; and the surface of the alveolar ridge under the major connector makes a vertical drop to the floor of the mouth. This case would require a mere "flash" of molten wax as relief for the major connector (Figure 8.105-A).

Figure 8.105. Lingual Bar Relief Conditions.



8.42.1.5.1.2. **Case #2.** The distal extension defect is very long; the tissue in the edentulous area is mobile; and the lingual surface of the mandibular ridge inclines toward the floor of the mouth (Figure 8.105-B). The dentist might recommend between 30-gauge and 28-gauge relief for this kind of case.

8.42.1.5.2. **Relief for Open Ladder and Mesh Retention.** Space must be provided in the edentulous ridge areas of both arches to allow acrylic resin to lock around all metal retention grids on the framework. At least one layer of 24-gauge adhesive coated casting wax should be used for the relief procedure.

8.42.1.5.2.1. **Adapting and Cutting the Wax To Fit the Edentulous Area (Figure 8.103-D).** Cut the wax about 1 to 2 mm short of the internal finish line pattern to allow the finish line wax to be applied directly to the cast. ***CAUTIONS:*** 1. Do not cut the cast! 2. Casting wax is pressure sensitive. Applying too much pressure while adapting the wax over high spots will cause a thinning of the wax and, therefore, a thin area in the acrylic.

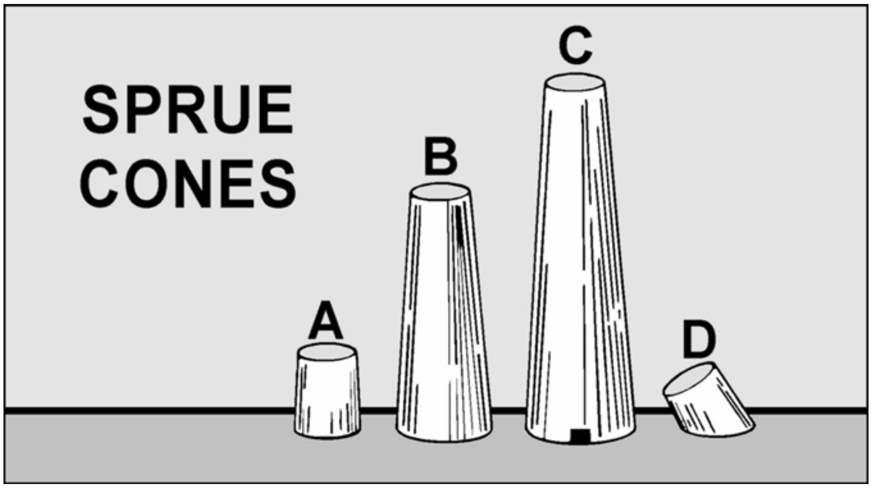
8.42.1.5.2.2. **Finish Lines.** Acrylic-metal joints are strongest when they are squared. Mix half baseplate wax and half blockout wax to make finish line wax. Apply a bead of this as a border on the relief pad. Extend it to meet the internal finish line pattern, cut it at a right angle to the cast, and blend it down to the level of the relief pad. The resulting corner should be sharp and square (90 degrees) (Figure 8.103-D).

8.42.1.5.2.3. **Tissue Stop.** If the RPD is of the distal extension variety, cut a hole about 2 mm square into the relief wax over the crest of the alveolar ridge to provide a metal "stop." A stop holds the distal extension retentive grid off the cast during denture base packing procedures. If the tissue stop is missing or not contacting the cast, it must be carefully augmented with self-curing acrylic before the acrylic bases are packed. Otherwise, the extension bases of the framework will flex under packing pressure.

8.42.1.5.2.4. **Bar Clasps.** Smooth the place where the approach arm of a bar clasp intersects with the relief wax. This prevents a step from being cast into the tissue side of the approach arm, causing a weak point with a high probability of fracture.

8.42.1.6. **Types of Sprue Cones.** Four types of sprue cones are illustrated in Figure 8.106. The "A" sprue cone is used for flat surfaces, and the "D" cone is used for inclined surfaces. However, the "D" cone is seldom used because it is usually necessary to add an inclined surface to obtain the proper amount of overjet (paragraph 8.48.2). Therefore, the "A" cone may be substituted for the "D" cone when necessary. (The use of the "B" and "C" cones will be discussed when the requirement arises.)

Figure 8.106. Sprue Cones.



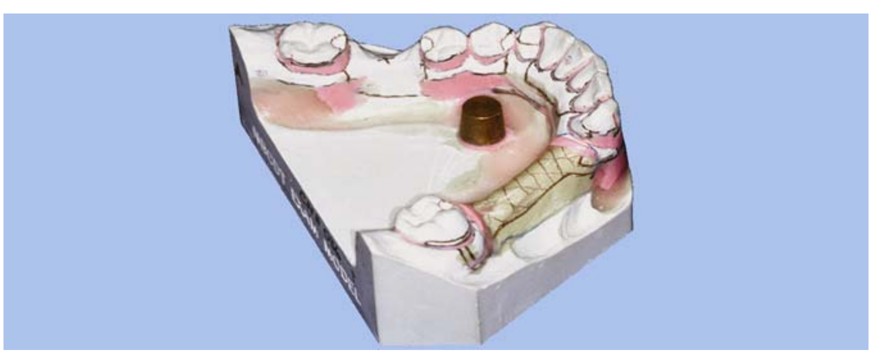
8.42.1.6.1. **Positioning the Sprue Cone (Figure 8.103-D).** Sprue cones are placed about 7 to 8 mm from the pattern. For measurement purposes, an "A" sprue cone is about 8 mm long. Metal flow principles and duplicating procedures should be considered when positioning a sprue cone, as follows:

8.42.1.6.1.1. **Metal Flow Principles.** For the metal to flow ideally into the mold, the long axis of the sprue cone should be at a right angle to the cast surface where the sprue lead will be waxed. In the "sink trap" concept, a liquid (molten metal, in this case) will find its own level. By adjusting the tilt of the sprue cone, it is possible to adjust the plane of the pattern within the investment mold.

8.42.1.6.1.2. **Duplicating Procedures.** If the tilt of the sprue cone results in an undercut when the cast is set on the duplicating base, it will cause distortion of the duplicating material in that area.

8.42.1.6.2. **Attaching the Sprue Cone.** Place the sprue cone in a "lying down" position so the tip is contacting the pattern. Tilt the cone back to a vertical position and tack it down with baseplate wax considering metal flow principles (Figure 8.107). Hold the cast so that the base is level, like it will be in the duplicating flask base. If the posterior of the sprue pin cause an undercut adjust the tilt of the pin as necessary. Seal around the base of the pin with baseplate wax.

Figure 8.107. RPD Sprue Cone Positioning.



8.42.2. **Duplicating the Master Cast.** The production of any RPD framework is "technique sensitive." That is, directions for producing the framework must be followed to the letter with no deviation. Virtually all RPD frameworks produced in ADLs are made from Ticonium. The regimen for fabricating a Ticonium framework is furnished through the courtesy of the Ticonium Company, Albany NY. Most of the information is extracted from their *Ticonium Technique Manual.*

8.42.2.1. **Preparation and Storage of Hydrocolloid.** A reversible hydrocolloid material is used in the duplication process for RPDs. If duplicating is to be done on a regular basis or in large amounts, use the auto-duplicator method. However, if duplicating is to be done only occasionally and in small quantities, use the microwave method.

8.42.2.1.1. **Auto-Duplicator Method.** The preparation and storage varies according to the brand of duplicating material and type of storage unit. An auto-duplicator has a storage tank in which hydrocolloid duplicating material is heated until it reaches a liquid state. It then maintains the material at pouring temperature until it is ready for use. In addition to a heating element, there is usually a stirring mechanism and a pouring valve on the machine. Refer to manufacturer instructions for more specific details.

8.42.2.1.2. **Microwave Method:**

8.42.2.1.2.1. This method uses a microwave, glass cookware with a cover, thermometer, and spatula. ***NOTE:*** Cookware such as Visions® works well because it retains the heat, allowing the material to cool more uniformly instead of gelling around the sides.

8.42.2.1.2.2. To prepare and cook down the hydrocolloid, first cut the duplicating material into very fine pieces. Add 1 tablespoon of distilled water for each cup of material. Cover and microwave on high for 4 minutes; then stir. Change the setting to medium and cook for 2 minutes at a time, stirring at each interval until the hydrocolloid is smooth (190 to 210 ^{o}F). If air bubbles follow the spatula when stirring it, the hydrocolloid is done.

8.42.2.1.2.3. Bench cool the hydrocolloid to 125 to 130 ^{o}F (pouring temperature), stirring occasionally. Take care to keep the cover on to avoid loss of moisture. When removing the cover, allow the condensation to run back into the pan. When cooled to pouring temperature, follow normal duplication procedures.

8.42.2.2. **Soaking the Cast.** The preferred method to soak a cast is to stand it on end in SDS (6 mm deep) for 20 to 30 minutes. Casts made from improved stones require a much longer soaking time. The SDS is kept at 90 ^{o}F, plus or minus 2 ^{o}F. The cast will wet through capillary action. If large areas of the cast are relieved with sheet wax, soak the cast with the teeth pointed downward. This will enable the air to escape up through the porous stone base instead of lifting the wax off the tissue surfaces of the cast.

8.42.2.3. **Assembling the Duplicating Flask.** The duplicating flask (Figure 8.108) consists of the base, body, and spout. There are two flask sizes. Select the one that provides at least one-half of an inch clearance between the edge of the cast and the rim of the base (Figure 8.109-A). Place Ticene (clay) in the rim of the base. This serves the following two important purposes:

8.42.2.3.1. It forms a seal between the base and body of the flask so the colloid does not leak while the duplication is being made.

8.42.2.3.2. It acts as an insulator during the cooling process. Soak the cast completely, center it on the base of the flask, and secure it with a small piece of Ticene (clay) on each side. Press the body firmly in place on the base and seat the spout. Place a small ball of Ticene behind each of the vent holes on the body (Figure 8.109-B).

Figure 8.108. Duplicating Flask Parts.

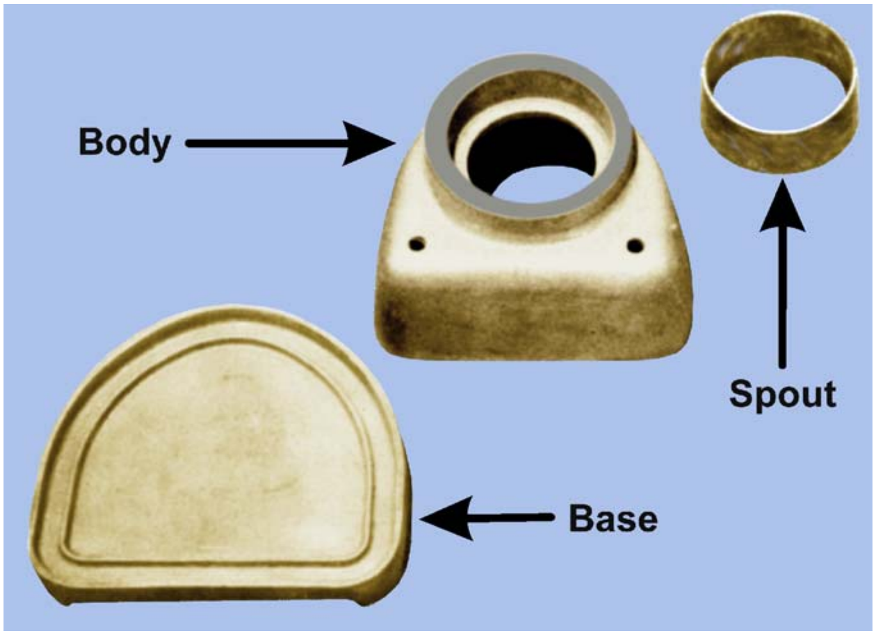
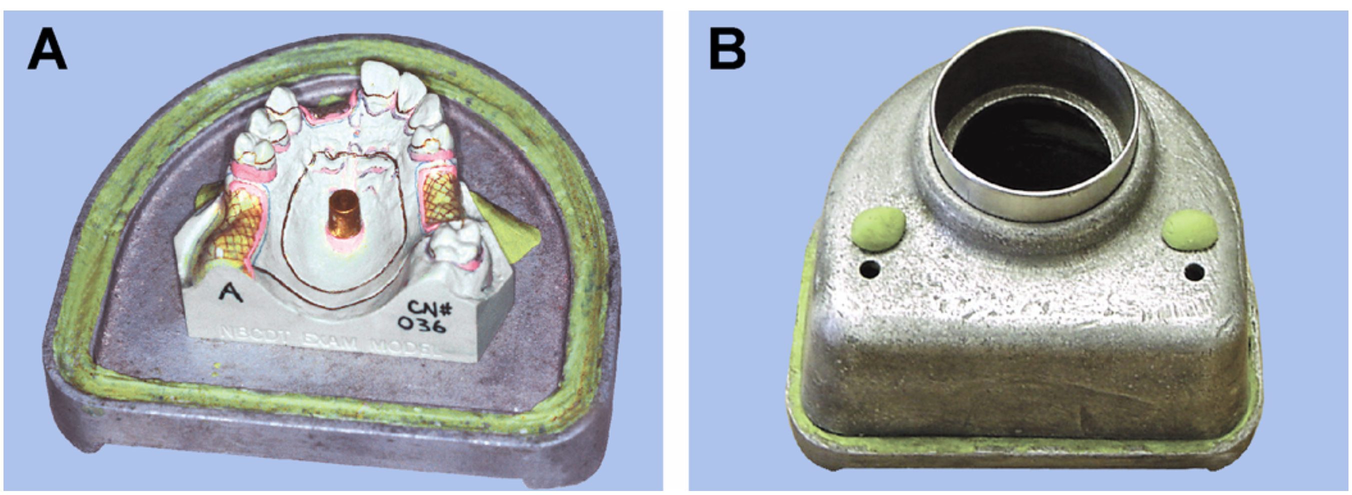
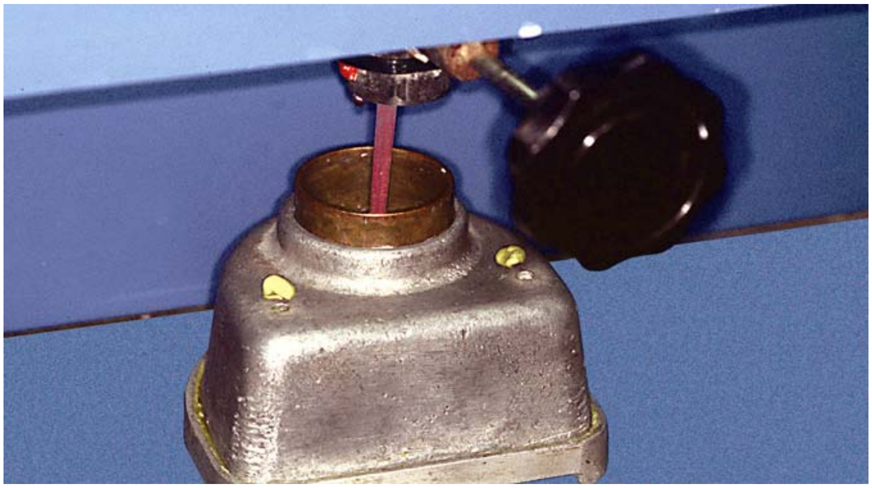


Figure 8.109. Assembling the Duplicating Flask.



8.42.2.4. **Pouring the Hydrocolloid.** Draw off a small amount of duplicating material (about 150 cc) to remove any clots or settled stone particles. Position the flask under the duplicator's pouring valve and open it until the duplicating material flows in a stream as wide as a pencil (Figure 8.110). Fill the body until the colloid reaches the level of the two vent holes. Plug the vents with Ticene. Continue filling the flask until the spout is at least 2/3 full.

Figure 8.110. Pouring the Hydrocolloid.



8.42.2.5. **Cooling the Flask (Figure 8.111-A).** For best results, cooling should start at the base of the flask and gradually work its way up. This pattern ensures the most intimate contact between the duplicating material and the surface of the cast. Place the flask in a flat pan that circulates water. Regulate the level of the water so it covers the base of the flask only. The temperature of the water has to be below the temperature of the room, but no less than 55 ^{o}F. A small flask usually cools in 30 **minutes, while a large flask requires 45 minutes.**

8.42.2.6. **Extracting the Master Cast (Figure 8.111-B).** After the flask is cool, remove the pouring spout by twisting it out. Cut off the excess colloid projecting from the body and separate the body from the base. Insert a knife into each of the depressions left by the dabs of Ticene used to hold the cast down. Using the flask walls as fulcrums, elevate the master cast out of the hydrocolloid with a quick snap. Try to lift both sides of the cast at the same time. (Lifting only one side tends to tear and otherwise distort the impression.) Check the impression for sprue cones and relief wax that might have been left behind.

8.42.2.7. **Pouring the Refractory Cast.** Use Ticonium investment *(Investic)* for the refractory cast. The properties of Investic have been matched to the casting contraction behavior of Ticonium metal. The investment material is formulated to provide a 1.7 percent expansion factor when these directions are followed exactly:

8.42.2.7.1. **Mixing:**

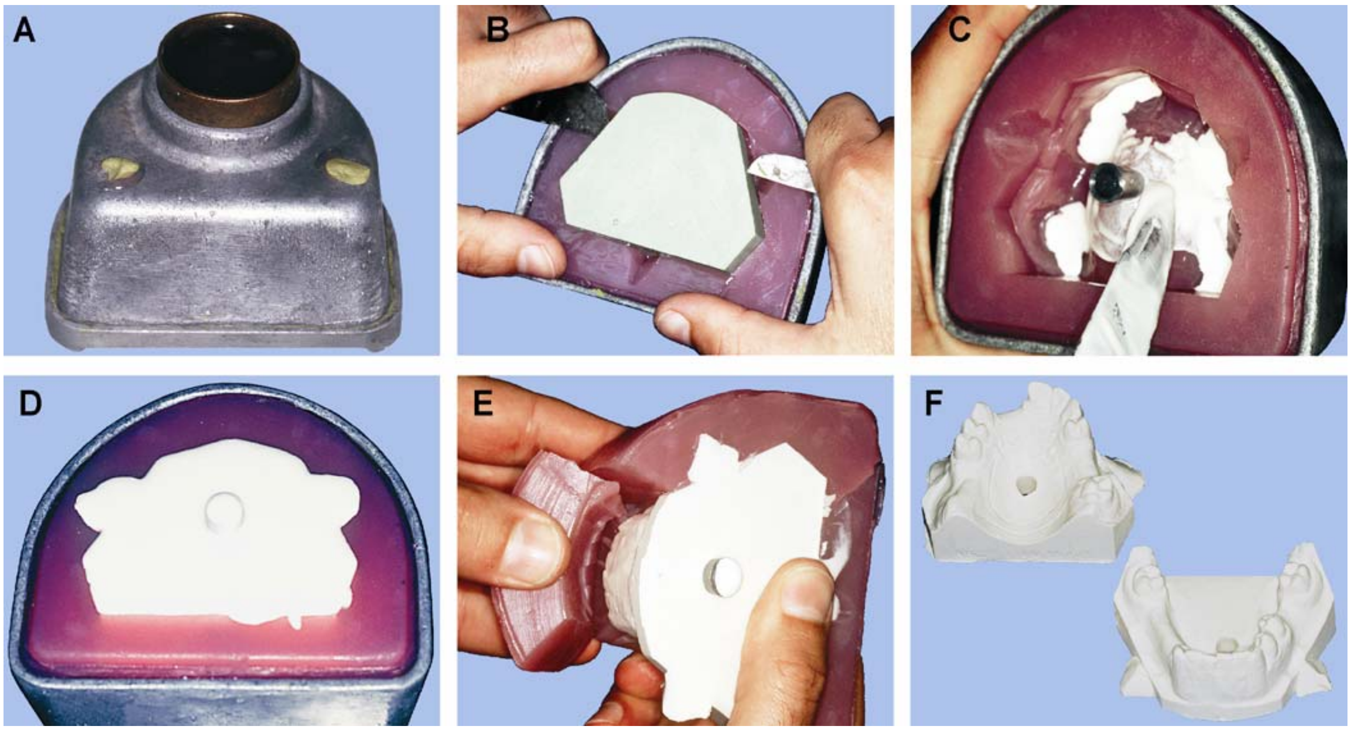
8.42.2.7.1.1. The normal ratio for Ticonium Investic is 29 cc of *room temperature distilled water* to 100 g of powder. Use 28 cc of water to 100 g of powder if more expansion is needed (large horseshoe).

8.42.2.7.1.2. Measure the water with a graduated cylinder and weigh the powder carefully. Blend the water and powder by hand and mechanically spatulate the mix under vacuum for 30 seconds. ***NOTE:*** The expansion obtained with the investment when it has been mechanically spatulated is more predictable than the results when it has been manually spatulated. Over-mixing breaks down the crystalline structure of the investment, while under-mixing produces a weak cast. (See the ***CAUTION*** on page 453.)

CAUTION

Refractory investment contains a combination of ingredients that separate or settle during periods of shipment or storage. This can cause distortion due to differences in expansion of various parts of the refractory and cracking of the outer investment mold. Mix the investment when opening a new bucket and each 2 to 3 days after that by tumbling the bag or bucket, using a figure-eight motion.

Figure 8.111. Duplicating a Blocked Out Master Cast in Refractory Material.



8.42.2.7.2. **Pouring:**

8.42.2.7.2.1. First, place a small amount of investment in tooth and ridge areas first (Figure 8.111-C); then vibrate the material directly into the mold. Do not force the investment to flow around the mold as with other kinds of impressions. (Chemical salts on the surface of the hydrocolloid are more likely to diffuse into the investment and weaken the resultant cast.)

8.42.2.7.2.2. Place the "B" cone in the hole left by the "A" or "D" cone. Fill the rest of the mold to the top of the impression (Figure 8.111-D). Do not allow the investment to run over to the body of the flask because this kind of contact prevents the investment from expanding as it sets.

8.42.2.7.2.3. Set the poured mold aside where it is not affected by equipment that generates vibrations. Let it set for 1 hour. When the investment has set, do not pull the cast out of the hydrocolloid.

8.42.2.7.2.4. Remove the cast and the hydrocolloid from the flask at the same time, carefully peeling the hydrocolloid away from the cast's surface (Figure 8.111-E). Withdraw the "B" cone and set it aside. Do not handle the cast by the tooth or ridge areas.

8.42.2.8. **Reclaiming the Hydrocolloid.** Rinse the hydrocolloid in distilled water; then cut it into small pieces and place it in a sealed container. The moisture from rinsing is usually enough to replace the water lost during the duplicating process.

8.43. Preparing a Dental Stone Duplicate of the Blocked Out Master Cast. Remove the “A” or “D” sprue cone and relief pads. Use a duplicating flask to make another reversible hydrocolloid impression of the blocked out master cast. Pour this impression with a mix of vacuum spatulated dental stone. The major reason for the dental stone duplicate is to test fit the Ticonium casting. The initial test fitting of a framework is rarely done on the master cast itself for fear of damaging the surface of the cast. Another purpose for using the duplicate blocked out master cast is that it can be mounted on an articulator and used as a vehicle for occlusion adjustments on the casting.

8.44. Preparing the Refractory Cast for Pattern Fabrication. Before casting an RPD framework in metal, a fully representative pattern of the proposed framework is made from wax and preformed plastic patterns on the refractory cast. Next, the refractory cast and associated pattern are covered by an encasement of additional investment. The whole assembly is subjected to high heat, burning out the pattern. This leaves a void into which molten metal is cast, and it forms a metal reproduction of the original pattern. The refractory cast cannot be used in its present state. The cast is wet and porous, and its base is too big. Before a pattern can be fabricated on the investment cast, the cast must be prepared to receive it. Follow the steps below:

8.44.1. **Trim the Cast (Figure 8.112-A).** Use an indelible pencil to draw an outline about 6 mm from the extremities of the proposed pattern. Adjust the cast trimmer’s table to a 45-degree angle. This angle makes the cast easier to hold during waxing and also allows it to “lock into” the outer investment mold. Wet-grind the cast to the penciled outline. Do not touch the abutment teeth (Figure 8.112-A). Rubbing your fingers across an abutment tooth can drastically affect the fit of a clasp because the investment is soft and abrades very easily. Now, rinse the cast in SDS to remove any slush accumulation from the grinding procedure.

8.44.2. **Dehydrate the Cast.** Dry the investment cast in a vented dehydrating oven for 1 hour at 190 ^{o}F (Figure 8.112-B). The color of the cast will change from gray when wet to white when dry.

8.44.3. **Wax-Dip the Cast (Figure 8.112-C):**

8.44.3.1. The advantages of a beeswax dip are: (1) it provides a smooth, dense surface on which to construct a pattern, and (2) it does not absorb water from secondary investments. This eliminates the need for soaking the cast before investing.

8.44.3.2. Melt refined beeswax in a thermostatically controlled pot. The dipping temperature should be 280 - 300 ^{o}F. A good indicator of proper temperature is when the wax first begins to smoke. Place the cast on some kind of wire carrier (potato masher) and immerse it in the heated beeswax. Watch for a foaming action. Let the refractory cast stay submerged for 15 seconds after the foaming begins.

8.44.3.3. Remove the cast, blow off any excess wax, and place the cast on a piece of absorbent paper to cool. Move it to another position after a few seconds so the wax does not collect on the base. After the refractory cast has cooled down completely, it is ready for pattern application.

8.44.4. **Transfer the Design from the Master Cast to the Refractory Cast (Figure 8.113).** It is very important to perform this procedure as accurately as possible. When transferring the design, follow this sequence: major connector, retention grids, resin veneer facings, reinforced acrylic pontics or facings, clasps and rests, and minor connectors. The transferred lines must be visible *without scuffing the cast*. All markings associated with the transfer of a design to a refractory cast are made with a wax-base pencil. (If a graphite pencil is used, the particles could cause pits in the framework casting.)

Figure 8.112. Preparing the Refractory Cast for Pattern Fabrication.

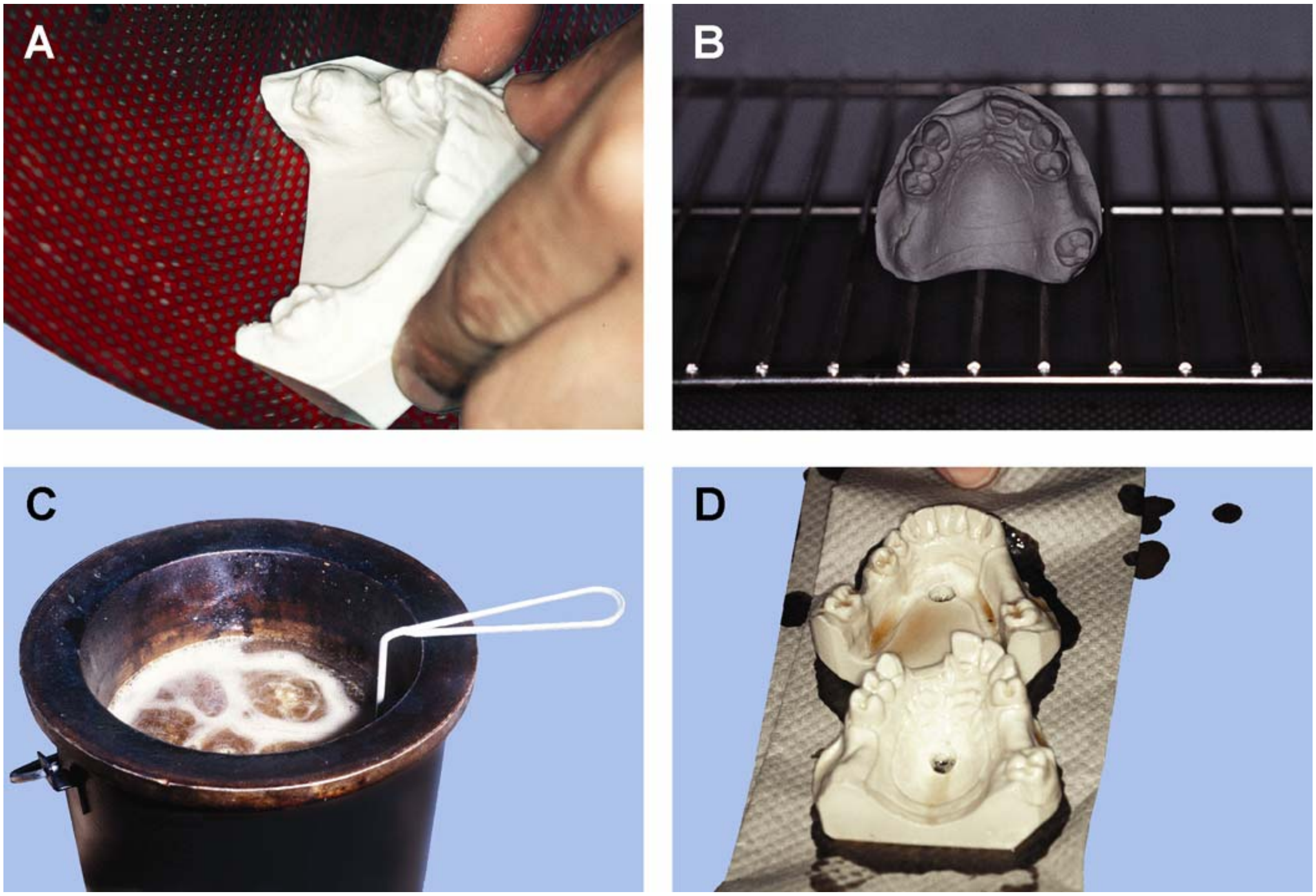
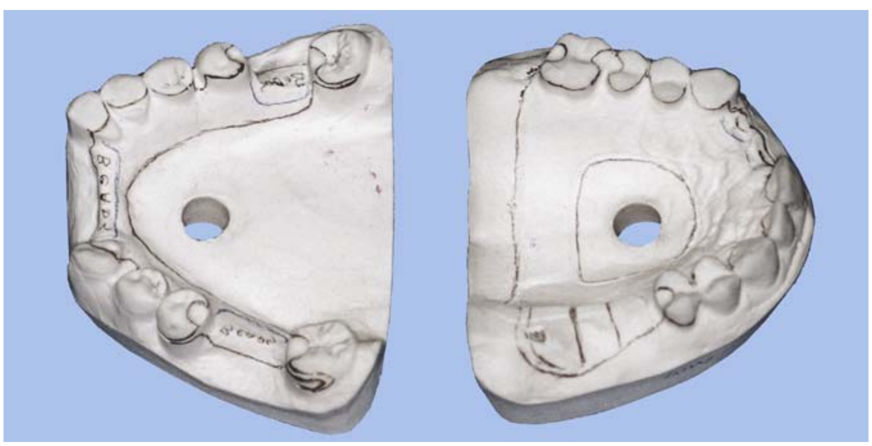
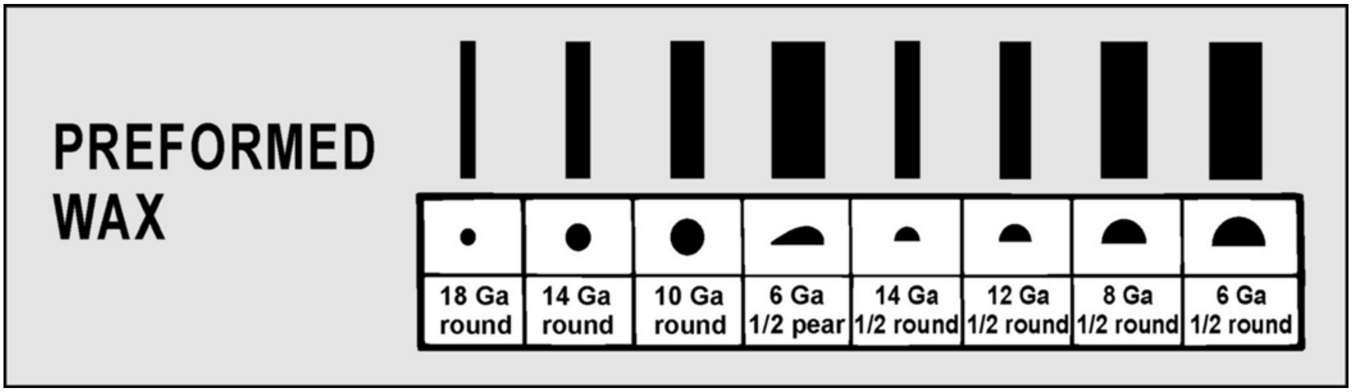


Figure 8.113. Design Transfer to the Refractory Cast.



8.45. Fabricating the Framework Pattern on the Refractory Cast. The most popular method of constructing a pattern for a framework consists of using ready-made, preformed wax (Figure 8.114) and plastic parts. Join the parts by careful freehand waxing. Use freehand waxing to modify areas of the overall pattern where additional strength and rigidity might be needed in metal casting. Choose from a large assortment of preformed shapes and sizes ranging from controlled thicknesses of sheet casting wax to plastic clasp arms. Many cases can be waxed up so the only freehand waxing necessary is to flow in the rests, connect the preformed parts, and establish the finish lines. Besides the desirable convenience factor, the use of preformed parts ensures a standard of quality in the finished framework that is difficult to achieve in any other way. Manufacturer's catalogs provide a wide variety of choices.

Figure 8.114. Preformed Wax Shapes.



8.45.1. **Principles of Pattern Construction.** The key factors in successful RPD pattern construction are as follows:

8.45.1.1. Follow the design accurately.

8.45.1.2. Use pliable preformed parts that readily conform to the surfaces of the refractory cast.

8.45.1.3. Be sure the parts are stuck down to a properly sealed cast.

8.45.1.4. Comply with a definite construction sequence where the larger components are placed first and the smaller ones are progressively placed in an orderly manner.

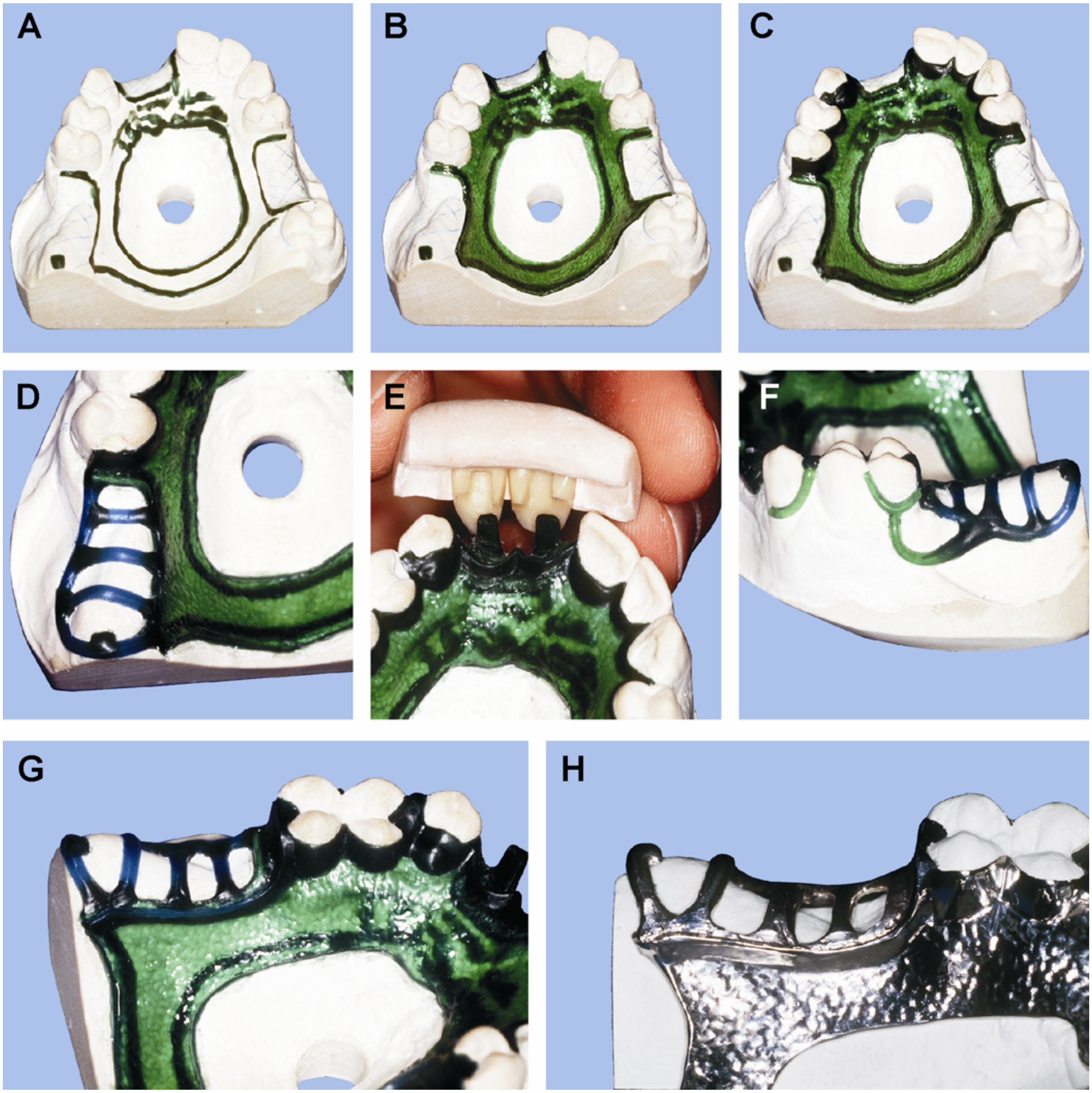
8.45.1.5. Contour the junctions of various pattern parts into graceful curves to minimize soft tissue abuse and tongue irritation.

8.45.1.6. Smooth the surfaces of the pattern to reduce the metal finishing time. Use a tacky liquid to apply preformed parts to a refractory cast. The liquid binds the pattern to the cast. There are many brand names of tacky liquid on the commercial market. It is possible to make an adequate tacky liquid by dissolving old plastic patterns in acetone. Some technicians paint the design with tacky liquid before they apply the preformed part. Others apply the tacky liquid to the part before they put it on the cast. This is a matter of personal choice. However, keep in mind that any excess tacky liquid casts in metal and produces fins.

8.45.2. **Waxing Framework Patterns.** The suggested construction sequence is as follows: major connector, acrylic resin retention grids, artificial teeth (resin veneer facings, reinforced acrylic pontics, or facings), clasps, rests, minor connectors, and external finish lines. The final step consists of smoothing the pattern with a piece of nylon or with wax solvent on a cotton tip applicator followed by water. It is possible to flame the pattern to remove small irregularities for those technicians with skill and courage.

8.45.2.1. **Maxillary Framework Patterns.** Before applying wax or plastic preform patterns, fill in the palatal bead lines with inlay wax flush with the surface of the cast. Flow wax along the edges of the relief pads, extending the wax 1 mm onto the relief pad. If the RPD major connector is going to cover the rugae, flow a *small amount* of wax on the high areas of the rugae. This will ensure against thin spots when adapting sheet-casting wax or stippled sheet over the rugae. Waxing for a maxillary RPD framework pattern is shown in Figure 8.115. The steps in the figure are as follows: A—Fill in the bead lines, relief pads, and flash wax over the rugae; B—Adapt the major connector; C—Flow inlay wax to for m lingual plating; D—Adapt retention grids; E—W ax the RAP site (detai ls in paragraph 8.46.1); F--Position clasps; G—Place rest and external finish lines; and H—Finish line detail in polished framework.

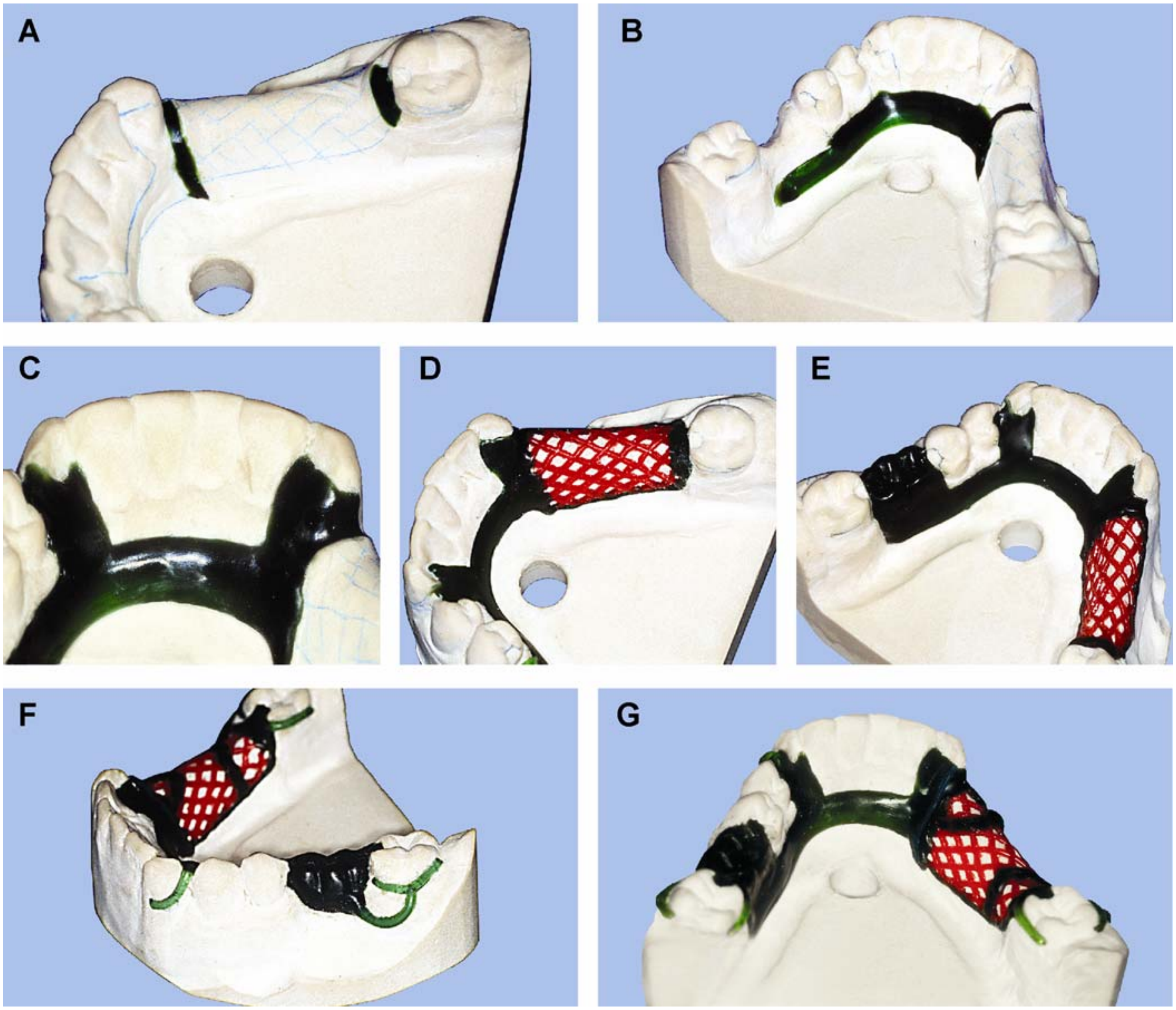
Figure 8.115. Waxing a Maxillary RPD Framework.



8.45.2.2. **Mandibular Framework Patterns.** Waxing a m andibular RPD fra mework is illustrated in Figure 8.1 16. The steps in th e fi gure are as f ollows: A—Flow wax along relief pads; B—Position m ajor connector; C—Flow in lay wax to form lingual plating; D—Adapt retention g rids; E—Flo w inlay wa x to f orm tooth; F—Position clas ps, res t, an d m inor connectors; and G—Position external finish lines.

8.45.2.3. **Finish Lines—A Special Note.** Superimposing an external finish line directly over an internal finish line tends to create a weak junction between a retention grid and the major connector. Instead, see Figures 8.117 and 8.118 for the proper relationship. Use the edentulous spaces as the reference and position the external finish lines about 1.0 to 1.5 mm peripheral to (outside of) the internal lines.

Figure 8.116. Waxing a Mandibular RPD Framework.



8.46. Fabricating RAPs, Braided Post Retention for Posterior Teeth, and Resin Veneers:

8.46.1. **RAP (Figure 8.119).** (***NOTE:*** The primary credit for developing RAP is given to the US Army Dental Corps.) The RAP is an anterior acrylic resin denture tooth attached to a specially constructed retentive site on the framework. The denture tooth is adapted to the edentulous space on the master cast, and the retention for the tooth is incorporated into the framework pattern on the refractory cast. Procedures for fabrication are shown in Figure 8.120 and as follows:

Figure 8.117. Finish Line Detail Showing the Toothborne Area.

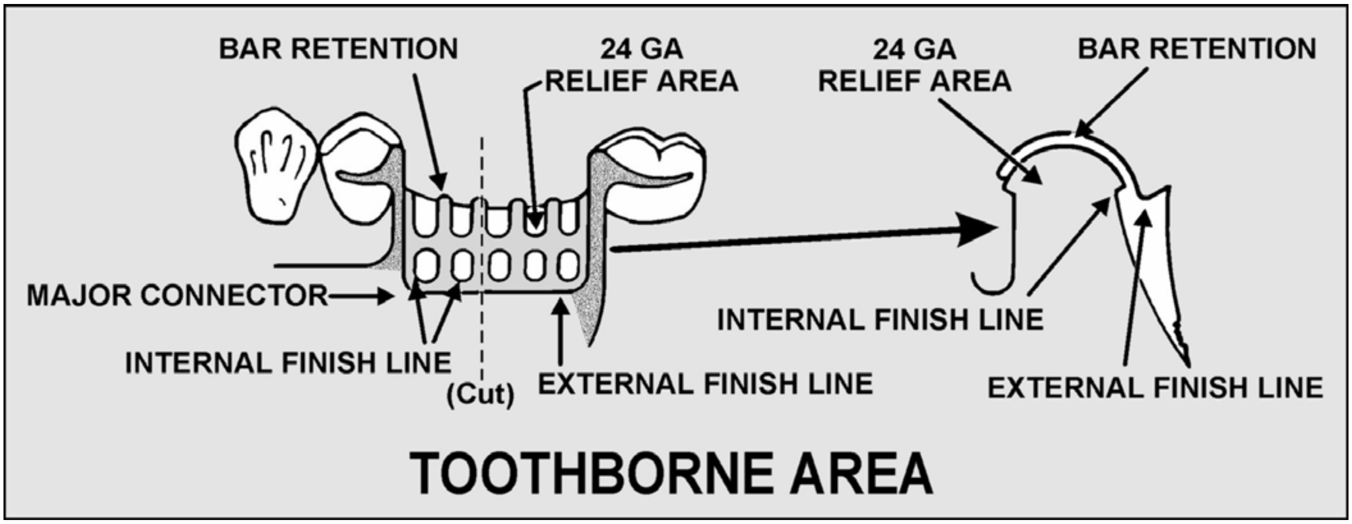


Figure 8.118. Finish Line Detail Showing the Distal Extension Area.

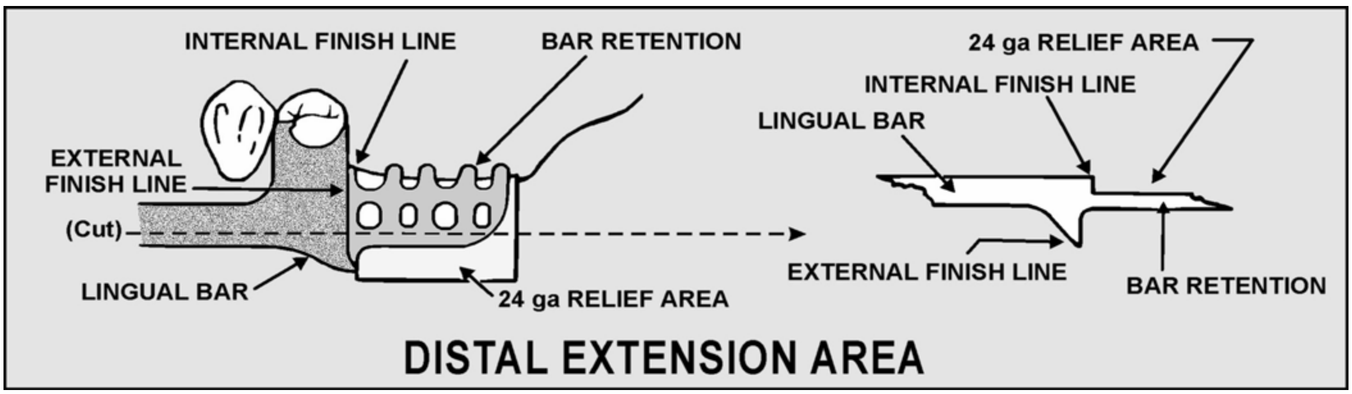
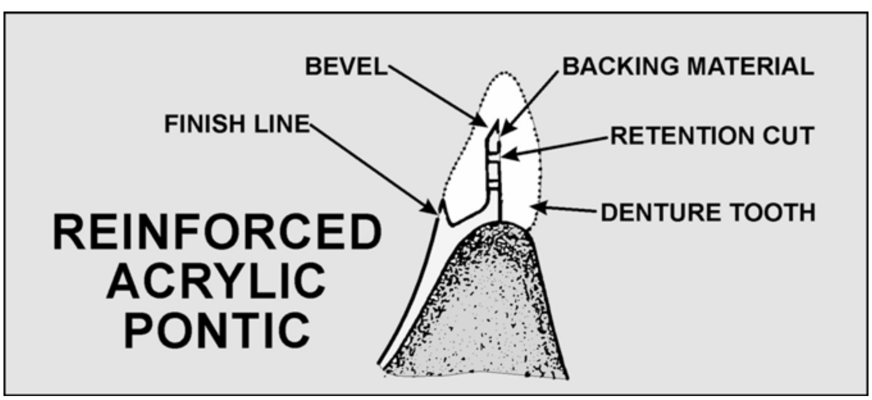


Figure 8.119. Reinforced Acrylic Pontic (RAP).



8.46.1.1. Mount the maxillary and mandibular master casts. The dentist should either index the upper and lower casts in MI or provide a jaw relationship record for mounting purposes.

8.46.1.2. Adapt the denture tooth (teeth) and wax-up for the RAP site as follows:

8.46.1.2.1. If the dentist agrees, prepare the site by scraping the cast where the artificial tooth will contact the ridge. This is done by first rubbing a pencil over the edentulous area to completely color the area where the replacement tooth will be. With a Hollenbeck, or similar sharp carving instrument, lightly scrape off the pencil marks. Scrape only heavily enough to remove the pencil marks. Do not attempt to "level" the ridge irregularities, but follow the contours of the tissue. Repeat the process two more times or as directed by the dentist.

8.46.1.2.2. If the dentist does not adapt denture teeth to the edentulous space and provide a matrix for positioning those teeth, follow his or her directions and select the mold and shade of the plastic denture teeth.

8.46.1.2.3. Grind as necessary to adapt the proximal and ridgelap areas of the teeth to the space (Figure 8.120-A). Next, cut a box-like recess into the tooth from the lingual. The box should be slightly dovetailed toward the center of the tooth. Take care when grinding the recess into the tooth; if the recess is too deep, the metal post may show through the facial of the finished RAP. The floor of the recess parallels the facial surface of the tooth. The incisal edge and the mesial and distal marginal ridge areas of the tooth should be preserved intact (Figure 8.120-B).

8.46.1.2.4. Apply a separating medium to the cast. Using the adjacent and opposing teeth as guides, temporarily position the denture teeth on the cast with utility wax.

8.46.1.2.5. Make a stone matrix over the setup (Figure 8.120-C). Include in the matrix the incisal edges of the denture teeth and abutment teeth. Do not bring the stone *over* the incisal edge and onto the lingual surface of the abutment teeth. This may cause the stone abutment teeth to break when removing the matrix. Involve only one natural tooth on each end. Extend the facial of the matrix as far as possible without entering areas of the master cast that are going to be blocked out. Do not cover more than two thirds of the facial of the denture teeth because access to the necks will be needed to seal the RAP's to the ridge.

8.46.1.2.6. Carefully remove the stone matrix and trim away the excess stone. (***CAUTION:*** *A matrix made on the diagnostic cast will usually not fit the master cast.*) A matrix made of silicone putty will not allow wax to stick to it, so the teeth will not stay in it and it flexes too much for an accurate seat.

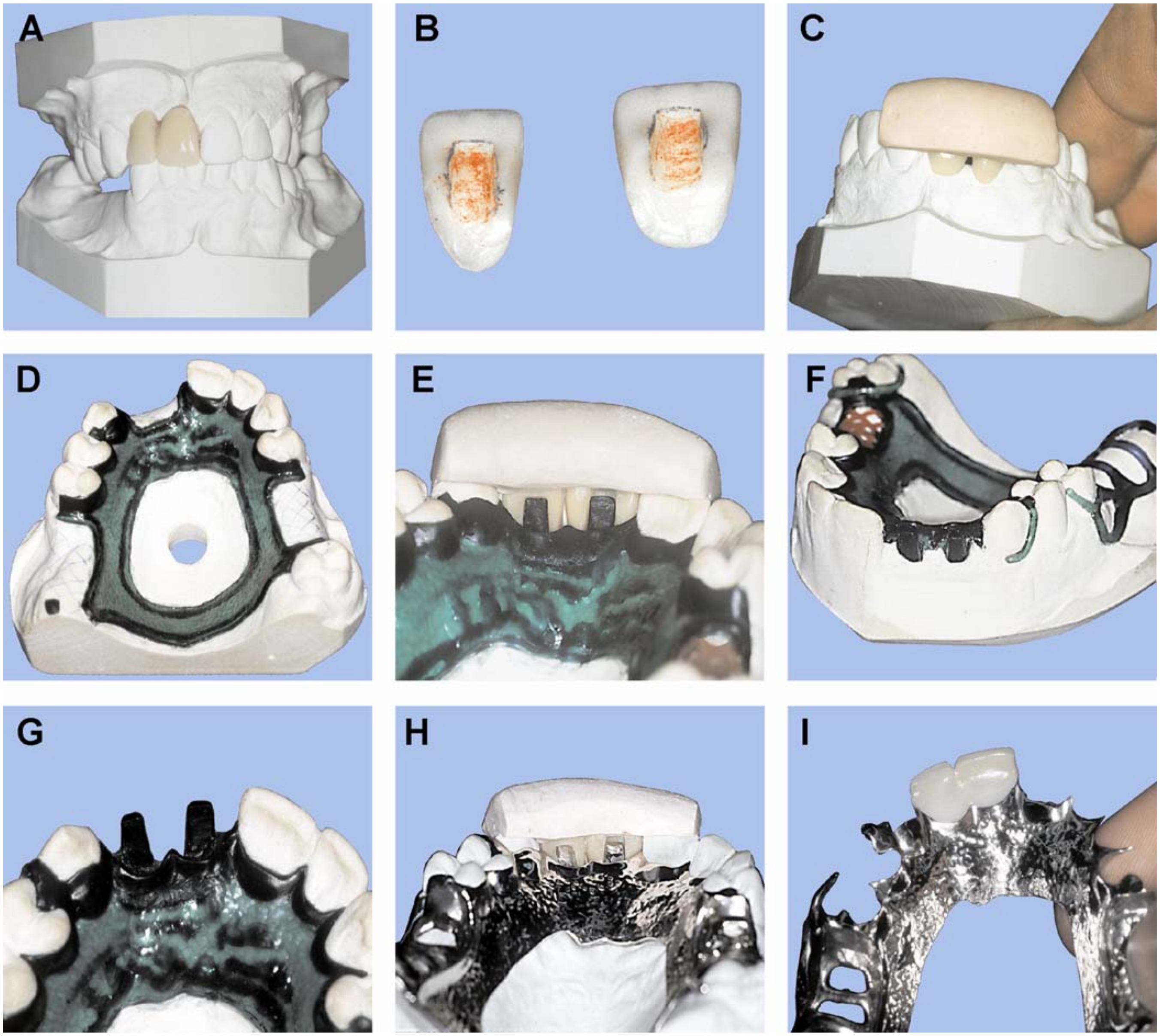
8.46.1.2.7. Select a plastic backing manufactured for facing support. Cut the backing material slightly smaller than the recess in the lingual aspect of a prepared denture tooth.

8.46.1.2.8. With the matrix and teeth positioned accurately on the refractory cast, tack the backing material into the recess of the denture tooth using a small dot of utility wax. Next, seal the backing to the cast with inlay wax. Ensure the plastic backing is still fully seated into the recessed area of the tooth and securely attached to the cast (Figure 8.120-E).

8.46.1.2.9. With a sharp instrument, remove some the utility wax holding the backing into the denture teeth. Remove the matrix and denture teeth. Fill in any voids and smooth the wax where the plastic backing attaches to the cast (Figure 8.120-F). Replace the matrix and check for accuracy of the denture tooth and backing's position. Correct as necessary.

8.46.1.2.10. Use 18-gauge round wax to establish an external finish line just lingual to the RAP site (Figure 8.120-G). The finish line should be located so when the plastic tooth is processed onto the backing, the gingival part of the cingulum will terminate on the line. Avoid the prevailing tendency to place the finish line too far to the lingual. Check the occlusion.

Figure 8.120. RAP Fabrication.



8.46.1.3. Finish the RAP metal backing (Figure 8.120-H):

8.46.1.3.1. The casting is finished in the usual manner and initially seated on a duplicate of the master cast. Notch the mesial and distal sides of the metal backing with a thin, high-speed separating disc. Finally, lingually bevel the incisal end of the backing about 45 to 60 degrees. This allows the backing more length for strength, and there is less possibility for the backing to punch through the resin used to fill in the recess.

8.46.1.3.2. Match the master cast, framework, denture teeth, and matrix into their proper relationships. Verify the metal backings fit the denture tooth recesses acceptably. If there is any binding, remove metal as necessary.

8.46.1.4. Process the RAP as follows: (***NOTE:*** Before processing the RAP, coat the facial surface of the metal backing with a suitable opaque to prevent metal showing through to the facial of the denture teeth.)

8.46.1.4.1. **Autopolymerizing Resin Method (Figure 8.120-I).** RAPs are routinely attached to frameworks with autopolymerizing tooth-colored resin. Paint the residual ridge with a tinfoil substitute, seat the framework on the cast, position the teeth with the matrix, and apply the self-curing resin. Complete the cure in a pressure pot containing water at about 110 ^{o}F at 15 psi for 10 minutes.

8.46.1.4.2. **Heat-Curing Resin.** When heat-curing denture base resin is going to be used to process posterior teeth to the framework, it is convenient to attach the RAP with heat-curing, tooth-colored resin at the same time. Place the denture teeth destined to become RAPs in the matrix and position on the cast. Wax-up the lingual contour of the denture teeth with pink baseplate wax. Place enough wax to completely fill in the recess and allow enough material for finishing and polishing. During the packing phase of the processing procedure, use heat-curing, tooth-colored resin in the RAP areas.

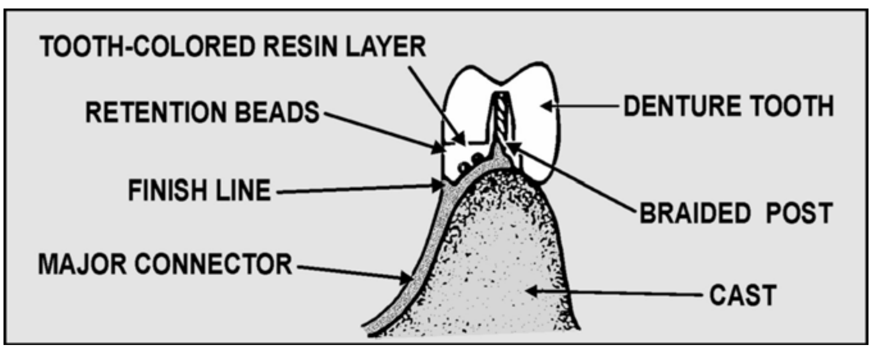
8.46.2. **Braided Post Retention for Posterior Teeth:**

8.46.2.1. **Steps For Fabricating the Framework With a Braided Post:**

8.46.2.1.1. Adapt a stipple sheet to the edentulous space and seal it down. Make a braided post from two 18 to 21-gauge round wax preforms. For strength, twist the wax into a tight spiral.

8.46.2.1.2. Proper placement of the wax post is essential for processing the denture tooth in the proper position. A post should be positioned so it lies in the center of each denture tooth (Figure 8.121). The technician waxing the framework must know where the denture tooth will be positioned. Use the teeth anterior and posterior as guides for spacing. Fasten the base of the post to the stipple sheet. Hold the refractory cast and the opposing cast together in MI. The tip of the post should fall over the line of stamp cusps in the opposing arch.

Figure 8.121. Braided Post Retention.



8.46.2.1.3. Stick retention beads down to the stipple sheet.

8.46.2.1.4. Wax in a lingual finish line (paragraph 8.45.2.3.).

8.46.2.2. **Adapting a Denture Tooth to the Space and Attaching It to the Framework:**

8.46.2.2.1. Seat the finished and polished framework on the master cast or on a duplicate cast.

8.46.2.2.2. Cut into the ridgelap area of a denture tooth with a #703 tapered fissure bur and make a channel that accommodates the braided post.

8.46.2.2.3. Adapt the denture tooth to the edentulous space.

8.46.2.2.4. Check the tooth for acceptable occlusion with the opposing teeth.

8.46.2.2.5. Fasten the denture tooth to the framework with heat-curing or autopolymerizing, tooth-colored resin. If using autopolymerizing resin, remember to make a matrix first (paragraph 8.46.1.2.5).

8.46.2.2.6. Adjust the occlusion and polish.

8.46.3. **Resin Veneer Substructures.** A resin veneer is a light-cured composite material that is retained on the framework by either mechanical or chemical bonding (or possibly both). Several resin systems are available on the market today. Resin veneers are an alternative to denture teeth when the edentulous space is small and a denture tooth would need to be greatly reduced to fit. They also work well when special staining or contours are required to achieve the necessary end results. Procedures to fabricate a resin veneer are shown in Figure 8.122 and as follows:

8.46.3.1. **Resin Veneer Substructure Design.** Resin veneers are less abrasive resistant than commercially fabricated denture teeth and facings. As such, the metal substructure portions of tooth replacements should be made to protect the acrylic veneers from abrasion and wear. Ensure metal guide planes are used for lateral excursions. This will help to eliminate shearing stresses on the resin. Mechanical retention for the veneer is gained by using retention beads, loops, or bar retention. Chemical retention is achieved by applying a silicate layer to the metal surface. This silicate layer then bonds to the resin.

8.46.3.2. **Waxing the Pontic.** Wax to full contour when a metal lingual or occlusal is necessary due to lateral excursion requirements (Figure 8.122-A). Pay special attention to detail on the lingual and incisal or occlusal surfaces because they will be in metal on the finished product. Check occlusal contacts and lateral excursions. If a metal lingual or occlusal is not necessary, simply position a braided post in the center of the area where the resin tooth will be (Figure 8.122-B). It is essential that the post is positioned in the center to allow for adequate thickness of resin around the post.

8.46.3.3. **Cutting Back the Full Contour Wax-Up Pontic.** The facial of the wax pontic substructure is hollowed out to a *minimum* depth of 3 mm. Unlike porcelain, the composite resin does not require an even thickness. The pontic can be completely hollowed out, resulting in easier casting of the framework and a lighter final appliance. An anterior pontic can be thin enough to begin to see light through it. ***CAUTION:*** *When the wax is this thin, it can easily be distorted.*

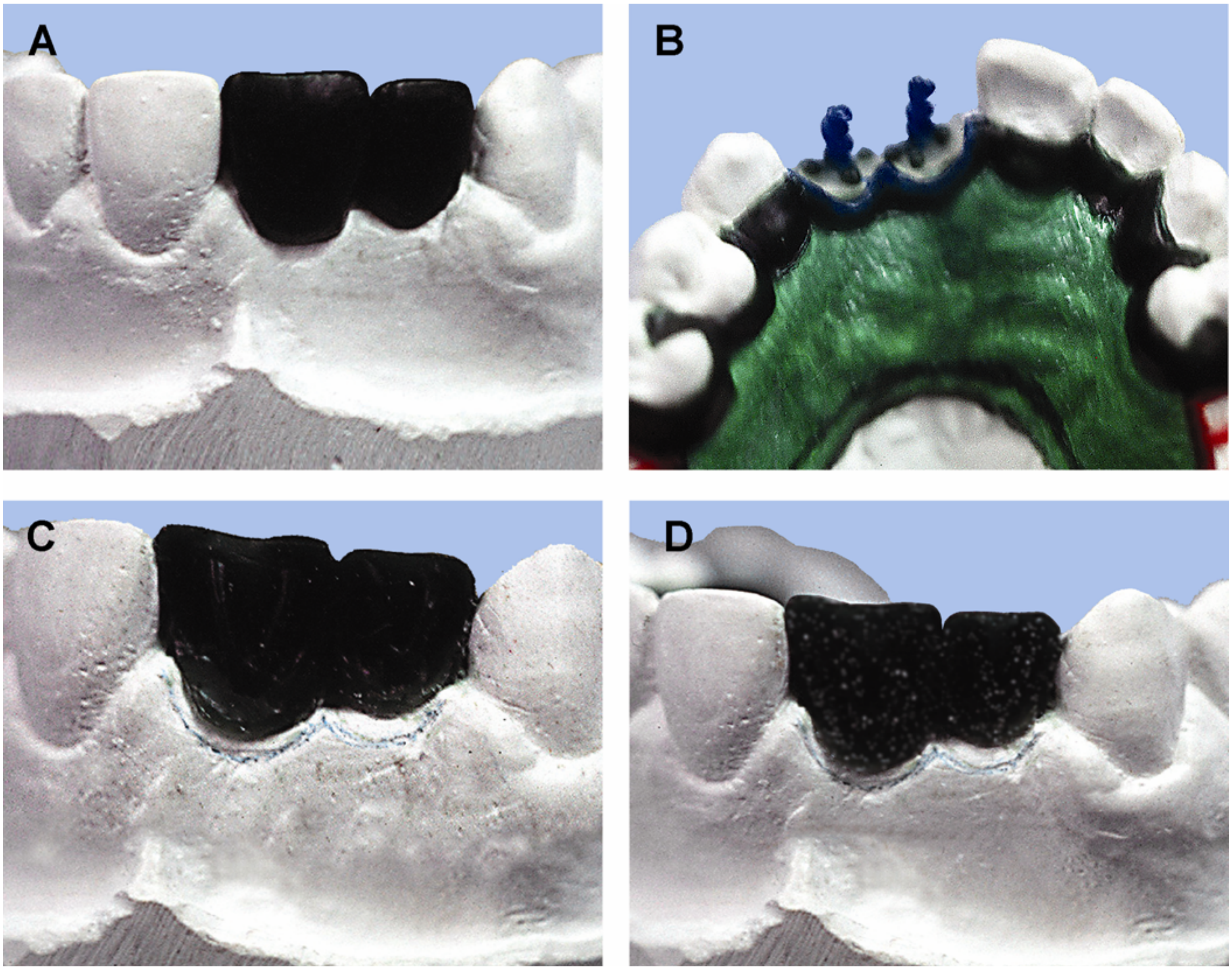
8.46.3.4. **Use of Mechanical Retention.** If mechanical retention is to be used, place V-shaped columns of 20-gauge round wax in the hollowed out area, taking care to leave enough space behind it for the composite material to wrap around it (8.122-C). Beads may also be applied to the cutback and the columns (Figure 8.122-D).

CAUTION

A minimum space of 1 mm must be maintained between the mechanical retention and the restored facial surface. This space is needed to accommodate the opaque and minimal body shade of the resin material. To determine if there is enough clearance, look directly down at the top of the occlusal or incisal surface. No beads or columns should be visible. The most common area to find retention that is too far facially is the incisal of anteriors. Remove beads or reposition columns if necessary.

8.46.3.5. After the framework is finished and polished, the resin can be applied (paragraph 8.58).

Figure 8.122. Resin Veneer Fabrication.



8.47. Incorporating Combination Clasp Retentive Arms into a Ticonium Framework. Ticonium wire is used in military dental laboratories to make the wire arm on a combination clasp. Platinum-gold-palladium wire was once used quite extensively before precious metals became prohibitively expensive. Combination bar clasps can be made, but combination circumferential clasps are much more popular. The retentive arm of a combination circumferential clasp is usually shaped from 18- or 19-gauge steel Ticonium wire. The heavier 18-gauge wire is used for long clasp arms, and the 19-gauge wire is used for shorter arms. The amount of undercut usually engaged by a wire retentive arm is 0.020 inches.

8.47.1. **Advantages of the Combination Circumferential Clasp:**

8.47.1.1. A cast clasp arm flexes mostly in the horizontal plane. A wire clasp arm flexes both vertically and horizontally and is thought to exert less destructive force on a tooth.

8.47.1.2. Some dentists believe a wire clasp covers less tooth surface and contributes less to decay.

8.47.1.3. Round wire is used in smaller diameters than cast clasps. A smaller, round wire reflects light in such a way that it is less noticeable than the larger cast clasp.

8.47.2. **Disadvantages of the Combination Circumferential Clasp:**

8.47.2.1. Because wire clasp arms are generally more flexible than cast clasp arms, they are more easily bent out of shape.

8.47.2.2. The wire clasp must be adapted to the cast so contact with the tooth is maintained throughout the length of the wire. This is difficult to do. Spaces represent food traps and potential sites of decay.

8.47.2.3. The use of wire sacrifices some of the bracing provided by a completely cast clasp.

8.47.2.4. The most common ways to unite a wire clasp arm with the framework when using Ticonium metal are to cast molten metal against the wire or to solder the wire to the framework. Critics maintain that this reduces the flexibility of the wire by at least 30 percent. This effect can be drastically reduced in the solder method by using the "solder to the retentive grid area" method (paragraph 8.47.3.3).

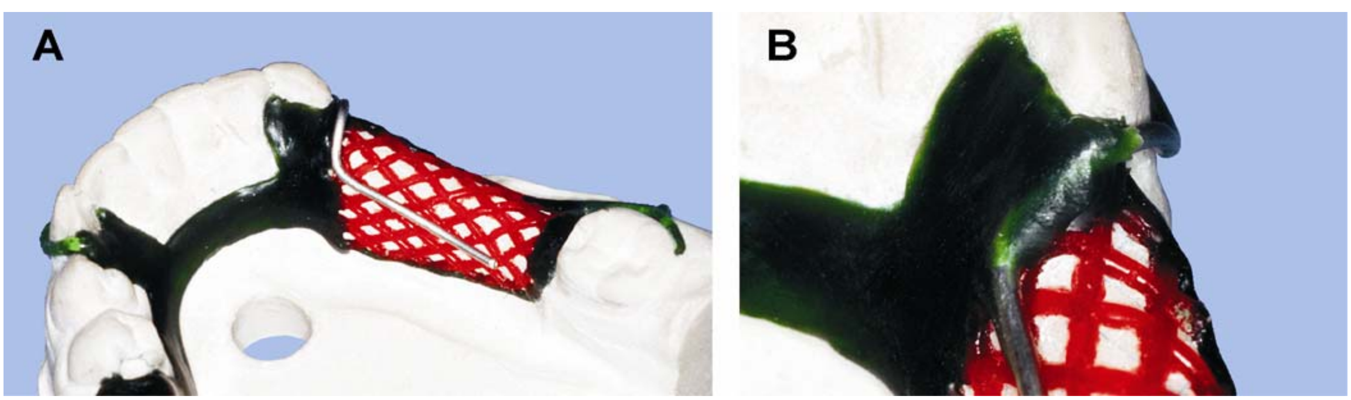
8.47.2.5. When Ticonium metal is cast to Ticonium or platinum-gold-palladium wire, no metallurgical union occurs between the casting and the wire. Any resistance the wire shows to being pulled out of the casting is strictly mechanical. The bends made in the nonclasp portion (tang) of the wire become critically important. (Mechanical retention depends on these angles.)

8.47.2.6. Cusp impacts in centric occlusion frequently contraindicate the use of wire. The 18-gauge wire and the cast metal necessary to surround it (sleeve) require considerable clearance.

8.47.3. **Procedures For Attaching the Wire Clasp.** The dentist's opinion about the effects of heat on the physical properties of wire determines the way to attach a wire clasp arm to the framework. Choices for attaching a wire clasp include the "cast to" method, "soldered to the minor connector" technique, or "soldered to the retentive grid area" method. In another method, the tang of a wire clasp arm is buried in the resin of the denture base. This is the most common way to replace a broken clasp arm (paragraph 8.70). No matter which method is used, a wire clasp arm must be bent to conform to the shape of the tooth. Most of the time, the arm will be part of a circumferential clasp. Keep the *tang* long so it can be bent for use in one of these techniques:

8.47.3.1. **"Cast-To" Method (Figure 8.123).** The wire retentive arm is included in the wax-up on the refractory cast, and later molten metal is "cast to" the embedded wire as follows:

Figure 8.123. "Cast-To" Method.



8.47.3.1.1. Contour the wrought wire arm to the tooth on the master cast or on a duplicate. It is critically important to adapt the entire length of the clasp to the tooth, including the shoulder of the clasp. Mechanical retention comes from a loop or well-defined bends placed in the tang of the wire.

8.47.3.1.2. Wax an RPD pattern on the refractory cast to include the wrought clasp arm (Figure 8.123-A and -B).

8.47.3.1.3. Sprue, invest, and cast the pattern.

8.47.3.2. **"Soldered to the Minor Connector" Technique (Figure 8.124).** The wire retentive arm is included in the wax-up on the refractory cast. However, it is removed before casting and later soldered to the framework as follows:

8.47.3.2.1. Contour the retentive arm of the clasp to the tooth on the master cast or on a duplicate.

8.47.3.2.2. Wax the RPD pattern on the refractory cast to include the wrought clasp arm (Figure 8.124-A). The tang of the wrought arm is embedded in the minor connector.

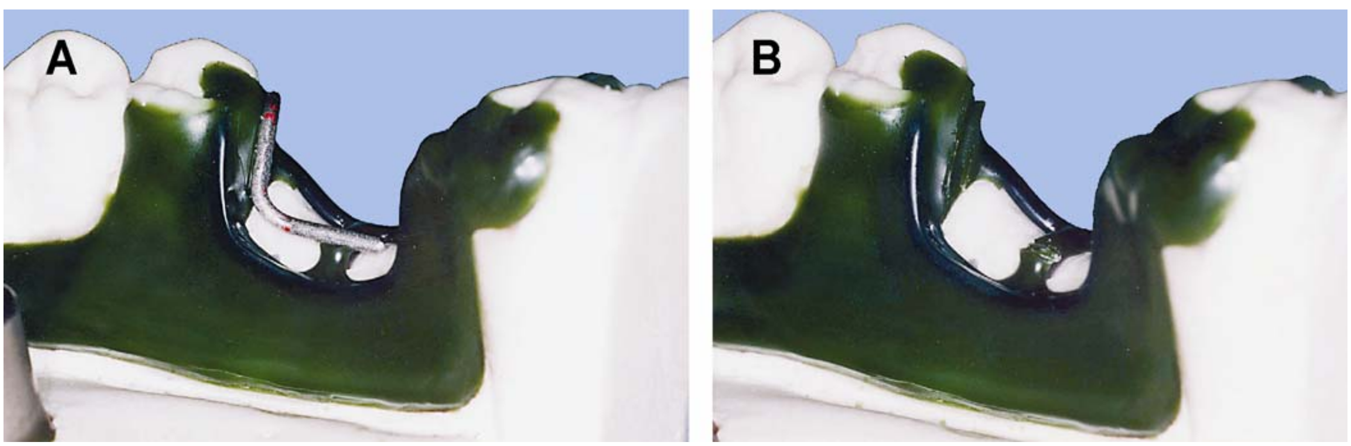
8.47.3.2.3. Carefully remove the wrought wire arm from the pattern. Leave a definite slot behind (Figure 8.124-B).

8.47.3.2.4. Sprue, invest, and cast the pattern.

8.47.3.2.5. Finish down the framework and place it on a duplicate master cast.

8.47.3.2.6. Return the wrought wire clasp to its slot and stabilize it with a plaster matrix. Solder the clasp tang to the framework with an electric soldering unit (Figure 8.125C&D).

Figure 8.124. "Soldered to the Minor Connector" Technique.



8.47.3.3. **"Soldered to the Retentive Grid Area" Method (Figure 8.125).** This method is essentially the same as the one described for soldering the wrought arm to the minor connector. The difference is that the tang is left longer so the wire can be soldered to the retentive grid instead. An advantage is that application of heat is far removed from the clasp arm proper.

8.47.3.4. **Twin-Flex Wires (Figure 8.126).** When esthetics is a primary consideration (anterior tooth replacements) or when the only available undercut is on the mesial or distal of an abutment tooth, the twin-flex wire may be indicated. The wire can be totally encased in the plating or may extend out from it. A space is provided in the plating to allow the wire to flex over the infrabulge of the tooth.

Figure 8.125. “Soldered to the Retentive Grid Area” Method.

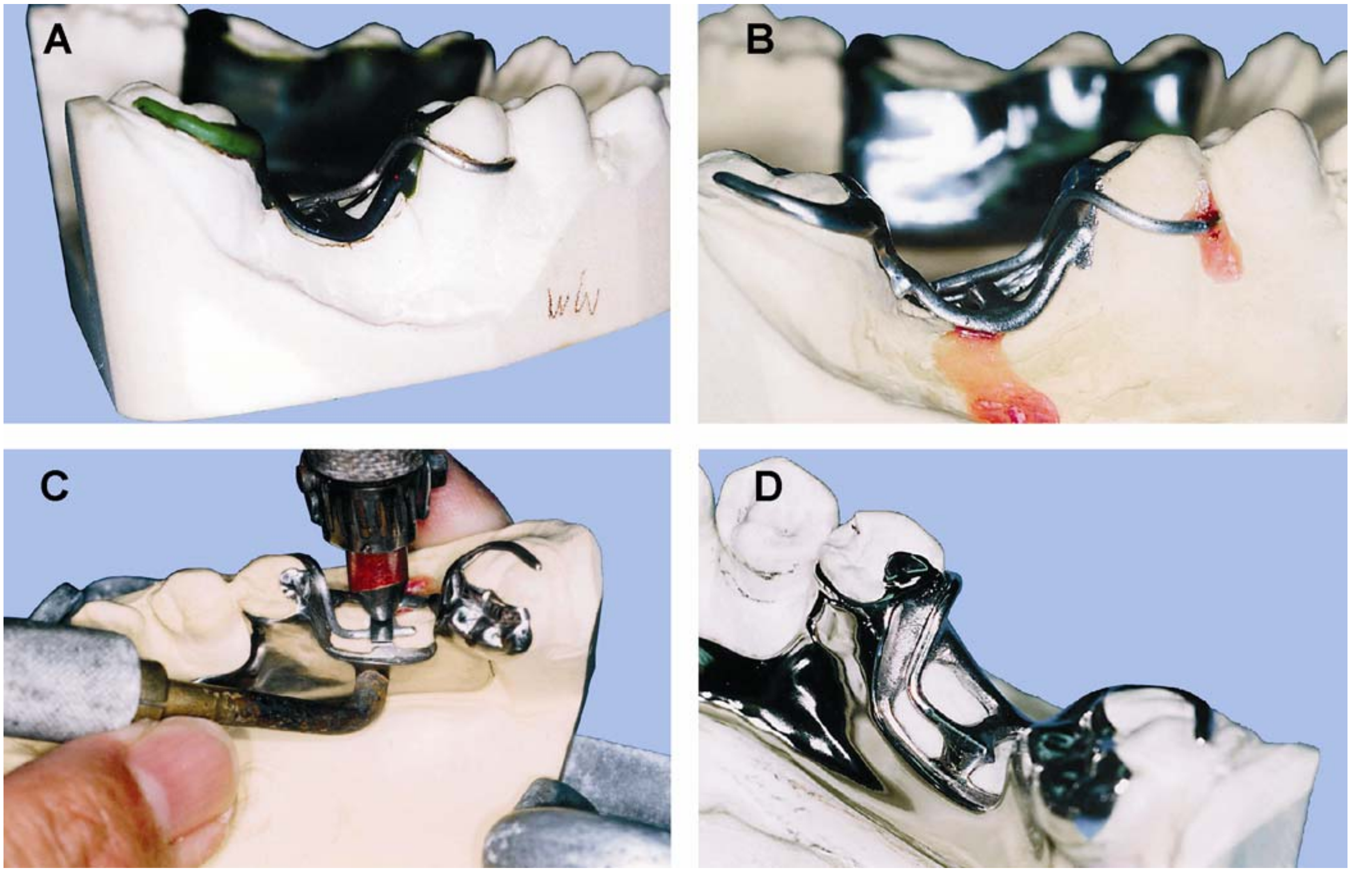


Figure 8.126. Twin-Flex Wire Incorporated Into the Framework.

8.47.3.4.1. Bend 20-gauge wire as for any wrought wire clasp. To allow room for solder to thoroughly encase the wire, place a piece of 24-gauge pressure sensitive wax on the tissue where the wire will lay.

8.47.3.4.2. To create the space in the plating for the wire to flex, cover the part of the wire that will flex with a “sleeve” of blockout wax. It must be at least .010 inches thick at the tip and then taper away.

8.47.3.4.3. Duplicate the cast with the wire in place into a refractory cast. Wax-up the RPD framework; then sprue, invest, and cast the framework.

8.47.3.4.4. Fit, finish, and polish the framework; then solder the wire to the tissue side of the framework.

Section 8F—Spruing, Investing, Burnout, and Casting

8.48. Spruing the Wax Pattern:

8.48.1. **Introduction:**

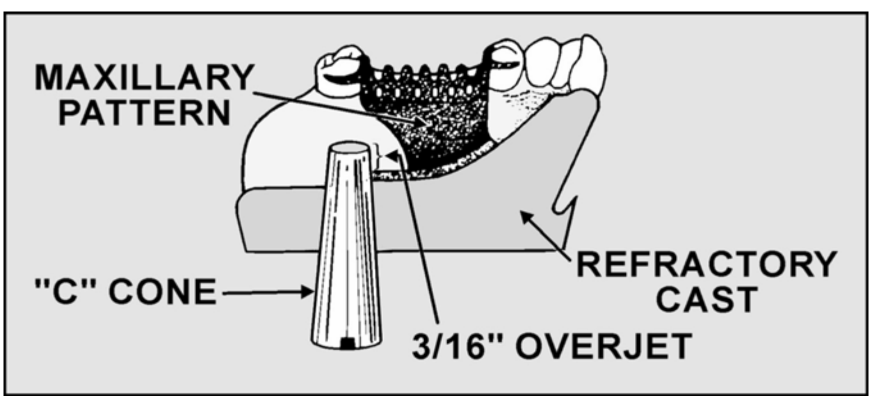
8.48.1.1. Spruing provides a pathway through which molten metal can flow during the casting procedure. In addition, the sprue acts as a reservoir for molten metal immediately after the framework is cast. Metal remains liquid longer in the heavier parts of the casting. Because a sprue is the bulkiest part, it feeds the lighter sections while cooling contraction is taking place (compensates for metal shrinkage).

8.48.1.2. The two ways to distribute sprue leads to a pattern are *single and multiple.* A single sprue is used on patterns that get progressively smaller in volume from the sprue's point of attachment to the outer reaches. If metal has to flow through a thin section to reach a heavy section, a secondary or "auxiliary" sprue lead may be run to the dependent area.

8.48.1.3. The Ticonium Company maintains that most Ticonium castings can be made from a single sprue. The main sprue for a Ticonium casting will either follow the *overjet* spruing principle or take the shape of an *oversprue.*

8.48.2. **Overjet Spruing.** Because the main sprue in this system passes through the base of the cast, overjet spruing is used for mandibular patterns and for maxillary patterns that do not fully cover the palate. Instead of having wax leads come off the tip of the main sprue, the wax leads exit the main sprue below its tip (Figure 8.127). Run off as many auxiliary wax leads from the main sprue as the pattern requires.

Figure 8.127. Overjet Spruing.



8.48.2.1. **Advantages of Overjet Spruing.** Molten metal turbulence at the entrance to the mold cavity is reduced and the molten metal has less scuffing effect on the investment. The tip of the main sprue (overjet portion) acts to catch particles of investment that might be broken loose by the initial rush of molten metal. These factors act to reduce the incidence of metal pitting and miscast components in castings. Overjet sprues keep the line of feed open longer to supply molten metal to the casting. This tends to produce denser castings.

8.48.2.2. **Procedures for Overjet Spruing:**

8.48.2.2.1. **Attaching a Wax Lead to the Pattern.** Make the wax lead long enough so one end of it contacts the pattern and the other end of it slightly projects over the main sprue hole. Use 6-gauge round wax for spruing. Pinch one end to achieve the *garden hose effect*. Attach the wax lead to the major connector. Seal all sides of the wax lead. Use additional wax to widen the lead to equal the width of the sprue cone.

8.48.2.2.2. **Attaching the Main Sprue Cone.** Take a stainless steel "C" sprue cone, heat the cone over a Bunsen burner, and insert it through the refractory cast. Seal the wax lead to the sprue cone three-sixteenths (3/16) of an inch below the tip to produce the required overjet. Blend the junctions of the wax lead into the "C" cone and into the pattern. This will produce a wedge shape. Seal around the cone to ensure its stability.

8.48.2.3. **Examples of Single and Multiple Lead Overjet Spruing:**

8.48.2.3.1. A single sprue is used on frameworks where molten metal does not have to pass through thin sections to bulkier sections (Figure 8.128-A).

Figure 8.128. Spruing Examples.

8.48.2.3.2. Multiple sprues are used on cases where the metal must flow through a thin section to reach a bulkier section. Some cases require double main leads to the major connector. Two examples are:

8.48.2.3.2.1. Anterior-posterior palatal strap and closed horseshoe major connectors (Figure 8.128-B).

8.48.2.3.2.2. Lingual bars with minor connectors that support anterior tooth backings or supplemental Kennedy bars. The sprue leads form a "V." Do not make the attachment or the sprues to the lingual bar directly in line with the minor connector or the bulky area. Always attach the sprue leads before or after the bulky spot.

8.48.2.3.3. Some cases require a smaller auxiliary sprue lead to a dependent part of the pattern (10- to 12-gauge round wax preform) (Figure 8.128-C). Examples of this requirement are isolated, large clasps on molar abutments and the presence of heavy pontics. Attach the auxiliary sprue near the bulky area and arch the sprue so its highest point is above the top of the clasp or pontic.

8.48.2.3.4. Internal spruing can be used on maxillary RPDs to guide metal directly to areas that may be at risk of not casting. These include approach arms, ring clasps, RAPs, and metal dummies or resin veneer substructures. Strategic parts of the pattern are thickened internally, or under the component (major connector, denture retention), in the wax-up to aid the flow of metal to particular components when cast.

8.48.3. **Overspruing.** Overspruing is used on full palate maxillary RPDs or in any case where overjet spruing is difficult. Suspend a wax sprue cone inverted over the pattern. The tip should extend just below the height of the pattern. Attach 8- or 10-gauge round wax sprue leads three-sixteenths (3/16) of an inch from the tip (Figure 8.129). Use 3 or 4 leads attached to the outer borders of the pattern. To prevent porosity and aid in finishing, add a tab made of wax or stipple to the pattern and attach the sprue lead there. Simply cut it off during the finishing process.

Figure 8.129. Overspruing a Maxillary Major Connector.

8.48.4. **Troubleshooting Spruing Problems:**

8.48.4.1. If the main sprue and its leads are not sealed at their junctions as described, there is serious potential for ledges of investment to protrude into the sprue channels. The current of molten metal breaks off any thin projections and carries them into the casting. This causes pits in the metal. If the particle of investment is big enough, it may block access to the terminal parts of the mold.

8.48.4.2. After the pattern and cast are completely invested, heat the "C" cone before removal. The wax used to seal the cone is less likely to pull particles of investment into the sprue channel.

8.48.4.3. After flattening off the surface of the mold, run a pencil size stream of water into the sprue hole to blow out any investment that might have fallen in.

8.48.4.4. Keep the sprue pins absolutely free of set investment particles.

8.49. Selecting the Type and Amount of Ticonium Metal Needed:

8.49.1. **Type of Ticonium Metal:**

8.49.1.1. **Number #100 Metal.** This metal is used for routine RPD castings. An ingot comes in large (5/8 inch) and small (7/16 inch) diameters and in a variety of lengths.

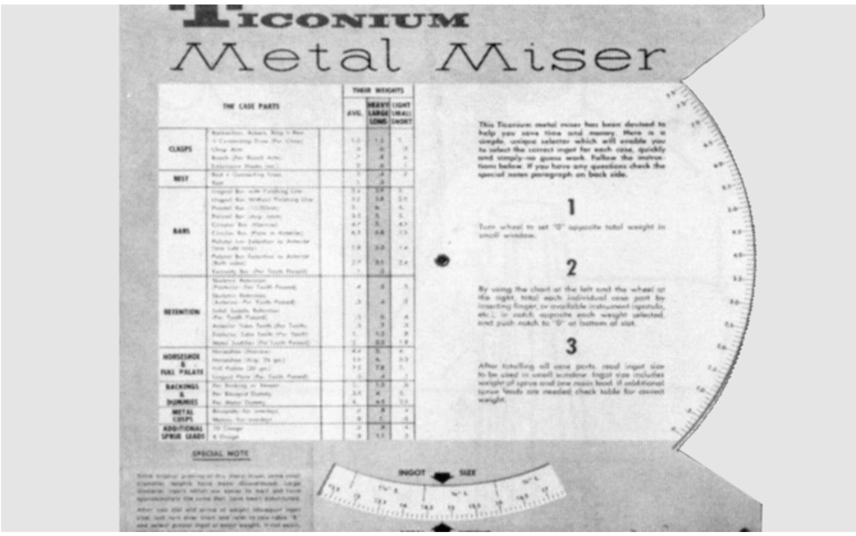
8.49.1.2. **Number #44 Metal.** This type is used for cast metal, complete denture bases. The ingot is grooved so it is easily distinguished from Ticonium #100. The #44 metal is not recommended for frameworks carrying cast clasps.

8.49.1.3. **Number #25 Metal.** This metal is used to cast metal structures that are going to be surgically implanted. It is formulated to cause as little adverse tissue reaction as possible. The metal is not intended for routine RPD castings.

8.49.2. **Amount of Metal:**

8.49.2.1. The best way to estimate the amount needed for a framework casting is to use the Ticonium metal miser (Figure 8.130). The Ticonium metal miser is a circular calculator. It consecutively adds value for each part of the case and reads out the total directly. The calculator also matches the total weight computed to a metal ingot size. The ingot size is written down for future reference.

Figure 8.130. Ticonium Metal Miser.



8.49.2.2. When the pattern and the refractory cast are flasked, a wet paper towel is used in the procedure. It is common practice to write the ingot size on the towel with an indelible pencil and to keep the paper towel with the case until it is used.

8.50. Investing the Pattern and Refractory Cast. The case with its wax pattern and attached sprue cone is embedded in a mix of refractory casting investment (Investic). After the investment hardens, it preserves the pattern form even though the burnout heat (1350 ^{o}F) eliminates the pattern itself. The requirements of the investment are *strength* to contain the rush of molten metal, *surface smoothness* so the resultant casting is smooth, a certain amount of *porosity* to allow gases in the mold to escape, and *expansion* to compensate for shrinkage of the metal after casting. Investing is accomplished as follows: (1) apply the "paint-on" layer over the pattern and the cast and (2) full-flask the pattern and refractory cast (Figures 8.131 and 8.132).

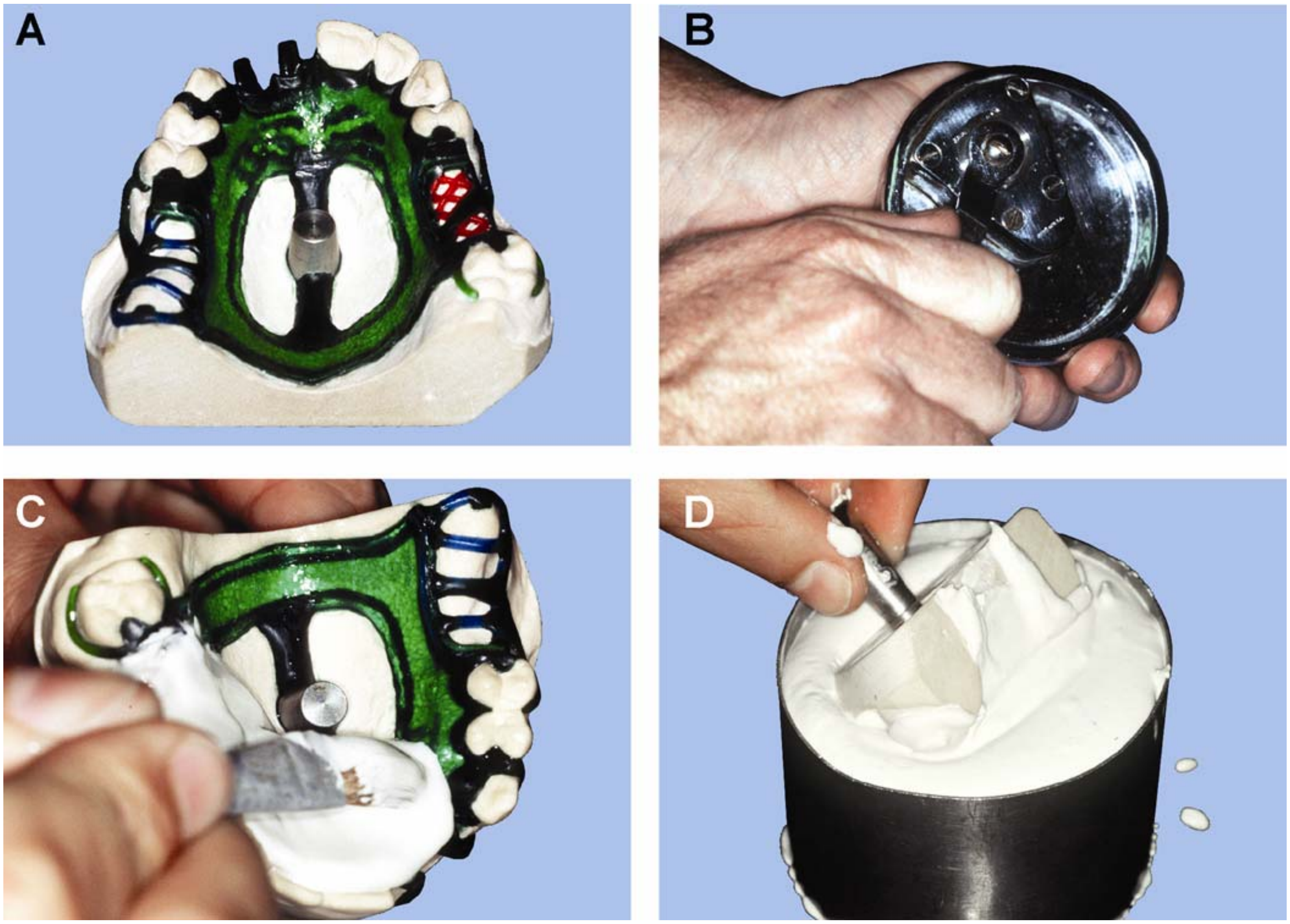
8.50.1. **Applying the "Paint-On" Layer:**

8.50.1.1. Dip the waxed up refractory cast in a surface tension reducer agent (debubblizer).

8.50.1.2. Proportion and mix the investment for the paint-on layer (Figure 8.131-B). The correct water to powder ratio is 30 cc of room temperature distilled water to 100 gm of powder. Either hand spatulate the investment for 60 seconds or mechanically mix it for 30 seconds. This amount should be enough for about 4 cases.

8.50.1.3. Paint on the investment (Figure 8.131-C) as follows:

Figure 8.131. Investing the Pattern and Refractory Cast.



8.50.1.3.1. Blow off any excess debubblizer that is puddled on the refractory cast.

8.50.1.3.2. Pick up some investment on a brush. Vibrate the investment ahead of the brush to cover the entire wax pattern and sprue uniformly. A strong vibrator is needed for the job; small electromechanical vibrators are not adequate.

8.50.1.3.3. Keep the thickness of the paint-on layer as uniform as possible. (About 3 mm is considered proper.) Avoid investment buildup in the palate of a maxillary cast. Avoid letting investment accumulate under a mandibular lingual bar pattern. Be careful not to trap any air bubbles. Painting on a thin layer is essential to permit the escape of gases produced during burnout. An even layer helps contribute toward uniform expansion of the investment.

8.50.1.4. With the slotted end of a sprue down, rest the investment cast on a pouring spout taken from a duplicating flask or an ice cube tray. Do not set the freshly painted cast where it may be affected by bench vibrations because the investment layer will flow and lose its thickness and uniformity.

8.50.1.5. After the paint-on layer has reached final set (about 10 minutes), it is ready to be full flasked.

8.50.2. **Full-Flasking the Pattern and Refractory Cast.** A set of Ticonium flasks contains a selection of seven sizes of stainless steel flask formers (150 gm to 700 gm). They are split-type flask formers held together with a clip. Procedures for flasking the pattern and refractory cast are as follows:

8.50.2.1. Select a flask that allows one-fourth (1/4) to one-half (1/2) inch of clearance between the refractory cast and the sides of the flask.

8.50.2.2. Proportion the investment with water to powder ratio of 30 cc water to 100 gm of investment. Either hand spatulate the mixture for 60 seconds or do it mechanically for 30 seconds. *Do not subject the mix to vacuum.*

8.50.2.3. Put the flask on a metal bench top or glass slab and fill the flask about three-quarters full. The metal bench top or glass slab will not absorb any water from the investment mixture.

8.50.2.4. Properly align the mold cavity with the casting machine's direction of spin to aid the flow of metal. Line up the case with the flask seam during the investment procedure. The flask seam is a feature that always appears on the surface of the mold. During casting, the seam will be the *leading edge* when the casting arm spins. Investing the most distant parts of the pattern away from the seam will put them at the *trailing edge*, thereby forcing the metal into these parts using centrifugal force.

8.50.2.5. Dip the refractory cast in water and blow off the excess. This will prevent the paint on layer from absorbing water out of the investment mixture.

8.50.2.6. Grasp the refractory cast by the "C" cone and begin to settle the cast into the flask. Be careful not to trap air in the palate or tongue space (Figure 8.131-D).

8.50.2.7. Use the following principles when spruing cases with "overjet" method:

8.50.2.7.1. If a cast has a single sprue lead, orient the lead toward the seam. ***EXCEPTION:*** If there is no pattern distal to the sprue pin, orient the lead away from the seam.

8.50.2.7.2. If an auxiliary sprue is used in addition to a main lead, always direct the main lead toward the seam.

8.50.2.8. "Oversprue" cases should be invested with any distant or thin areas oriented away from the seam.

8.50.2.9. Sink the cast in the investment material until the paint-on layer is about 6 mm from the bottom of the flask for all "overjet" cases. (It is good practice to mark the stopping point on the sprue cone before sinking the refractory cast.) For "oversprue" cases, do not hold the sprue to sink the cast because this may break the sprue leads. The part of the sprue where the leads attach must be at least 4 mm below the top of the investment.

8.50.2.10. Make sure the refractory cast displaces enough investment so the flask is completely full. If more investment is required, it can easily be added. Just before the investment reaches initial set, use a wide flat edged blade to remove any excess investment above the top of the flask (Figure 8.132-A). Ensure the mold is exactly the same height as the investment ring. This will allow the mold to fit properly into the casting machine. Allow the investment to reach final set (15 minutes).

8.50.2.11. Remove the "C" cone by first heating it and then placing the dull edge of a brown-handled knife in the slot and twisting slightly until the sprue cone drops out (Figure 8.132-B). Be sure the sprue hole opening is smooth and sharp. If necessary, lightly sand the edges of the sprue hole until smooth.

8.50.2.12. Blow loose particles of investment out of the sprue hole with a stream of water. Visually inspect the sprue hole and repeat as necessary.

Figure 8.132. "Face Off" the Mold and Mark the Ingot Size.

8.50.2.13. Remove the clip and slide off the flask former.

8.50.2.14. Mark the ingot size on the bottom of the mold with jeweler's rouge (Figure 8.132-C).

8.50.2.15. Make sure the level of moisture within the mass of the investment remains relatively constant. Store the molds in plastic bags to maintain their moisture content.

8.51. Burnout of the Pattern and Casting the Framework. The typical burnout and casting setup consists of a Ticonium twin controller, an electric oven, and a Ticomatic casting machine. The burnout is performed in an oven. (For photographs of this equipment, see Volume 2, Chapter 9.) The twin controller is the oven's time and temperature control unit. The word "twin" does not mean that the controller monitors the heating time and temperature of the two ovens simultaneously. Two ovens can be connected to the controller, but the unit programs and operates only one of the ovens at a time. One advantage might be that a large capacity and a small capacity oven can be connected to a controller, giving the option of running up an oven appropriate for the size of the load. After a case is burned out, the Ticomatic casting machine melts and casts metal uniformly, precisely, and automatically.

8.51.1. **Purpose of the Burnout.** The burnout eliminates the entire pattern from the mold and produces the required thermal expansion (1.0 percent). Refractory investments are compounded so the combined setting, hygroscopic, and thermal expansion is equal to the percentage contraction of solidifying metal (1.7 percent). For example, setting expansion accounts for 0.4 percent, hygroscopic expansion accounts for 0.3 percent, and thermal expansion (heating the mold 1350 ^{o}F) accounts for 1.0 percent (for a total of 1.7 percent).

8.51.2. **Procedures for Burnout With the Ticonium® Twin Controller.** Schedule the burnout whenever possible after working hours. This saves time and eliminates the odor from the burning wax and plastic during working hours.

8.51.2.1. Ensure the twin controller is plugged in for proper operation of the timer.

8.51.2.2. Flip the selector switch on the twin controller to the oven you want to control.

8.51.2.3. Turn the temperature on the twin controller indicator setting to 1350 ^{o}F (733 ^{o}C).

8.51.2.4. Estimate the burnout time. Generally, wax will require a burnout time of 1 hour once the oven has reached high temperature and plastic patterns will require 2 hours. The time a mold spends at 1350 ^{o}F is referred to as the *heat-soak* cycle. The time required to raise the temperature to 1350 ^{o}F will vary according to brand and model of oven. Ticonium supplies two types of burnout oven:

8.51.2.4.1. The Ticonium® burnout oven, which has a capacity of nine molds. The heatup time is 2 to 3 hours from room temperature to 1350 ^{o}F. Then heat soak for 1 to 2 hours for a total burnout time of 3 to 5 hours.

8.51.2.4.2. The Ticonium® super oven, which has a capacity of 20 molds. Because this oven has such a large capacity, the suggested burnout time is 6 to 8 hours.

8.51.2.5. Control the burnout time as follows:

8.51.2.5.1. For manual operation, remove the trippers. Then use the “on-off” lever below the time dial.

8.51.2.5.2. For automatic cycling:

8.51.2.5.2.1. Set the time clock. Pull the time dial outward and rotate it until the correct time of day is in alignment with the pointer marked “time.”

8.51.2.5.2.2. Count back the required number of burnout hours from the actual time of day you intend to cast. To set the silver “on” tripper, loosen the knurled screw, slide the tripper around the edge of the yellow dial to the time the heat cycle is supposed to start, and tighten the knurled screw firmly. For example, if the intended casting time using a super oven for the burnout is 8:00 a.m., set the “on” tripper for 12:00 a.m. (midnight). The black “off” tripper is provided as a safety precaution. Set the “off” tripper for a time after the casting run should be completed. This tripper turns the oven off automatically, if it is not turned off manually first.

8.51.2.5.2.3. Using the skipper wheel beside the yellow time dial prevents automatic burnout cycling for the day or days of the week is not required. Use the skipper wheel by placing skipping screws in the wheel for the day (or days) the oven is to remain turned off.

8.51.2.5.3. Manually turn the twin controller “on-off” lever to the “off” position after a casting run to prolong equipment life.

8.51.2.6. Load the oven. The following considerations are important when loading the ovens:

8.51.2.6.1. Always face the sprue hole down so the wax can be more easily eliminated.

8.51.2.6.2. Use shrouds or plugs to raise the molds off the oven floor at least 1 inch and to separate successive layers. Do not allow the molds to touch the oven walls, each other, or the thermocouple protective shield. This will cause “cold spots” which could result in uneven expansion.

8.51.2.6.3. Keep each mold in a plastic bag to retain moisture. Moisture in the mold is essential because the steam helps produce more uniform heat saturation and minimize investment cracking.

8.51.2.6.4. Stagger the top layer of the molds so the wax being eliminated from the sprue holes of the top layer drains between the molds on the bottom layer.

8.51.2.6.5. Periodically check the oven vent holes. Clogged vents can be responsible for incomplete burnout of the molds.

8.51.3. **Casting Procedures.** The Ticomatic® casting machine is a centrifugal machine designed to melt metals by using high frequency electric current produced in a water-cooled induction heating coil. The coil surrounds the crucible that holds the metal. The molten metal is fed into the mold by centrifugal force to produce the casting. Because the machine can be operated over a wide range of temperatures, it can be used for casting gold alloy as well as chrome alloys.

8.51.3.1. To prepare the unit for casting:

8.51.3.1.1. Balance the casting arm. To do this, slide the counterweight on the casting arm to a position that balances out the size of the mold you intend to cast. All molds of the same size will balance out at about the same counterweight setting. It is efficient practice to cast all molds of the same size together, reset the counterweight, and continue on to a group of molds of another size.

8.51.3.1.2. Turn on the main power supply.

8.51.3.1.3. Turn on the water for those units connected to an external water source. ***NOTE:*** For those Ticomatic units connected to an external water source, allow a minimum of 15 minutes warmup time before using the machine.

8.51.3.1.4. Turn the "on-off" switch in the sensing head to the "on" position.

8.51.3.2. To raise the control arm for positioning the high frequency coil to the locked (left) position:

8.51.3.2.1. Rotate the casting arm until it is parallel with the front of the cabinet and with the counterweight end to the left.

8.51.3.2.2. Retract the slide carrying the crucible until the crucible is directly over the heating coil.

8.51.3.2.3. Touch the toe switch to unlock the control arm and raise the heating coil to a position around the crucible. There is a two-second delay circuit built into the unit so you do not have to keep your toe pressed against the toe switch; you merely need to touch the switch.

8.51.3.3. Before you start the first melt, ensure the yellow pilot light in the sensing head is lit, the relay range knob is set properly, and the blue pilot light in the control console is lit.

8.51.3.4. Mount the flask on the casting arm as follows:

8.51.3.4.1. Make sure the swivel plate yoke assembly is hooked in the correct slot for the length of flask to be cast.

8.51.3.4.2. Verify the setting of the counterweight.

8.51.3.4.3. Raise the locking arm handle until it hits the stop.

8.51.3.4.4. Insert the flask in the opening between the swivel plate and the front plate. Make sure the seam faces away from the operator. Hold the face of the flask firmly against the front plate and line up the sprue hole with the opening. Adjust the height of the flask so the sprue hole is above the center line of the opening and toward the operator (the 2-o'clock position on a clock face).

8.51.3.4.5. Slowly lower the locking arm handle until the swivel plate comes in contact with the rear surface of the flask. When the swivel plate seats itself and resistance to further closure increases, press down firmly to lock the flask in position.

8.51.3.5. Proceed with the casting as follows:

8.51.3.5.1. Place the correct ingot size in the crucible.

8.51.3.5.2. Press the "start" button on the control console. ***NOTE:*** Because the control arm is in the "locked" position, the red pilot should light, indicating the coil cannot be released.

8.51.3.5.3. Move the control arm as far right as it goes and maintain a slight upward lift on the handle as it moves. ***NOTE:*** The green pilot should light, indicating the arm will release when the correct casting temperature is reached. Without further attention from the operator, the sensing head will measure the temperature and release the arm at the correct time. The control arm will drop and the arm will spin for 15 seconds, making the casting.

8.51.3.6. Prepare for the next casting as follows:

8.51.3.6.1. Raise and lock the casting arm (paragraph 8.51.3.2).

8.51.3.6.2. Remove the flask from the arm.

8.51.3.6.3. Remove the oxide from the crucible.

8.51.3.6.4. Proceed with the next melt.

8.51.3.7. Shut down the machine as follows:

8.51.3.7.1. Place dummy flask in position on arm.

8.51.3.7.2. Turn off the main power supply.

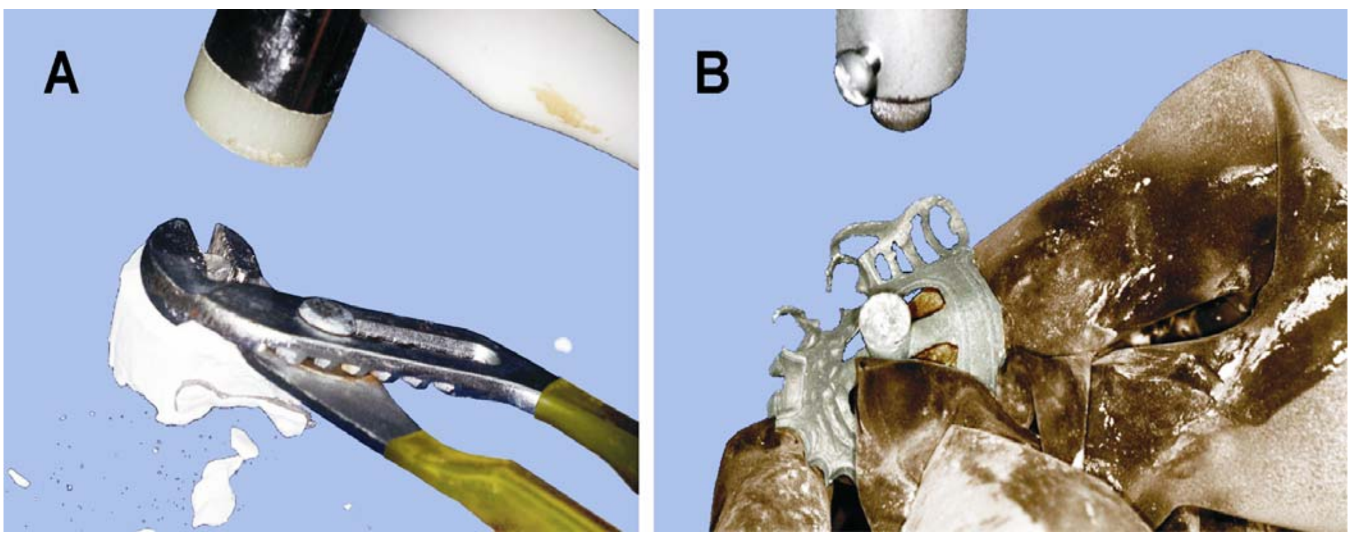
8.51.3.7.3. Turn off the water on the units attached to an external water source.

8.51.4. **Setting the Molds Aside To Cool**. A mold should be cool enough to be handled in 30 minutes. Never quench a mold in water because it can cause serious warpage of the casting.

Section 8G—Finishing, Polishing, and Fitting the Framework

8.52. Freeing the Casting of Investment Debris. Follow Figure 8.133 and the following steps:

Figure 8.133. Freeing the Casting of Investment Debris.



8.52.1. Tap the sides of the mold lightly with a plaster knife. The outer investment should fall away easily, exposing the paint-on layer and the main sprue button.

8.52.2. Grasp the button with pliers while tapping the *pliers* with a hammer. Most of the remaining investment should fall away from the casting.

8.52.3. Use a sandblaster to remove surface oxide. Hold the case several inches below the nozzle. (If a casting is held directly under the nozzle of the sandblaster, the high pressure stream of air and zircon grit could cause the casting to warp.)

8.53. Finishing and Polishing the Ticonium (Nickel-Chrome Alloy) Framework:

8.53.1. **Introduction:**

8.53.1.1. When the wax pattern for the framework is carefully formed, extensive grinding and shaping efforts are not necessary. The effectiveness of a finishing and polishing effort depends on the speed of the lathe, hardness and shape of the abrasive particles, amount of pressure applied, and physical qualities of the object being polished.

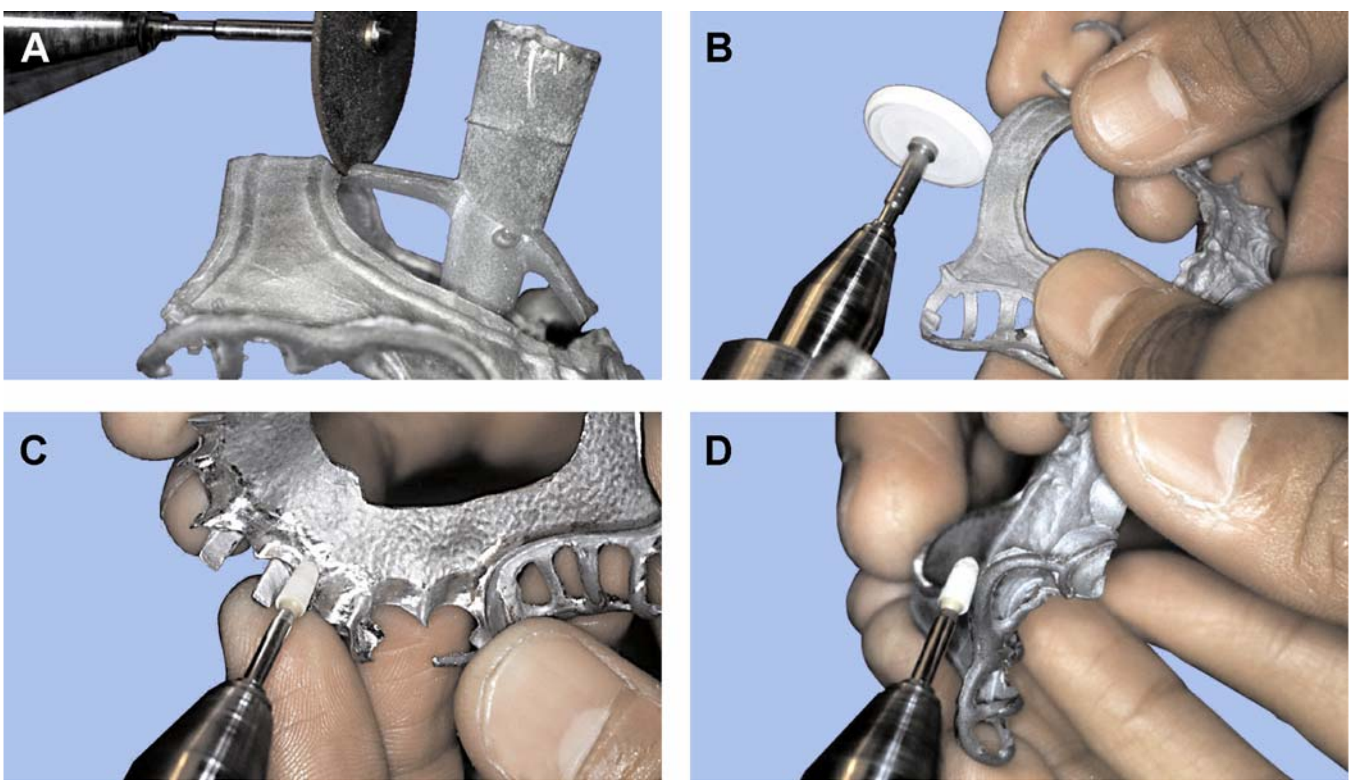
8.53.1.2. Finishing and polishing chrome alloys requires a high speed lathe (24,000 revolutions per minute [rpm]). Metal finishing and polishing procedures should be done systematically, moving from coarse to progressively finer abrasives. After removing all of the scratches from the surface of the framework, use an exceedingly fine polishing agent to generate a high luster. Two rules that apply to most metal finishing procedures are to:

8.53.1.2.1. Let the abrasive and the speed of the lathe do the cutting. Avoid using heavy pressure because it heats the work and could possibly warp the casting. Heavy pressure also crushes abrasive particles, slows cutting, and causes the abrasive to clog and glaze.

8.53.1.2.2. Be certain each successive finishing operation removes all scratches left by the preceding abrasive.

8.53.2. **Rough-Finishing Procedures (Figure 8.134).** Use a series of *wheels, discs,* and mounted *points* in finishing the casting as follows:

Figure 8.134. Rough-Finishing the Casting.



8.53.2.1. Cut off the sprue with a separating disc (Figure 8.134-A).

8.53.2.2. Use a heatless stone or a triple-mounted cutoff wheel to remove the bulk of metal where the sprue was attached. Contour the grossly ragged edges on the major connector (Figure

8.134-B). On palates where the stipple effect has been reduced or lost, use a #2 bur to reproduce the stipple by cutting in a "fish scale" pattern. With a #1 or 2 round bur, slightly relieve the area under the rest shoulders.

8.53.2.3. Restore the casting to finished wax-up state. Use mounted points and barrel stones to remove any remaining flash on the casting (Figure 8.134-C). Remove any positive bubbles on the casting with an appropriate size round bur (2, 4, 6, or 8 rd). ***CAUTION:*** Never stone the tissue side of a maxillary framework, stay away from the clasps, and treat them as a separate entity in the next step.

8.53.2.4. Shape up the top and bottom of a clasp by removing any flash or sharp edges that might exist due to sealing, overwaxing, or careless investing (Figure 8.134-D). Use a small tapered stone to *delicately* clean the inside of the clasp only if necessary. *Do not* grind off a significant amount of metal or the retention aspect of the clasp may be ruined.

8.53.3. **Ti-Lectro® Polishing (Figure 8.135).** The Ti-Lectro procedure polishes chrome alloy castings by an electrolytic deplating process.

Figure 8.135. Ti-Lectro® Polisher.

8.53.3.1. Sandblast the casting. Rinse the casting in clean water and dry it thoroughly. Abrasive grit and water contaminates Ti-Lectro® polishing solution. Do not touch the casting with bare hands. Skin oil is also a contaminant.

8.53.3.2. Heat the solution with a Ti-Lectro® heater until the temperature reaches 120 to 140 ^{o}F. (A heated pan of water can be substituted for an electric heating device.) For exceptionally large castings and castings with deeply vaulted palates, use a somewhat lower temperature solution for better results. If a pan of heated water is used to raise the bowl of solution to the proper temperature, remove the bowl from the pan before continuing to the next step.

8.53.3.3. Attach a cathode "alligator" clip to a wire that originates from the negative (black) terminal of the Ti-Lectro polisher's control box. A heavier clip known as the anode is attached to a rod, which in turn is mounted on a black Bakelite platform. The wire leading to the rod's mounting can be traced back to the positive (red) terminal on the control box.

8.53.3.4. Place the basket-like, cathode grid assembly in the bowl. Attach the cathode clip to the assembly's terminal tab. Attach the anode clip to the casting.

8.53.3.5. Submerge the casting and the tip of the anode clip in the Ti-Lectro® solution. The rod to which the anode clip is joined can be adjusted up or down so only the anode tip is in the solution. Always attach the anode clip to the posterior portion of palatal castings to prevent escaping gases from pocketing. Do not allow the casting to touch the cathode basket grid. Be certain the framework is completely submerged in the solution.

8.53.3.6. Switch on the control box and regulate it to the proper amperage. For each square inch of surface on both sides of a case, allow 2 amperes of electrical current. ***NOTE:*** For most cases, 6 to 8 amperes should be sufficient.

8.53.3.7. Set the time clock to 6 minutes for average castings immersed in electrolytic solution at 120 to 140 ^{o}F. Large horseshoes and those cases with deeply vaulted palates might require more time (8 minutes). Also, reverse the position of these cases in the anode clip after half the polishing time elapses. Take the framework out of the solution and inspect it. If the case is not bright enough, put it back in the solution for 2 more minutes.

8.53.3.8. After the case is polished, switch off the control box. Remove the Bakelite platform with its associated anode assembly from the bowl. Release the casting into the bowl containing an acid neutralizing solution. (A neutralizing solution may be made by dissolving 2 tablespoons of sodium bicarbonate in approximately one quart of water.) Dry the framework with an air blast.

8.53.3.9. As soon as possible, rinse the anode clip because the Ti-Lectro® solution attacks and corrodes it. ***NOTE:*** The Ti-Lectro® solution should be effective for up to 200 castings. Used solution is considered to be a hazardous waste and must be collected and disposed of according to local hazardous waste disposal procedures.

8.53.3.10. Some common problems associated with Ti-Lectro® polish are as follows: (***NOTE:*** Be sure the wiring on the unit is properly connected and inspect the unit for corroded contacts.)

8.53.3.10.1. If the casting whitens, but does not shine, ask the following questions:

8.53.3.10.1.1. Is the solution too cold? Is it stirred?

8.53.3.10.1.2. Is the solution contaminated with grinding and sandblasting dust?

8.53.3.10.1.3. Is too short a time allowed?

8.53.3.10.1.4. Is the amperage too low?

8.53.3.10.2. If the casting shows etching, ask the following questions:

8.53.3.10.2.1. Is the solution too hot? Was it stirred?

8.53.3.10.2.2. Is the casting in the solution too long?

8.53.3.10.2.3. Is the amperage too high?

8.53.3.10.3. If the polish is uneven, ask the following questions:

8.53.3.10.3.1. Is the case centered in the cathode basket grid?

8.53.3.10.3.2. Is the casting properly sandblasted?

8.53.3.10.3.3. Is the framework rinsed after sandblasting?

8.53.3.10.3.4. Is there oil contamination from the technician's hands or from a compressed air jet?

8.53.3.10.3.5. Are the teeth on the anode clamp corroded away?

8.53.3.10.4. If the casting has turned dark yellow-brown, water is in the polishing solution.

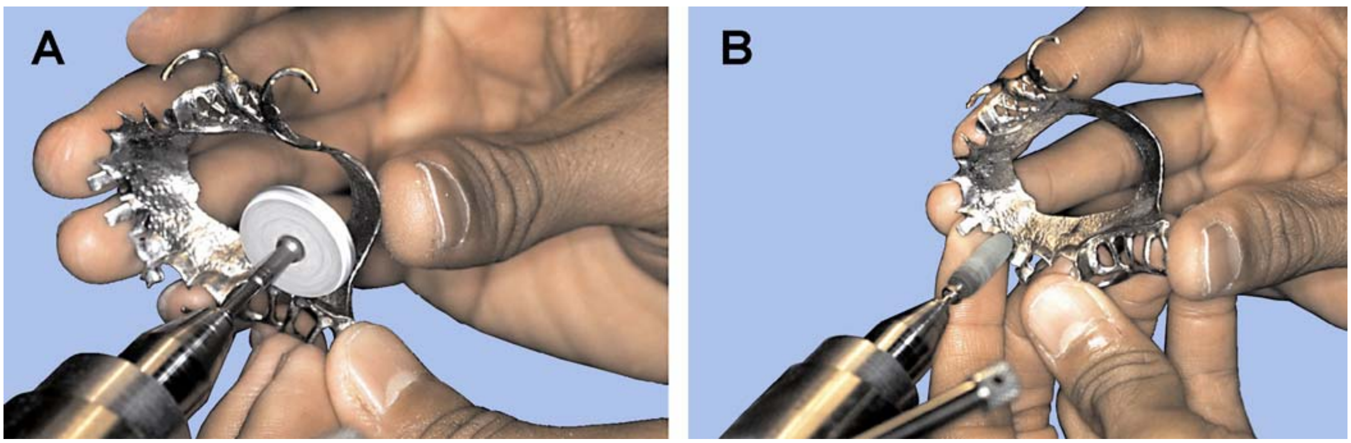
8.53.3.10.5. If areas of the casting have turned black, use a cooler solution. This is most likely to happen on cases with deeply recessed areas.

8.53.4. **Fine-Finishing:**

8.53.4.1. The objective of fine-finishing is to eliminate the gross scratch patterns left on the casting by preceding abrasives. Again, leave the tissue side of the palate alone.

8.53.4.2. Apply a rubber wheel to all areas of the casting that are accessible. Use rubber points or fine rubber wheels to get to the remaining areas (Figure 8.136-A and 8.136-B). Remember, rubber wheels and points can be modified into convenient shapes by holding a truing stone against them.

Figure 8.136. Fine-Finishing.



8.53.4.3. Fine-finish the clasp arms with fine stones, rubber wheels, and rubber points. The most important thing to remember about finishing clasp arms is to *be careful*. It is very easy to ruin a clasp arm's shape and make it more susceptible to breakage. An abrasive point can remove metal so fast that retention is gone before the technician is aware of it.

8.53.5. **Testing the Initial Fit of a Casting on a Duplicate Master (Fitting) Cast:**

8.53.5.1. Do not attempt the initial seating of a framework on the master cast itself (paragraph 8.43).

8.53.5.2. Under magnification and adequate lighting, thoroughly inspect the natural tooth and soft tissue side of the casting for nodules, bubbles, or any other imperfections. Devote special attention to rests, minor connectors leading to rests, and guiding plane surfaces in general.

8.53.5.3. Carefully remove the imperfections with the finest bur or abrasive device that can do the job.

8.53.5.4. If the casting still does not seat, apply disclosing pigment to reveal spots on the casting that might be keeping it from seating completely. Repeat application of the disclosing pigment, trial seat the casting and carefully relieve the spots that show up until the casting is seated. This process can take many repetitions and requires patience. Do not force the casting onto the cast. Because stone is softer than the metal casting, the cast will be abraded in areas of interference, damaging the cast and making it useless to determine if a proper fit has been achieved.

8.53.5.5. A framework is seated when all rests on the casting come into full contact with their rest seats.

8.53.6. **Seating the Framework on the Master Cast.** The rests and rest seats should be in complete contact. If not, repeat application of the disclosing pigment, trial seat the casting, and carefully relieve the spots that show up (as was done to fit the casting to the duplicate cast) until fit has been achieved. ***NOTE:*** Some dentists do not want the original master cast touched by the casting. Honor such a request.

8.53.7. **Correcting Major Occlusal Discrepancies:**

8.53.7.1. Notice discrepancies caused by the framework that prevent opposing teeth from coming into full maximum intercuspation. These discrepancies must be eliminated at this time. This emphasis is important because the occlusion is corrected again after the denture teeth are processed to the framework.

8.53.7.2. Why the duplication of effort? The only way denture teeth can be accurately positioned on a framework is for that framework to properly occlude against opposing teeth first. The objective in this step is to restore the patient's occlusal vertical dimension and to eliminate gross and obvious interferences in lateral and protrusive excursions.

8.53.7.3. Most of the time, the assumption is that the dentist will eliminate any remaining interference when the framework is tried in the patient's mouth. However, if the interferences are not eliminated before denture teeth are set and processed, the denture teeth will also prevent the natural teeth from coming into contact, magnifying the error.

8.53.7.4. Laboratory correction of a framework's occlusion does not ordinarily involve using an adjustable articulator set to match the patient's actual anatomical characteristics. It is likely that some form of simple, fixed-guided instrument will be selected for the job. Articulator choice depends on what the dentist orders and whether appropriate patient records are available (facebow transfer, lateral and protrusive jaw relationship records). In many instances, opposing casts that show a reproducible maximum intercuspation occlusion are mounted in that position. In other situations, record bases and occlusion rims might be necessary to relate the casts and perform the mounting.

8.53.7.5. For cast-mounting considerations and articulator adjustment procedures, see Chapter 6 (paragraphs 6.12 and 6.13) and Chapter 8 (paragraphs 8.40.2 and 8.40.3).

8.53.7.6. All castings do not require occlusion correction. An RPD opposing a complete denture might be an example. For cases requiring correction:

8.53.7.6.1. Remove the framework from the master cast.

8.53.7.6.2. Mount the master cast according to the dentist's prescription. (If the dentist did not want the casting tried on the master cast, use the duplicate master cast.)

8.53.7.6.3. Seat the framework on the master cast.

8.53.7.6.4. Restore the occlusal vertical dimension. Do all grinding on the casting. Continue the procedure until the incisal guide pin meets the incisal guide table. Most of the "high spots" will appear on rests and maxillary lingual plates. Metal in stress-bearing areas in its final, polished condition has to be at least 1 mm thick for strength. Stress-bearing areas include (1) areas where rests come over the marginal ridge, or (2) the minor connector of an embrasure clasp as it crosses the occlusal surface. Nonstress-bearing areas may be thinned to 0.5 mm.

8.53.7.6.5. Also, a lingual plate is not supposed to show perforations. The point is, if the rest or lingual plate is to the minimum allowable thickness and interferences on those components still remain, the only option is to stop grinding. Relieve the opposing natural tooth until the other natural teeth touch and draw a circle with a red pencil around the area of the opposing tooth that was relieved to alert the dentist. The dentist has to make a choice between thinning out the rest or lingual plate even more or reducing (cutting down) the opposing tooth.

8.53.7.6.6. Correct interferences in excursions. Eliminate working, balancing, and protrusive contacts between the metal of the casting and the opposing teeth in the posterior quadrants. Also, contact should not occur between the casting and opposing anterior teeth in working and protrusive excursions. If this contact is unavoidable, it should be made as light as possible.

8.53.7.6.7. Refinish the abraded areas as described in paragraph 8.53.4 and shown in Figure 8.136-A and -B.

8.53.8. **Polishing the Casting (Figure 8.137):**

8.53.8.1. Apply Ti-Cor on a felt wheel or point and go over the entire case until it takes a higher luster (Figure 8.137-A). A felt wheel can be softened or "fluffed" by soaking it in boiling water until it is thoroughly wet and then allowed to dry. Wheels treated in this manner will hold the polishing agents better. Always apply the polish to the top of the felt wheel. This helps prevent the polish from flying into the lathe's light bulb. For difficult to reach rugae surfaces, apply the Ti-Cor with a bristle brush. Always use plenty of polish on the felt wheel, felt point, and soft texture bristle brushes. The polishing compound produces the luster, not the wheel, point, or brush.

8.53.8.2. After going over the case with the felt wheel, use a size 12, 2-row, 1 7/8-inch brush on a bench lathe turning at slow speed (about 3400 rpm). Brush the case thoroughly, using generous amounts of Ti-Cor.

8.53.8.3. Prepare a heated solution of detergent to cleanse the particles of Ti-Cor from the casting. A 5-percent solution of ammonia and green soap makes a good cleaning agent. Use an ultrasonic unit if available. A steam cleaning unit may also be helpful.

8.53.8.4. Dry the framework. Apply Ti-Hi to a felt wheel and use it on a bench lathe to obtain a brilliant, lasting luster. Exercise extreme care if using a rag wheel because a framework is easily caught (Figure 8.137-B).

Figure 8.137. Final Polishing of the RPD Framework.

8.53.8.5. Clean the framework with soap solution and a denture brush. Place the casting in an ultrasonic cleaner for 10 minutes. Rinse off the cast in hot water and allow it to air dry.

8.53.8.6. Disinfect and send the framework to the dentist for trial and adaptation in the patient's mouth.

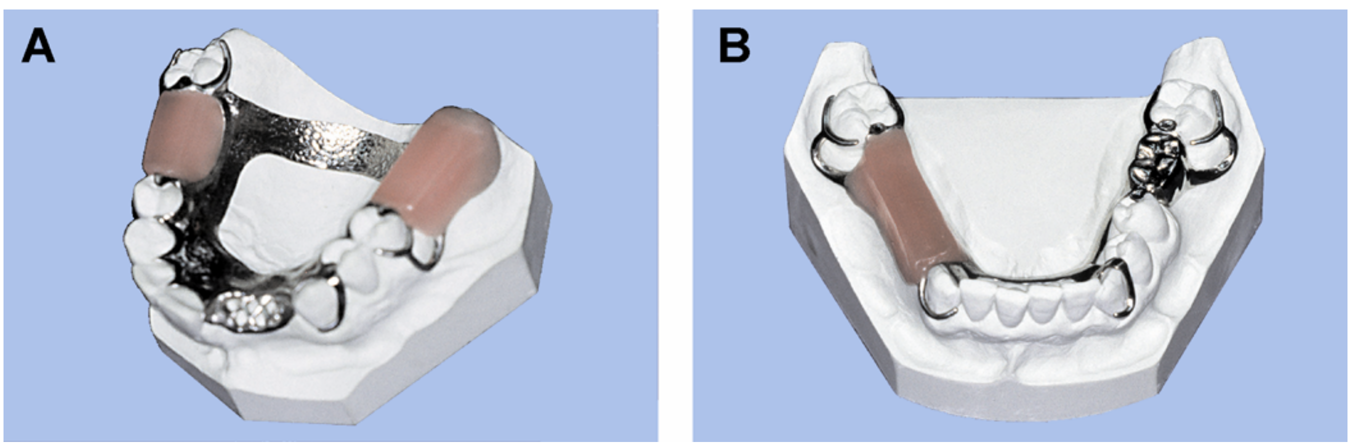
Section 8H—Fabricating, Processing, and Finishing an RPD Denture Base

8.54. Introduction to Resin Base Fabrication:

8.54.1. After the dentist receives the finished framework from the laboratory, the casting is seated and adapted in the patient's mouth. All occlusion interferences attributable to the framework are eliminated. Before artificial teeth can be positioned, mount the lower cast in proper relation to the upper cast.

8.54.2. Occlusion rims are not usually necessary in cases where enough natural teeth are present to locate a reproducible maximum intercuspation. The dentist may determine that occlusion rims are needed to relate the lower cast to the upper. The occlusion rims are ordinarily attached directly to the framework (Figure 8.138). ***NOTE:*** A separating medium must be placed between the cast and the wax when making occlusion rims on a framework. *Adapt a layer of tinfoil to the edentulous area,* seat the framework, and apply the molten wax for the occlusion rim. Be sure to take the foil out before flasking the RPD.

Figure 8.138. Occlusion Rims.



8.54.3. The dentist modifies the occlusion rims, makes a jaw relationship record on the patient, and then sends the framework to the laboratory for addition of resin denture base and artificial teeth. (The casts and other associated material are included.)

8.55. Procedures for Arranging Teeth and Waxing an RPD Base:

8.55.1. **Mount the Casts.** Follow these steps:

8.55.1.1. Key the base of the cast. The keys accurately reestablish the original position of the cast on its mounting after the resin processing. This remounting procedure is important for correcting processing errors.

8.55.1.2. Mount the upper cast in an average manner (Chapter 6, paragraph 6.12). Use a facebow transfer if the dentist supplies it.

8.55.1.3. Invert the articulator. Place the lower cast in occlusion against the upper in the manner the dentist prescribes (for example, maximum intercuspation contact between casts, interocclusal record).

8.55.1.4. Stabilize the assembly with modeling plastic and metal rods (coat hanger wire).

8.55.1.5. Mount the lower cast.

8.55.2. **Select Denture Teeth.** Plastic denture teeth are almost universally chosen for attachment to RPD retention grids. As far as the esthetic problem is concerned, the dentist tries to choose artificial teeth that blend with the color and shape of remaining natural teeth. If so few natural teeth remain that the only information they provide is basic shade, tooth selection considerations are the same as those for complete dentures. The 0-degree posterior teeth are rarely used because the cusped tooth forms (20- and 30-degree posteriors) are easier to arrange against natural teeth.

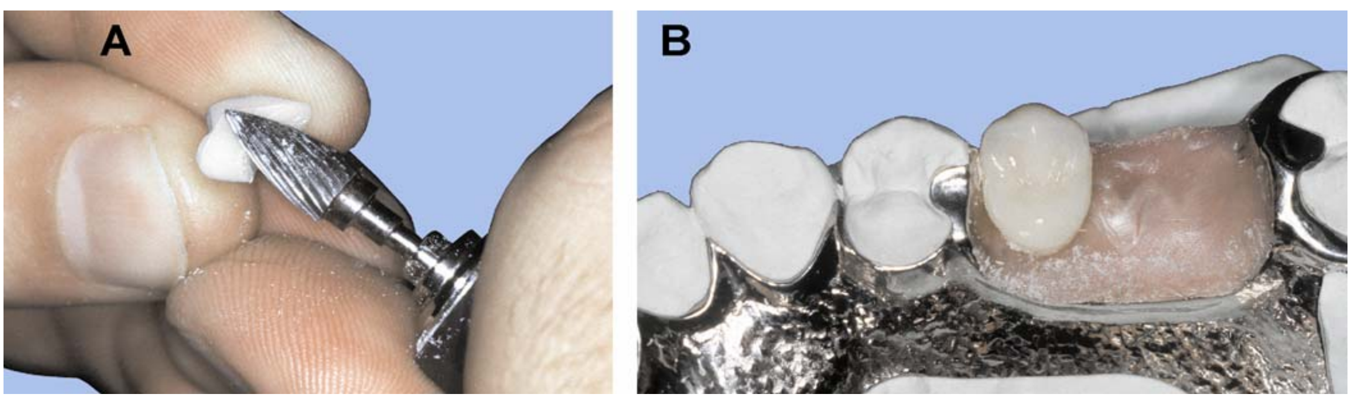
8.55.3. **Arrange Denture Teeth:**

8.55.3.1. **Procedures for Arrangement:**

8.55.3.1.1. Adapt tinfoil to the edentulous areas of the cast under the framework retention grids. *This step is not necessary if the dentist does not ask for a try in.* Place the framework on the cast and flow wax through the retention grids to stabilize the framework while the teeth are being set. Position the teeth in maximum intercuspation (MI).

8.55.3.1.2. Hollow grind the ridgelap if needed to preserve the facial surfaces. Contour the proximal surface of a denture tooth to make it fit more closely against a minor connector if necessary (Figure 8.139).

Figure 8.139. Denture Tooth Adaptation.



8.55.3.1.3. Set posterior teeth a little high (0.5 mm) in occlusion. Grind the occlusal surfaces to develop the best possible occlusion with teeth in the opposing arch. This setting and subsequent alteration procedure is done on a tooth-by-tooth basis. ***NOTE:*** Remember, do not set denture teeth on a maxillary tuberosity or a mandibular retromolar pad. When all artificial teeth are set and adjusted, the incisal guide pin must touch the incisal guide table.

8.55.3.2. **Denture Tooth Alignment and Occlusion Considerations:**

8.55.3.2.1. **Anterior Teeth.** From an alignment point of view, artificial anterior teeth are supposed to blend with the remaining natural teeth. Denture teeth may be ground in any way to achieve that goal, short of grossly weakening or disfiguring them as follows:

8.55.3.2.1.1. **RPD With an Anterior Toothborne Portion.** Artificial anterior teeth should not be subjected to working excursion contact. If working side contact is unavoidable, it should be distributed among as many artificial and natural teeth as possible. An isolated artificial tooth should not bear the full load of a protrusive excursion because it cannot stand such abuse for long. It will probably break out of the supporting denture base.

8.55.3.2.1.2. **RPD With an Anterior Extension Portion.** Arrange artificial anterior teeth to balance with the working excursions of the remaining natural anterior and posterior teeth. Protrusive balance is also desirable in these situations. It tends to minimize anterior tipping forces and anterior residual ridge resorption. However, achieving protrusive balance can generate esthetic problems such as incorrect alignment or shortening of artificial anterior teeth. When making a choice between esthetics and protrusive balance, the tendency is to favor esthetic values because they usually represent the dominant consideration in anterior areas.

8.55.3.2.2. **Posterior Teeth:**

8.55.3.2.2.1. **In Maximum Intercuspation (MI).** The maximum number of contacts must be developed between upper and lower posterior teeth bilaterally.

8.55.3.2.2.2. **In Lateral Excursions:**

8.55.3.2.2.2.1. It is recommended that natural teeth should bear most of the contact load in a working excursion. The posterior teeth of an RPD should be positioned and shaped to avoid working and balancing contact with teeth in the opposing arch. For this recommendation to work well, the case must show at least some anterior guidance (adequate vertical overlap with almost no horizontal overlap between upper and lower natural anterior teeth). In cases with little or no anterior guidance, the occlusal surfaces of posterior denture teeth might have to be ground off substantially to conform to the recommendation.

8.55.3.2.2.2.2. In the previous paragraph, notice the use of the word *recommendation,* as opposed to a word like *rule.* There are many schools of thought on this subject. When in doubt, check the dentist's directions. There are situations where *balanced occlusion* between the RPD and the teeth of the opposing arch might be the occlusion scheme of choice (for example, long, bilateral distal extensions, a combination anterior and posterior extension case, and the RPD opposes a complete denture). These examples are difficult cases that inevitably require compromises. Ask the dentist for help if there is any question.

8.55.3.2.2.3. **In Protrusive Excursions.** Except for an RPD that involves an anterior extension or an RPD that opposes a complete denture, straightforward protrusive balance is not desirable.

8.55.4. **Wax Up the RPD.** The principles followed for waxing up an RPD are similar to those that apply to waxing complete dentures (Chapter 7, Section 7R). A few differences are as follows:

8.55.4.1. **Wax-Up for Try-In:**

8.55.4.1.1. The assumption is that the dentist might mar the wax-up by making alterations in the denture tooth position. With a basic, uncharacterized wax up for try-in, gingival areas are waxed and carved the same as complete dentures. The borders of the flanges should extend to the blue pencil outline placed on the cast by the dentist at the time the design was drawn. In distal extension cases, the denture base should cover the maxillary tuberosity and the mandibular retromolar pads.

8.55.4.1.2. One of the places where the resin base joins with the framework is at an external finish line. The contour of the resin base must smoothly transition into the contour of a framework across a finish line. While the wax try-in is in progress, all changes the dentist requests should be made.

8.55.4.2. **Final Wax-Up:**

8.55.4.2.1. The try-in is over, and the dentist returns the case to the laboratory for processing. *Recall that a case waxed for try-in might have tinfoil stuck to the tissue surface of the wax base. Carefully strip out the tinfoil.*

8.55.4.2.2. Fully seat the framework and the wax base on the cast in the articulator. Double check to be sure the framework is fully seated and no wax or debris has gotten between the framework and the cast.

8.55.4.2.3. With the artificial teeth in proper maximum intercuspation against the opposing arch, seal the wax base to the cast. Perform a fully characterized wax-up that blends with the patient's gingival and alveolar mucosal features (Figure 8.140).

Figure 8.140. Denture Teeth Set and Denture Bases Waxed.

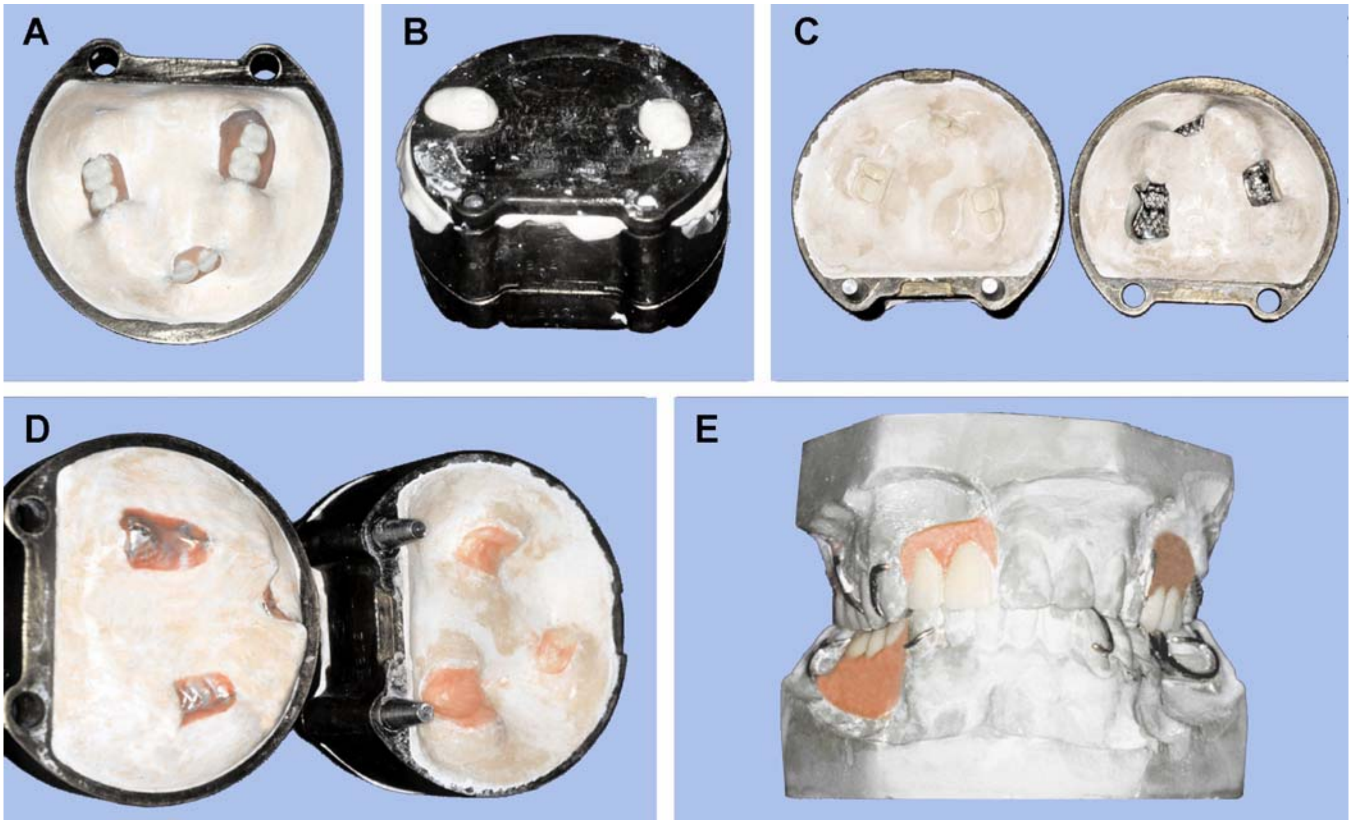
8.55.4.2.4. Remove wax from clasp arms so they do not become embedded in plastic during the packing and processing procedure. Extend a flash of wax just over the external finish lines to allow for finishing the resin back to a smooth transition between the metal and resin. Also extend the borders of the flanges slightly beyond the blue pencil outline drawn on the cast. The overextension allows for loss of resin material during finishing and polishing the processed denture base.

8.55.4.2.5. Extend the wax into the sulcus rolls if there is no guiding blue line. Remember the rule concerning tuberosity and retromolar pad coverage.

8.56. Processing an RPD Base:

8.56.1. **Flasking and Boilout of the RPD (Figure 8.141).** Flasking an RPD is similar to flasking a complete denture (Chapter 7, Section 7S), but the framework is held in position on the cast in the lower half of the flask during the entire boilout, packing, and processing procedure. Use a method of this kind to maintain the correct relationship of the framework to the cast. A disadvantage of this method is that the presence of the framework complicates applying the separating medium after the boilout but before the packing. The following procedures are used:

Figure 8.141. Flasking, Packing, and Processing RPD Bases.



8.56.1.1. Fit the cast into the lower half of the flask. Trim the cast to adequately clear the flask's walls. Soak the cast in saturated SDS for about 15 minutes. Apply a separating medium, such as liquid soap, to the base of the cast to protect the integrity of any keying grooves that might be present.

8.56.1.2. Half-flask the case (Figure 8.141-A) by covering the tops of any stone teeth present on the cast. Also cover all clasps, bars, and metal plates. Do not cover the denture teeth or the wax-up. When the dental stone sets, contour the surface so there are no undercuts. Apply a separating medium (liquid soap) to all exposed dental stone surfaces.

8.56.1.3. Use the *stone cap* method to full-flask the case. Let the dental stone set for at least an hour (Figure 8.141-B).

8.56.1.4. Place the flask in boiling water for about 4 1/2 minutes to soften the wax denture base (Figure 8.141-C). From the boiling water, remove the flask, open it, and eliminate all the wax from the mold. Use the same method (wax boilout) for removing the wax from complete dentures.

8.56.1.5. Apply a tinfoil substitute:

8.56.1.5.1. The presence of tinfoil or a tinfoil substitute on cast and mold surfaces during acrylic resin processing is just as necessary for an RPD as it is for complete dentures. If a separating medium is not applied, the processed denture will be covered with a crust of acrylic resin mixed with stone particles.

8.56.1.5.2. Two coats of tinfoil substitute are painted over all mold surfaces. Avoid getting tinfoil substitute on the ridge laps of the denture teeth. Be sure to paint the denture base areas of the cast. Work the tinfoil substitute under the retention grids. Do not use so much that there is a heavy, obvious fluid buildup. This is a step where the advantages of open ladder retention as opposed to mesh are quickly appreciated. It is much easier to get under the open form of retention grids. Carefully rinse any excess tinfoil substitute from the retention grid.

8.56.2. **Mixing, Packing, and Processing the Acrylic Resin (Figure 8.141-D):**

8.56.2.1. Follow the manufacturer's directions for monomer-polymer proportions and determine the proper packing consistency (early dough or "snap" stage). Handle acrylic resin with gloved hands to prevent contamination.

8.56.2.2. After the resin has reached packing consistency, press some of the mass around the denture teeth until the upper half of the mold is about half full. Then work another portion of the acrylic resin under and around the retention grids until the lower half of the mold is also partly filled. Use enough material to ensure overpacking on the first closure of the mold.

8.56.2.3. Place one or two sheets of separating film between the upper and lower halves of the flask. Place the two flask halves together carefully. Follow the same trial packing ritual previously outlined for complete dentures. (Two or three trial packs are usually required before metal to metal contact of the flask halves is achieved.) Use fresh sheets of separating film for each successive opening and closing.

8.56.2.4. When completing the trial packing, moisten the surfaces of the acrylic in the upper and lower molds with monomer. Discard the separator sheet, close the flask, and process the case in the same manner as complete dentures are processed.

8.57. Finishing the RPD:

8.57.1. **Deflasking the RPD.** Use the ejector press to separate the RPD mold from the flask. Saw through the outer walls of the mold and pry the sectioned pieces away from the cast and the RPD (Figure 8.141-E). Avoid lifting or otherwise displacing the RPD from the cast. Pick off the gross debris and clean the denture teeth with a brush, but *do not shellblast the case.* Shellblasting inevitably lifts the resin base away from the cast and ruins the opportunity for reestablishing the occlusion of the RPD at this time.

8.57.2. **Remounting the RPD.** Reposition the stone casts on the original plaster mountings, using the indexing keys that were cut into the cast. Remount the deflasked RPD and the opposing cast on the articulator so processing errors can be corrected.

8.57.3. **Selective Grinding the RPD (Figure 8.142).** When selectively grinding an RPD case, only artificial teeth can be altered. Modify the directions given for selectively grinding complete dentures to conform to the following:

8.57.3.1. **Reestablish the Occlusal Vertical Dimension.** Bring the incisal guide pin into contact with the incisal guide table.

8.57.3.2. **Adjust the Eccentric Excursions.** There should have been a plan for eccentric tooth relationships when the artificial teeth were initially arranged (anterior guidance, unilateral balance, and bilateral balance). Grind the artificial teeth to conform to that original plan.

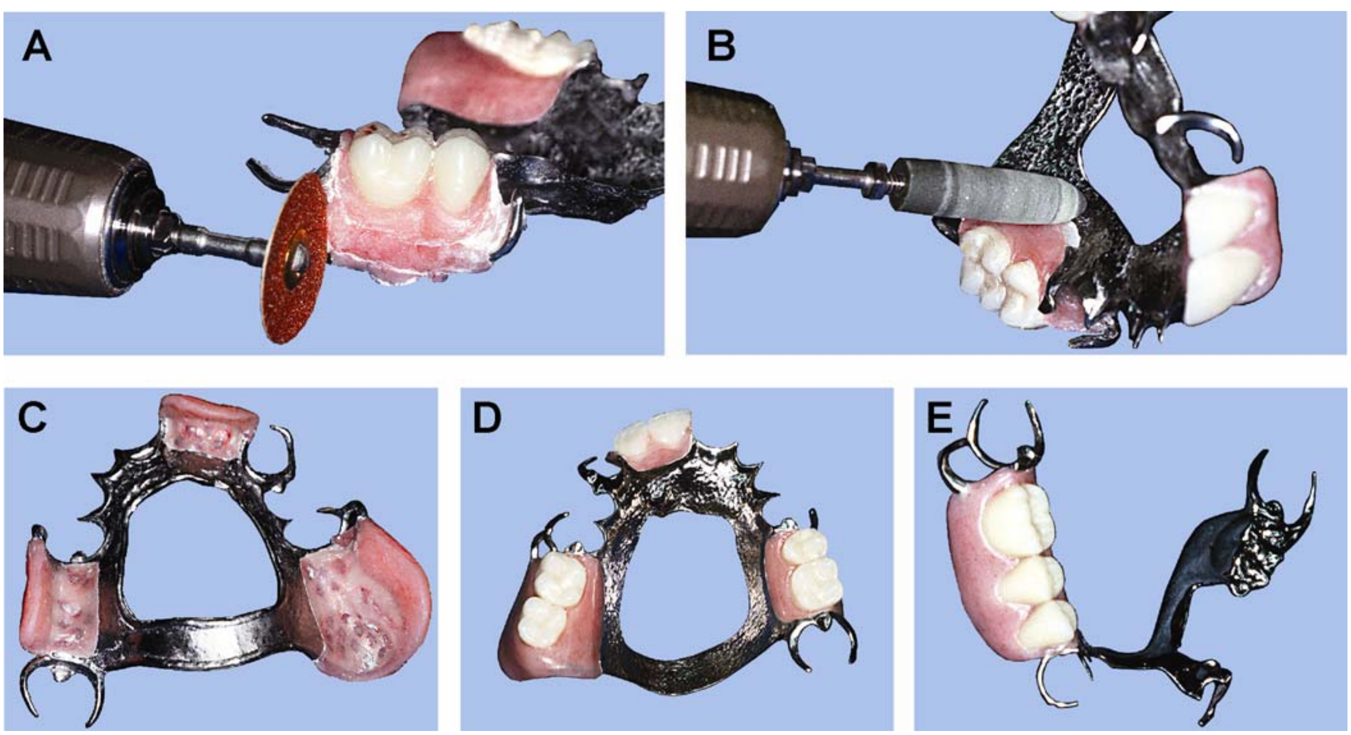
8.57.4. **Recovering the RPD From the Cast.** With a bur or a sharp knife, cut through the stone tooth under each clasp to relieve the clasp of all strain during the recovery process. After each clasp has been freed, carefully saw into the base of the cast in the same manner as for the recovery of a complete denture. Insert a plaster knife into the saw cuts and gently fracture the cut sections.

Do not apply force to the clasps or connectors while the sections are being removed. Finally, taking care not to distort the clasp arms, take the stone teeth out of the clasp assemblies.

Figure 8.142. Restoring Occlusal Vertical Dimension.

8.57.5. **Finishing the RPD.** Fit an arbor band on a lathe and remove the flash of acrylic resin from the denture border. If there is any doubt about a border extension, leave it long until a dentist indicates otherwise. Use a sharp pick to remove any flash or stone from around the necks of the teeth. Finish the areas around the clasp assemblies and finish lines with special care so the parts of the framework are not marred, weakened, or distorted. Use burs, sandpaper disks, or abrasive strips that are specifically made for the purpose of freeing the arms of the clasps from the denture base material so their flexibility is not impaired (Figure 8.143).

Figure 8.143. Completed RPDs.



8.57.6. **Polishing the RPD.** Polishing RPDs is similar to polishing a complete denture, but is significantly more hazardous. There is danger that the RPD could be damaged. Wear protective eyeglasses. Cover the clasp tips with the fingers. Do not allow the arms of the clasps or other RPD projections to become entangled in the revolving brushes or wheels. Make certain the brush or rag wheel is spinning *with* the direction a clasp arm is taking. Produce a final, high luster on the resin and metal parts of the RPD. Clean off the polishing compounds and disinfect the prosthesis. Place the case in a sealable plastic bag that contains a cotton roll moistened with a few drops of water.

8.58. Veneering an RPD Framework With Resin. The substructure design characteristics for resin veneers are described in paragraph 8.46.3. Following are the procedures for applying composite resin to a completed RPD framework:

8.58.1. **Applying a Bonding Agent.** Some composite resin systems use a chemical bonding agent that is applied to the metal substructure to strengthen the bond between the metal and the resin. This is usually accomplished by blasting a chemical coating to the metal that allows a chemical bond between the metal substructure and the resin veneer (Figure 8.144-A).

8.58.2. **Applying and Processing the Opaque:**

8.58.2.1. The area to receive the veneer must be clean of all dirt, oil and debris. Seal any areas of the cast where the resin material may overlap onto the stone.

8.58.2.2. Select the opaque for the desired shade and shake the bottle well. The opaque should have a creamy consistency. With a small sable brush, apply several thin, even coats of opaque to the casting (Figure 8.144-B). Allow each layer to dry at room temperature for about 15 minutes. Close the bottle tightly after application because the solvent is very volatile and evaporates easily.

8.58.2.3. Recheck the opaque area for complete coverage. Reapply opaque to any areas where metal can still be seen through the opaque.

8.58.2.4. Accomplish special shading effects by staining different areas within the opaque layer. For example, add blue stain to the incisal portion to create the appearance of translucency. Add orange stain at the gingival when the dentist's prescription calls for light gingival staining.

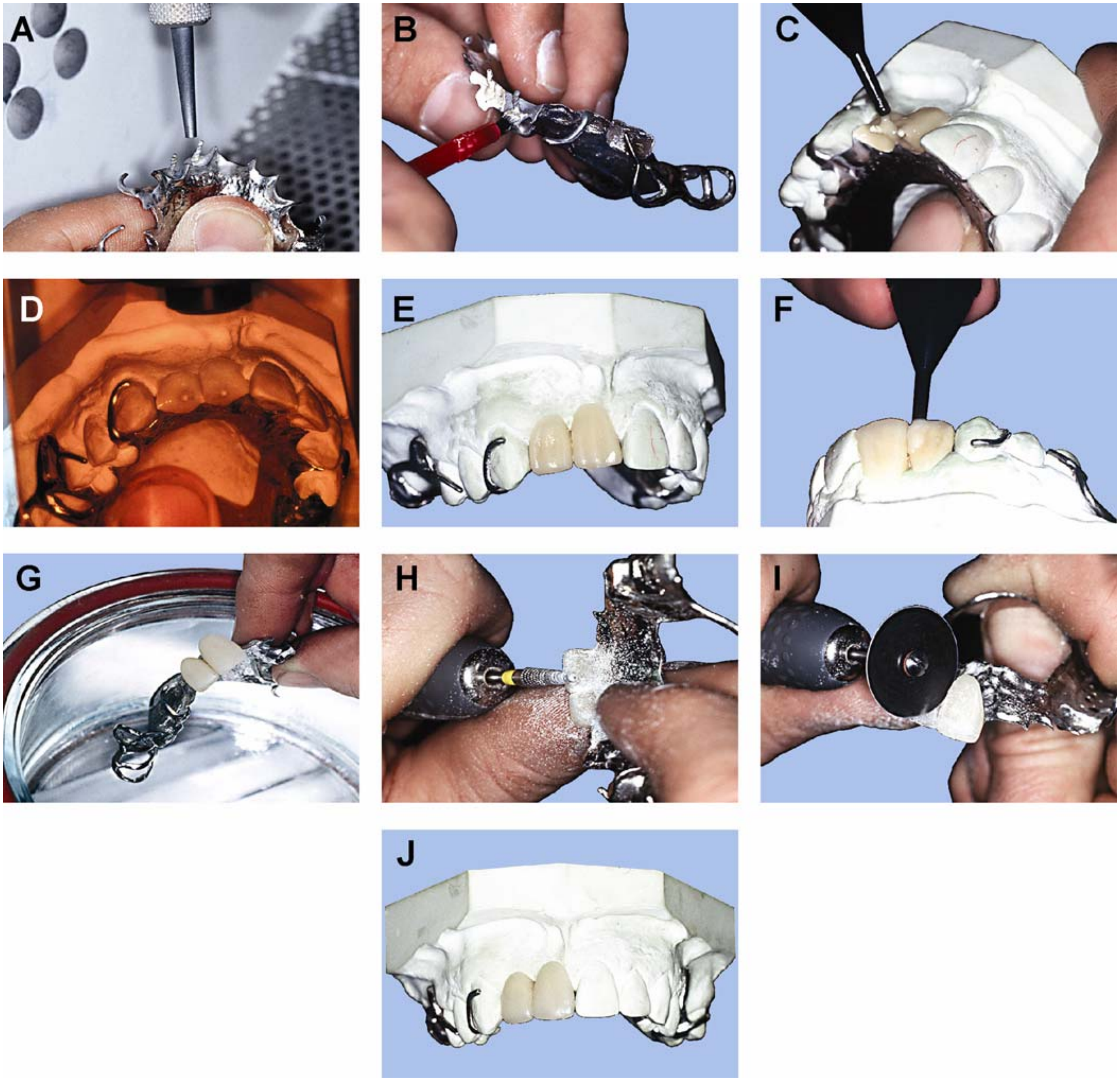
8.58.3. **Applying and Processing the Dentine and Enamel Layers:**

8.58.3.1. Resin comes in ready-to-use dispensers and consists of dentine, incisal, effect, and intensive materials in different shades. The pastes may be mixed or layered to achieve various effects. They may be applied with the framework on or off the cast, depending on whether the veneer will overlap onto the ridge area of the cast. They may be applied directly from the tubes onto the framework or they may be placed on a glass slab and applied with a brush or instrument.

8.58.3.2. Be careful to keep unset material out of bright light or it will begin to harden prematurely. For the same reason, recap the tubes when they are not being used.

8.58.3.3. Apply approximately 1 mm of dentine paste and cure it under the alfa light for 5 seconds (Figure 8.144-C and -D). The light comes on automatically when the work is placed under the unit. This hardens the material enough that it may be shaped if necessary with stones or burs. Additional layers of dentine, enamel, and effect pastes may be added in layers until the desired contour is achieved (Figure 8.144-E and -F).

Figure 8.144. Veneering an RPD With Resin.



8.58.3.4. When the buildup is completed, remove the framework from the cast and place the RPD into the curing unit (Figure 8.144-G). Close the lid and activate the machine. Complete processing in the curing unit takes about 15 minutes. If the veneer will be more than 11 mm thick, process it in increments in the curing unit as the thickness of each layer approaches 11 mm.

8.58.3.5. After processing, the veneer may be shaped and contoured with stones, burs or disks (Figure 8.144-H and -I). Carefully trim around the edges of the veneer to blend the resin into the contours of the metal. After the veneer is cleaned of any dust and debris, it may be polished the same as any resin (Figure 8.144-J).

Section 8I—Altered Cast Technique for Fabricating Distal Extension RPD Bases

8.59. Introduction. An altered (or corrected cast) is a master cast for an RPD framework that has had its tissue areas modified by a secondary impression (Figure 8.145). After a master cast is made with the usual single impression, a dentist might choose to make another "corrected" or "functional" impression in a case that involves unilateral or bilateral distal extensions. The corrected impression is used to modify or alter distal extension areas on the master cast. The dentist makes the corrected impression and alters the master cast after confirming the framework fits in the patient's mouth and before arranging the artificial teeth. The procedure is designed to ensure the best possible soft tissue support for a distal extension denture base.

8.59.1. **Fabricating the Custom Tray Fabrication.** To produce a corrected impression, the dentist needs a custom tray constructed over the framework's distal extension retention grid. After he or she fits and adjusts the framework, the dentist returns the framework with an outline of a proposed impression tray on the master cast. The steps in making this tray are:

8.59.1.1. Block out large undercuts with baseplate wax.

8.59.1.2. Seat the framework on the master cast. Be sure the rests are fully seated. Seated rests are the best indicators that the entire framework is in place.

8.59.1.3. Mix self-curing resin to a dough-like consistency. Adapt the material over the edentulous areas to form a tray that is firmly attached to the retention grids. After the resin polymerizes, lift the framework with the attached tray from the cast (Figure 8.145-A through -E).

8.59.1.4. Trim the custom tray to the outline on the master cast. Trim away resin from the tissue side of the tray until it is almost even with the retention grid (Figure 8.145-F). This will give room for the impression material. Smooth any sharp edges of the tray and return the tray to the dentist.

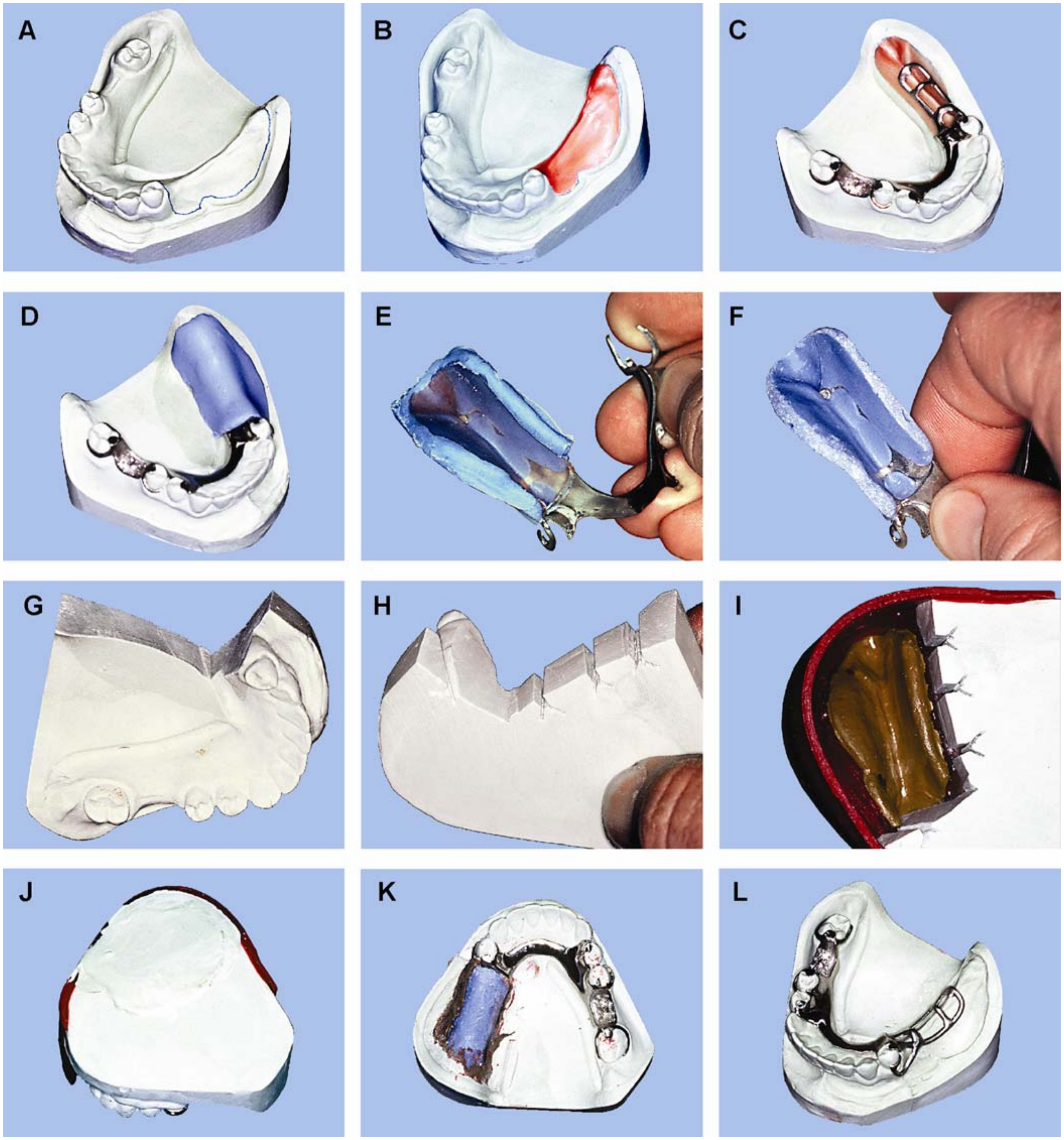
8.59.2. **Making the Corrected Impression.** The dentist will make the corrected impression. He or she places an impression material of choice in the tray and the entire assembly (framework and all) is fully seated in the patient's mouth. The impression is then sent to the laboratory.

8.59.3. **Altering the Master Cast.** A corrected impression may have been made from any of a number of impression materials subject to varying amounts of distortion from different influences. For example, impression wax is easily distorted by heat or pressure. Zinc oxide eugenol is brittle and fragile; rubber base can distort relatively quickly over time; and polyvinylsiloxane is very stable, but may not adhere well to the custom tray. Handle the impression accordingly. Alter the cast to accept the new impression following these steps:

8.59.3.1. Use a spiral saw blade to cut across the distal extension, from buccal to lingual, on a line that passes 1 mm behind the distal abutment. Through the cast, make another cut that is parallel and lingual to the lingual sulcus to join anteriorly with the first cut. These two cuts are made to remove the distal extension tissue area (Figure 8.145-G). With the spiral saw or crosscut fissure bur, place multiple dovetails in the cut surface of the cast to form mechanical retention for the corrected addition (Figure 8.145-H).

8.59.3.2. Check to make sure there is no impression material on the tissue surface of rests, minor connectors, or major connectors. Place the framework and corrected impression on the prepared master cast. Check to see if any of the impression material touches the master cast. If it does, either the cast or the impression must be trimmed. It is usually best to trim the cast, but check with the dentist if there is a doubt. Ideally, there should be 1 to 2 mm between the impression material and the cast. Be certain all rests are in complete contact with their respective seats. Secure the metal framework to the dry master cast with sticky wax.

Figure 8.145. Corrected Cast Technique.



8.59.3.3. Around the borders of the impression, adapt a beading of utility wax the same as it was adapted for a complete denture. Box the impression and the cast to confine the flow of dental stone (Figure 8.145-I). Soak the base of the cast for about 5 minutes. Make sure the cut edges of the cast are moist so they do not absorb water from the new mix of stone.

8.59.3.4. Prepare a mix of vacuum spatulated stone, place the boxed assembly on a vibrator, and gently vibrate the stone in to the impression and retention cuts of the cast (Figure 8.145-J). *Check to be sure the framework is still seated properly on the master cast.*

8.59.3.5. After the stone sets, remove the boxing material (Figure 8.145-K). ***NOTE:*** Some dentists make a jaw relationship record right on top of the plastic tray after the corrected impression sets. If a jaw relationship record is present, pour the altered cast, rough trim and key the cast, and mount the altered and opposing casts before making any attempt to remove the framework and tray from the altered cast.

8.59.3.6. Place the altered cast in a warm bath (135 ^{o}F) to soften the corrective impression material. Remove the framework and tray off the cast. Completely clean all debris from the altered cast (Figure 8.145-L).

8.59.4. **Preparing To Mount the Altered Cast.** Trim, key, and mount the cast if this has not already been done.

8.59.5. **Removing the Acrylic Resin Tray.** Flame the acrylic resin tray until it softens. Peel the tray off the framework. Wait until the framework cools to clean it thoroughly.

8.59.6. **Repositioning the Framework.** Seat the framework on the cast with all the rests in place. The retention grid's tissue stop may not touch the altered cast. ***Important:*** To compensate for this discrepancy, place a drop of autopolymerizing resin between the stop and the cast to take up the space. This prevents framework distortion when packing the denture base material.

Section 8J—Interim RPDs

8.60. Introduction. These prostheses were formerly called "temporary" RPDs. The word *interim* means "a period of time in between events." Before a conventional RPD is constructed, extraction sites must be well healed. Also, to replace an RPD that is broken, or one that no longer fits, may take a while. An interim RPD is a quick, inexpensive substitute for replacing the missing natural teeth. An interim RPD may be made with autopolymerizing, heat-processed, or light-cured acrylic with plastic denture teeth attached (Figure 8.146). Wrought wire clasps are frequently used to help retain the prosthesis in the mouth.

8.61. Interim RPD Procedures:

8.61.1. The dentist draws a design on the casts and sends the casts to the laboratory.

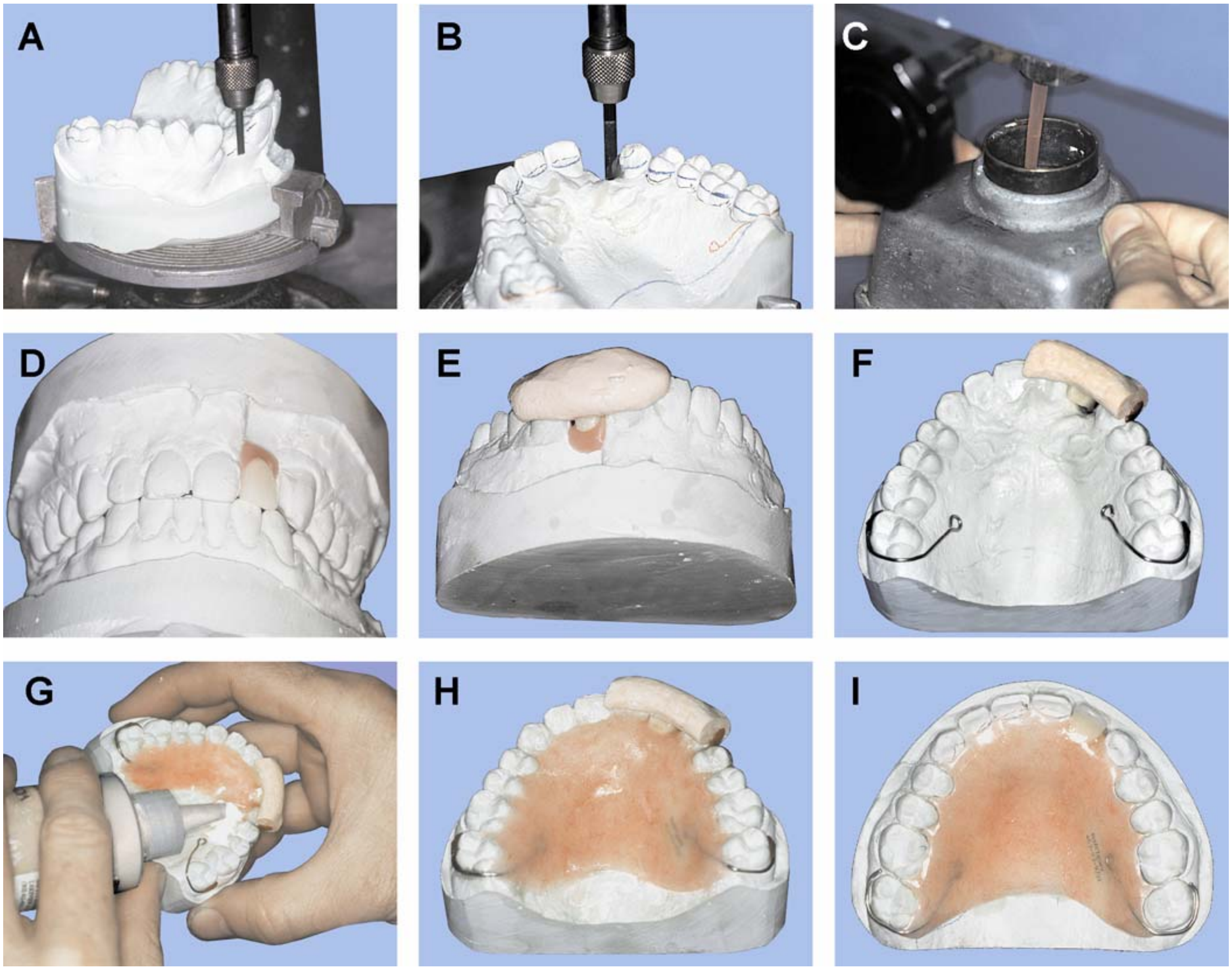
8.61.2. It maybe necessary to relieve the cast if denture teeth are to be butted against the edentulous ridge without the use of a facial flange (paragraph 8.46.1.2.1). Check with the dentist.

8.61.3. Bilaterally opposing undercuts on natural teeth and soft tissue vary in depth. Deep undercuts that are not blocked out before prosthesis fabrication can interfere with its placement in the patient's mouth. Survey the cast at a neutral (0 degree) tilt and mark the heights of contour on the remaining natural teeth (Figure 8.146-A). Also, mark the facial and lingual soft tissue heights of contour. Perform a 0-degree blockout of lingual and proximal tooth undercuts and flash a small amount of wax in the gingival crevices (Figure 8.146-B). Block out lingual soft tissue undercuts on mandibular casts. Carve the wax back 1 mm gingival to the survey line of each tooth. Round off any blockout wax ledges that might have been created.

8.61.4. Duplicate the cast, using the following steps (Figure 8.146-C):

8.61.4.1. Stand the cast on end in SDS for about 1/2 hour.

Figure 8.146. Interim RPD Construction.



8.61.4.2. Place the cast in a duplicating flask. Use reversible hydrocolloid or alginate as the duplicating material. If alginate is chosen, measure 2 to 3 times more water than the amount recommended for standard water-to-powder proportions to obtain a conveniently runny mix.

8.61.4.3. Pour the duplicate cast in vacuum spatulated dental stone.

8.61.5. Mount the cast against its opposing cast on a simple articulator.

8.61.6. Adapt plastic denture teeth to the duplicate cast (Figure 8.146-D). Grind the denture teeth to fit the edentulous spaces. Use the opposing cast for positional reference and construct a suitable matrix to record the placement of the teeth (Figure 8.146-E).

8.61.7. Bend the wrought wire clasps (Figure 8.146-F). The most commonly used wire clasp forms for interim RPD are the C, the Adams, and the ball (Chapter 9, paragraph 9.16.2). Adapt whichever clasps are requested, being certain to incorporate an adequate terminal bend or loop for mechanical retention in the acrylic resin denture base.

8.61.8. Relate the teeth and clasps to the duplicate cast. Paint the duplicate cast with tinfoil substitute**.** Use the matrix to reposition the denture teeth. Use sticky wax to attach the teeth to the matrix. Orient the wrought wire clasps in their proper positions. Be sure they do not interfere with the teeth or matrix. Fasten the clasps to the cast by applying sticky wax to the clasps on the facial surfaces of the abutments. Keep the wax from the denture-bearing areas.

8.61.9. Sprinkle autopolymerizing resin to form the denture base portion of the interim RPD (Figure 8.146-G and -H). The denture base should be 2 to 3 mm thick to minimize finishing. Place the assembly in a pressure pot under water at 110 °F, 20 psi for 10 minutes. (Alternately, the base may be processed using heat cured or light cured resin.)

8.61.10. Finish and polish the interim RPD. Lift it off the duplicate cast with a controlled jet of air. Finish it to conform to the dentist's outline. The finished denture base should be 2 to 3 mm thick. Polish the RPD. Try it onto the master cast to ensure it fits properly and goes to place easily (Figure 8.146-I). Place the prosthesis and a moist cotton roll in a sealable plastic bag until delivery. ***NOTE:*** It is possible to perform all of the procedures on the blocked out master cast without ever making a duplicate.

Section 8K—Performing an RPD Reline

8.62. Relining an RPD Resin Base. One convenient, satisfactory way of performing an RPD reline is to use autopolymerizing resin and a duplicating jig (Jectron, Hooper) as follows:

8.62.1. Relieve all undercuts on the tissue surfaces of the resin base areas to be relined. Grind enough old resin out to make room for a layer of impression material. Disinfect the RPD and return it to the dentist. ***NOTE:*** The dentist makes an impression in the patient's mouth, using the relieved denture base as the tray. The impression material sets while the framework is seated on the abutment teeth.

8.62.2. Box and pour the impression site only. Do not remove the resultant cast from the impression site until after the cast is mounted in the jig (Chapter 7, paragraph 7.182).

8.62.3. Make a stone patty on the bottom half of the duplicating jig. Float the occlusal and incisal aspect of the RPD into the patty. Sink enough of the denture teeth and major connector to form a perfectly reliable index. Do not sink the framework so far that its delicate parts are buried in the stone. The RPD must come out of the index without significant difficulty.

8.62.4. Moisten the base of the minicast poured in the sectional impression. Attach the minicast to the upper half of the jig. Be sure the top and bottom halves of the jig meet in metal-to-metal contact.

8.62.5. Proceed as with a complete denture reline (Chapter, 7 paragraph 7.182).

Section 8L—Review of the Swing-Lock System

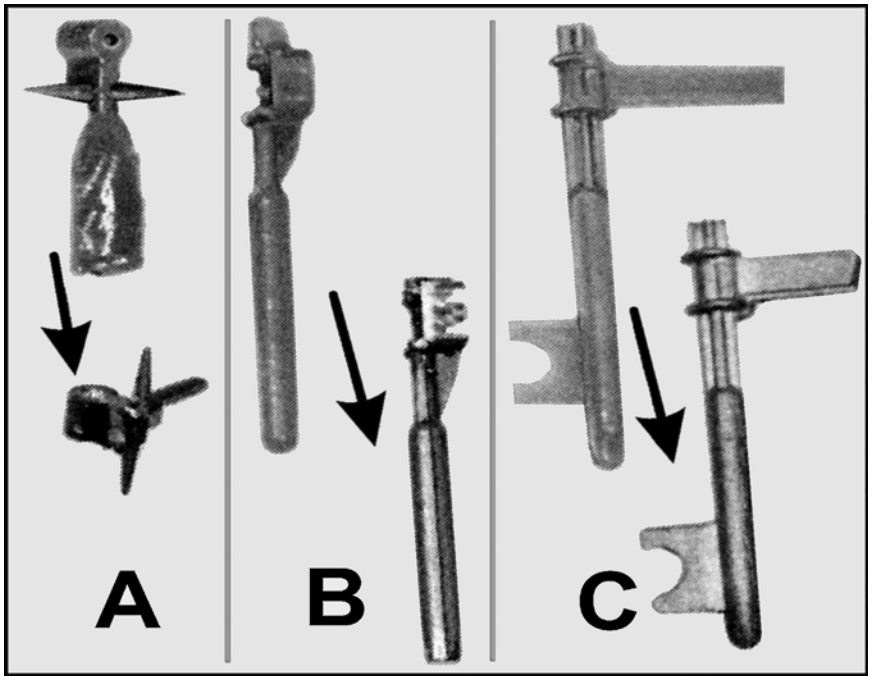
8.63. Prefabricated Hinge and Lock System. There are oral conditions for which RPDs with conventional clasps are inadvisable. *Swing-Lock* is the commercial name for a prefabricated hinge and lock system that can be substituted for clasps in an RPD framework.

8.63.1. A Swing-Lock RPD consists of labial and lingual sections. The labial part is hinged and locked to the lingual portion around the remaining teeth in the arch. The completed labial section can be all metal struts, a cosmetic gingival veneer or a combination of the two.

8.63.2. A Swing-Lock RPD may be indicated for the following reasons; (1) in the use of minimal, mobile, tilted, irregular, or otherwise questionable teeth as abutments for RPD; (2) for the splinting of mobile teeth, (3) in the cosmetic replacement of lost gingival tissues; and (4) for restoring cleft palates, post surgical, and accident cases.

8.63.3. The Swing-Lock attachments (Figure 8.147), hinge (A), hinge positioner (B), and lock (C) come from the company as plastic patterns that are then cast in the dentist's alloy of choice (Ticonium, Type IV Gold). After casting, the metal parts are positioned in the RPD framework wax-up, the rest of the framework (labial and lingual sections) is cast, and the Swing-Lock attachments become embedded in the metal.

Figure 8.147. Plastic Patterns and Resultant Castings.



8.63.4. The first thought is that the framework casting will completely fuse the Swing-Lock parts and that nothing on that RPD will ever hinge and lock. However, the hinge and lock develop a natural oxide coating before the framework is cast. The molten metal for the frame casting hits the Swing-Lock parts and intimately molds to them. However, the oxide coating prevents the molten metal from directly uniting with them. The result is a precision hinge and lock mechanism.

8.63.5. In the interests of familiarity, a review of the technique is presented in Figure 8.148. This technique is just another way the dentist can treat certain oral conditions.

Section 8M—RPD Repairs

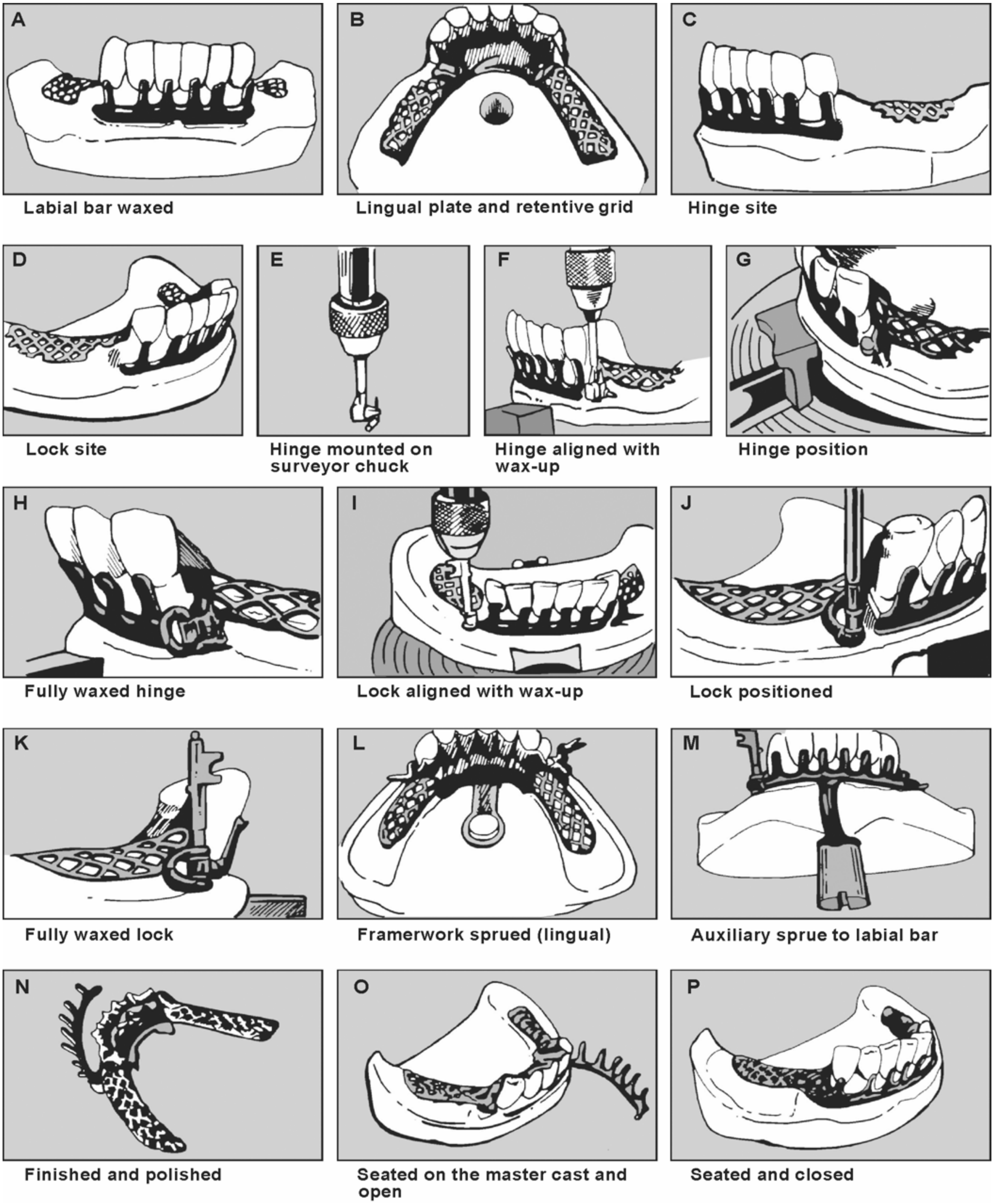
8.64. Overview:

8.64.1. The repair of or addition to an RPD is a very common laboratory request. Most repairs are not difficult; yet they require ingenuity, precision, and thoroughness to ensure long-term success.

8.64.2. For all but the simplest repairs, a stone matrix is required to position parts correctly so a proper fit in the mouth can occur. Sometimes for a fractured denture base or resin tooth, parts can be temporarily attached with sticky wax and then a matrix formed to align parts for the repair.

8.64.3. Quite often the dentist must do a pickup impression with the RPD in the mouth to produce a master cast or matrix. Because the prosthesis remains in the impression when poured, critical areas, such as undercuts and clasps, should be adequately blocked out with soft wax to allow removal of the RPD from the master cast without damage to the cast or RPD.

Figure 8.148. Swing-Lock RPD Fabrication.



8.64.4. After disinfection and blockout, the pickup impression should be poured immediately in stone or plaster. If a soldering procedure is needed, it should be done on a duplicate refractory cast and the original cast used for final fitting and finishing.

8.65. Repair and Addition to Denture Bases:

8.65.1. The laboratory procedures involved for this type of repair are similar to those for a complete denture.

8.65.2. Pieces are approximated and a matrix formed as previously described. After the stone matrix has reached its final set, the denture base fragments can be removed and the fracture line prepared. The fracture site should be examined to help determine the cause of failure, if possible, to avoid a repeat fracture. If the thickness of resin is less than 2 mm, the area should be trimmed back to provide bulk (thickness) for the repaired section. Edges of old resin should be prepared on each side of the repair line in the same manner as a complete denture repair (Chapter 7, Section 7AH).

8.65.3. Coat the matrix with tinfoil substitute and allow to dry. The fragments of the RPD base are then secured in position with sticky wax, and the repair is accomplished using autopolymerizing acrylic resin. The repair area should be overbuilt to allow for finishing. Place the prosthesis in a pressure pot containing warm water (110 ^{o}F) at 15 psi for 10 minutes for polymerization to occur. After the resin has fully set, finish and polish the repair.8.65.4. The extension of a denture base section is done in a very similar manner as described above, except the dentist must provide for the new area to be covered. The RPD may be extended with a compound or polysulfide rubber base or addition silicone impression as it is positioned in the mouth and then “picked-up” with an overlying alginate impression to allow pouring of a master cast for the addition.

8.65.4. The extension of a denture base section is done in a very similar manner as described above, except the dentist must provide for the new area to be covered. The RPD may be extended with a compound or polysulfide rubber base or addition silicone impression as it is positioned in the mouth and then “picked-up” with an overlying alginate impression to allow pouring of a master cast for the addition.

8.66. Resin Retention Repairs:

8.66.1. Where resin on a RPD joins to a polished metal surface, a finish line (or groove) in the metal should be created to allow for at least 1 mm resin bulk at the junction. The bulk resin decreases the tendency for fluids to seep into the gap between the metal and the resin causing discoloration and a space for microorganism growth. It is important to offset internal and external finish lines (that is, not directly overlying each other) to prevent overthinning of the metal (Figure 8.149).

8.66.2. Most resin (and tooth) additions can be attached chemically and mechanically to the adjoining old denture base. At times, mesh fragments from scrapped frameworks or wrought wire loops must be added to the framework by soldering to provide a surface for addition of a new part. Also, where little or no contact area is available for connecting new resin to old, 1 to 2 mm slots or holes can be made in the metal of the major connector to allow for mechanical retention of the added resin or denture tooth (Figure 8.150). Regardless, mechanical retention is essential for a successful addition.

8.67. Repairing Broken Artificial Teeth:

8.67.1. **Denture Teeth on a Resin Base.** Prepare the fracture site as you would for a complete denture tooth repair (Chapter 7, paragraph 7.174.3). Select, adapt, and attach a replacement tooth in a similar manner. If the old tooth is relatively intact, but just displaced from the denture base, it can be repositioned and reattached with autopolymerizing resin for a very simple repair. Mechanical retention in the resin tooth and denture base should be made in the form of a diatoric, dovetail, or grooves to optimize the strength of the repair because denture base resin does not fully bond to plastic denture teeth. A cast of the opposing dentition helps refine the occlusion.

Figure 8.149. Finish Line Cut Into an RPD Framework.

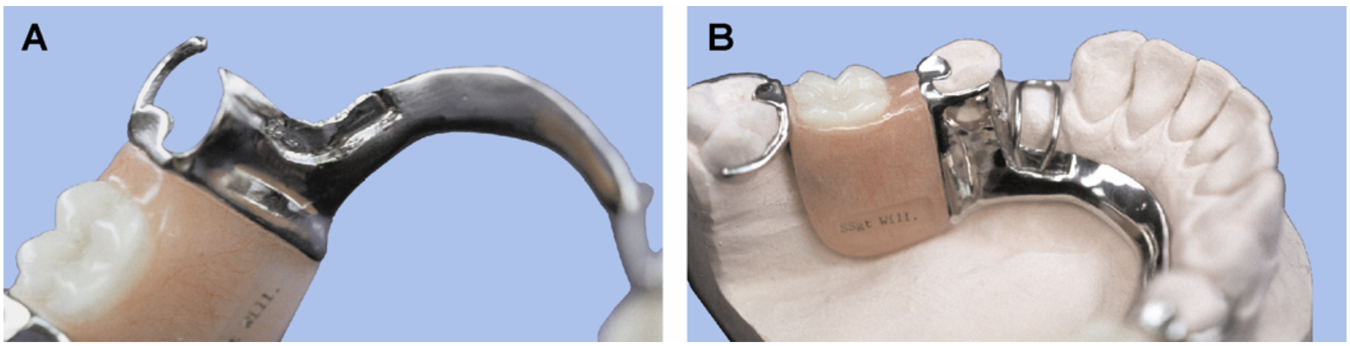
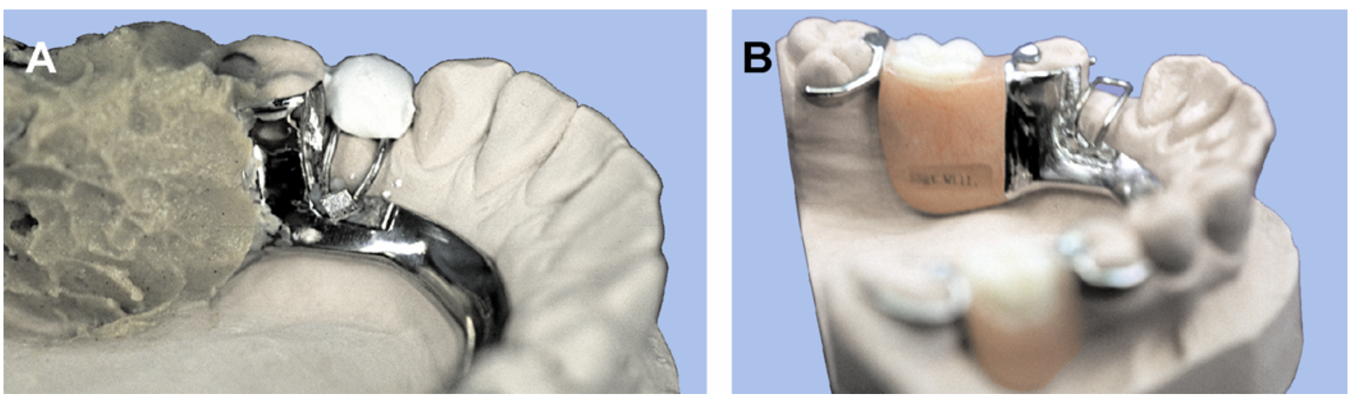


Figure 8.150. Retention Added to an RPD.



8.67.2. **Reinforced Acrylic Pontic (RAP) Repair:**

8.67.2.1. An alginate pickup impression of the RPD is usually needed for this repair. After disinfection, the impression should be adequately blocked out and poured in stone.

8.67.2.2. A new denture tooth is adapted to the RAP site, using the adjacent and opposing teeth as a guide, and luted in place with sticky wax on its lingual surface. A light coat of separator is placed on the adjacent stone teeth, and a facial plaster matrix is made. When the matrix is fully set, the tooth is removed and attached to the facial matrix with sticky wax on its incisal edge. The master cast is carefully coated with tinfoil substitute, and the denture tooth is attached using tooth colored autopolymerizing resin while being held in place with the facial matrix. The repair is placed in a pressure pot containing warm water (110 ^{o}F) at 15 psi for 10 minutes. Then it is finished and polished.

8.67.3. **Prefabricated "Channel and Post" Facings:**

8.67.3.1. Use a high-speed diamond bur to drill out fragments of the facing and clean the cement from the repair site.

8.67.3.2. Choose a replacement facing of proper shade and size. Adapt the facing to its backing on the framework. If it is obvious that a great deal of modification needs to be done, rub a #2 pencil lead across the metal backing of the framework. Slide the facing down the post. An area requiring grinding will show up on the facing as a mark.

8.67.3.3. After adapting as well as possible, give the facing and framework to the dentist for final adjustments and cementation.

8.67.4. **Repairing Braided Post Posterior Teeth:**

8.67.4.1. Use a bur to carefully drill out residue fragments around the braided post to allow room for replacement tooth.

8.67.4.2. Select a replacement acrylic resin denture tooth of proper shade and mold.

8.67.4.3. Take the tooth and drill a hole of a length and diameter that accommodates the supporting post.

8.67.4.4. Rub a #2 pencil lead on the post and metal seat for the tooth. Make the tooth conform to the seat by grinding the black marks that transfer over to the tooth.

8.67.4.5. Use self-curing, tooth-colored acrylic resin to attach the tooth in place.

8.68. **Addition of Artificial Teeth:**

8.68.1. Adding a tooth to an RPD is similar to replacing a broken resin tooth. An alginate pickup impression of the prosthesis is needed for a master cast for the procedure. A replacement resin tooth of proper shade and size is selected, ideally comparable to the tooth that was extracted or the contralateral tooth in the same arch.

8.68.2. Carefully adapt the tooth, as needed, and fabricate a facial or occlusal plaster matrix to hold the tooth in position for luting with autopolymerizing denture resin. The marginal ridges of the added tooth (or teeth) should be even with the adjacent tooth and the facial profile should follow the curvature of the arch. Do not place a resin tooth in excessive malalignment by attempting to make occlusal contacts.

8.68.3. When possible, the dental arch should be relatively symmetrical, and the contours created should be smooth with even transitions. Uneven contours or gross variations from the occlusal plane decrease patient comfort and adaptation. Before attaching the new tooth, be sure to provide mechanical retention in the form of slots or dovetails in the adjacent metal, denture base resin, and each added tooth.

8.69. Repairing Metal Framework Fractures and Distortions:

8.69.1. Metal frameworks display many kinds of fractures and distortions. Electric soldering may repair some if the fragments are big enough or the damage is not in a highly flexible area.

8.69.2. Some of the more common problems repairable by electric soldering are (1) minor connector leading to a clasp or auxiliary rest fractures, (2) distal extension grid fatigues and breaks off at the junction with the major connector, or (3) palatal strap or a lingual bar becomes twisted out of shape.

8.69.3. Although it is possible to make a rest out of solder or to solder a clasp arm at its shoulder, the odds that this type of repair might fail are high. Soldering is ordinarily done with the framework aligned on a cast. The dentist first makes an impression of the RPD seated in the patient's mouth. The RPD stays in the impression, the parts of the frame and the base that have no influence on the repair are blocked out, and a cast is poured in dental stone.

8.69.4. Because soldering applies high heat to the fracture site, the resin components of the RPD must be insulated against damage. A common practice is to provide protection by adapting wet tissue over all acrylic resin parts. Sometimes, however, wet tissue is not completely effective because the fracture site is too close to the resin area. Under these conditions, make a stone matrix to record the position of the denture teeth. Remove the teeth and base from the framework, perform the soldering operation, and then reattach the teeth with new acrylic to the framework.

8.69.5. To guarantee the integrity of any repair is a gamble. Many times, the strength of a repair is open to question. Too often, a design deficiency is responsible for the problem in the first place, and the repair solves nothing. From a practical point of view, the complexity and life expectancy of a repair must be weighed against the advisability of making an entirely new prosthesis. In the final analysis, highly complicated, time-consuming repairs of short-lived value are not justified unless the opportunity, talent, and equipment to make a new RPD are not available.

8.69.6. The electric form of soldering is especially useful for soldering near an acrylic resin denture base because heating is highly localized and the need to remove the denture base in performing the repair may be eliminated (Figure 8.151). An electric soldering machine works on the principle that all conductors of electricity offer resistance to current flow and become heated as a result. To solder, you should:

8.69.6.1. Prepare the framework by roughening the sections to be joined.

8.69.6.2. Adapt platinum foil to the dental stone cast under and around the break site, if necessary. The foil serves as a backing against which solder flows (Figure 8.151-A).

8.69.6.3. Seat the broken pieces of the framework on the cast and secure them with sticky wax.

8.69.6.4. *Use soldering investment* to hold the parts of the framework in correct position, but *do not use excessive amounts of investment.* Expose as much metal as possible (Figure 8.151-B).

8.69.6.5. Boil off the sticky wax after the soldering investment has set. Adapt wet tissue to the acrylic resin parts on both sides of the fracture line, if present.

8.69.6.6. Place the cast on a soldering stand.

8.69.6.7. Select a carbon tip that is adequate for the size of the repair. Make sure you adjust the machine to the proper settings for the work you are doing.

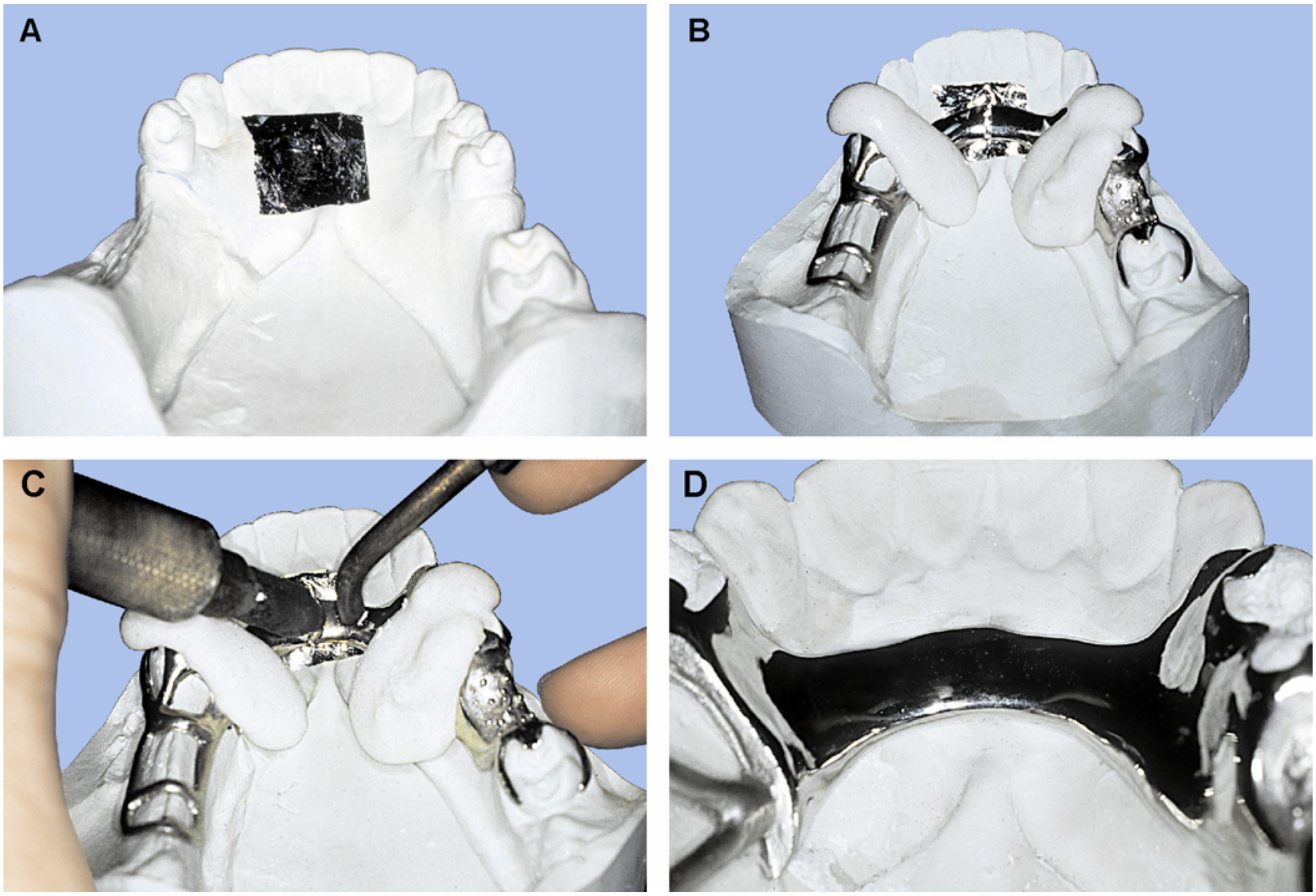
8.69.6.8. Generously apply flux in the joint area and over both sections. The application of flux is critical to the success of the repair. A flux with a watery consistency gives the best results.

8.69.6.9. Cut a piece of solder that is big enough to complete the repair on the first attempt and place it on the joint. The heat generated to melt the first mass of solder causes oxides to form that block the effective addition of more solder. Use *Ticonium triple-thick* white solder for electric soldering because the additional bulk of this solder retards melting long enough to let the framework parts heat up as well. The parts to be joined have to be as hot as the melting solder or satisfactory union does not occur.

8.69.6.10. Make the ground electrode contact the metal framework and wet the carbon tip in a bowl of water to improve current conduction before you turn the current on. Place the electrode firmly against the solder (Figure 8.151-C).

8.69.6.11. Press the foot pedal and allow time for the solder to flow freely. Release the foot pedal. *Never remove the carbon electrode from the solder while the foot pedal is depressed (that is, while current is flowing through the case).* Sparks will jump from the carbon tip to the solder causing surface pitting.

Figure 8.151. Soldering Procedures.



8.69.6.12. Remove the soldered framework from the cast and finish and polish as needed (Figure 8.151-D).

8.69.7. Torch soldering is used when the solder joint is long, or unusually bulky or when you need a large mass of solder to do the job. Use a gas that is a mixture of propane and oxygen and *Ticonium standard solder* for all torch soldering operations as follows:

8.69.7.1. Use a heatless stone to roughen the ends of the sections to be joined.

8.69.7.2. Adapt platinum foil to the stone cast so it extends under both sections.

8.69.7.3. Seat the broken sections on the cast in proper relationship and temporarily secure them with sticky wax. Flow sticky wax *into* the joint to be soldered.

8.69.7.4. Pull the broken parts of the RPD from the cast as one unit. Lay old burs across the two sections with a liberal amount of sticky wax. Use as many burs as needed to keep the fragments accurately related. Do not use wood sticks as a substitute for burs because, when the case is invested, water may cause the sticks to warp, jeopardizing the accuracy of the repair.

8.69.7.5. Carefully remove the framework from the cast. The platinum foil should come with it.

8.69.7.6. Adapt baseplate wax to the tissue side of the platinum foil. The edges of the wax must end 2 mm short of the foil edge on both sides of the break.

8.69.7.7. Embed the framework in soldering investment. The investment must hold the pieces of the framework together in correct alignment when the burs are removed. Cover the baseplate wax and platinum foil, completely exposing the oral side of the break and as much of the peripheral metal as possible.

8.69.7.8. After the investment sets, boil out the wax. Put the case in a dehydration oven at 190 ^{o}F for 1 hour to remove the moisture from the investment.

8.69.7.9. Regulate the flame of a propane-oxygen torch until the blue green tip is visible.

NOTE: This cone—the reducing part of the flame—is used for soldering.

8.69.7.10. Cover the joint thoroughly with flux. Next, lightly brush-flame the flux until it dries and has a powdery appearance.

8.69.7.11. Pick up the solder with a pair of tweezers and dip it into the flux. Heat the framework to a dull red glow with the reducing part of the flame. Feed the strip into the joint while you keep the framework hot with the torch. The heat of the metal pieces should melt the solder, not the direct application of the flame to the strip. (Direct melting of the strip causes over heating of the solder, which causes pitting.) Once you begin the solder procedure, you must complete it. Do not remove the flame from the work because cooling allows rapid oxide formation.

8.69.7.12. Remove the case from the investment and finish and polish it. Try the framework back on the cast for fit.

8.69.8. Common framework repairs are as follows:

8.69.8.1. **Warped Mandibular Lingual Bar:**

8.69.8.1.1. Use a disc to cut the lingual bar into separate right and left sections.

8.69.8.1.2. The dentist will seat the individual parts in the patient's mouth and make the required impression.

8.69.8.1.3. With the RPD sections seated in the impression, block out all framework and denture base undercuts that do not affect the successful completion of the repair. Pour the cast.

8.69.8.1.4. Follow electric soldering procedures to rejoin the RPD parts.

8.69.8.2. **Warped Maxillary Palatal Strap.** This repair differs significantly from the procedures used to repair the lingual bar. The line of separation between the metal sections is much longer, and the strap is a candidate for torch soldering rather than electric soldering. The denture teeth and all resin areas of the RPD must be removed and ultimately replaced.

8.69.8.2.1. Cut all the way through the major connector along the most severe part of the bend to produce both left and right sections. ***NOTE:*** *The dentist seats the pieces in the patient's mouth and then makes a complete arch impression.*

8.69.8.2.2. With the RPD sections seated in the impression, block out all framework undercuts and parts that have no effect on the repair's success. Remembering that denture tooth and resin denture base areas are also involved in a torch soldering repair, the tissue surface undercuts are not blocked out. The cast is poured in dental stone.

8.69.8.2.3. At this point, make an index of the denture tooth position relative to the framework. The side of the cast is notched adjacent to the resin teeth and denture base material that is going to be removed. A separating medium is applied to the base of the cast, and a plaster matrix that extends from the notch onto the occlusal and incisal edges of the denture teeth is made.

8.69.8.2.4. Remove the RPD from the cast. Take the denture teeth off the base by any convenient means, making every effort to preserve them intact. Heat-soften the denture base resin and separate it from the framework.

8.69.8.2.5. Place the stripped framework sections back on the cast. Proceed to mend the major connector by the torch soldering method described earlier.

8.69.8.2.6. Finish and polish the framework, fit it to the cast, and use the matrix to align the denture teeth in their original positions. There are two ways teeth can be reattached to the framework in a new denture base: (1) autopolymerizing resin can be sprinkled into place, or (2) the areas can be waxed to contour and then invested and processed with heat cured acrylic.

8.70. Clasp Assembly Repairs:

8.70.1. **Clasp Arm Breaks.** The most common kinds of clasp damage are for one of the arms of a circumferential clasp to break off or to fracture a bar clasp approach arm:

8.70.2. **Circumferential Clasp Arm.** When such a break occurs adjacent to an area that carries a resin denture base, the repair is simple. Bend 18-gauge Ticonium wire into proper shape for a replacement arm and embed a substantial retentive loop in the denture base with self-curing resin.

8.70.3. **Bar Clasp Approach Arm.** Bar clasp approach arms always exit a denture base on their way to the surface of a tooth. There are two options in fixing such breaks. The first is to substitute an 18-gauge wrought wire circumferential clasp arm for the bar clasp approach arm and proceed as in paragraph 8.70.2 above. However, this method changes the mechanics of the RPD. If a bar clasp was used originally, there must have been a reason. Consult the dentist before making the change. In the second option, the assumption is that the clasp fragment was saved. Electrically solder a retention lug to the clasp fragment and embed the lug in the denture base with autopolymerizing resin.

8.70.4. **Minor Connector Supporting All or Part of a Clasp Assembly Break.** The following two conditions are possible:

8.70.4.1. The broken piece is salvageable. When the minor connector supports a clasp that occupies an embrasure, electrically solder the piece directly to the framework. If the broken part is an intact circumferential clasp situated next to a resin denture base, electrically solder a retention lug to the body of the clasp and embed the lug in the denture with self-curing resin.

8.70.4.2. The broken piece has been lost. Under this condition, a replacement clasp assembly must be made. Either cast a replacement or fabricate one from wrought wire and melted solder. Fasten the clasp assembly to the RPD by using a retention lug and self-curing resin or by electrically soldering the assembly to the framework. Pick the most appropriate method for the situation.

8.70.5. **Rest Repair.** Most rest repairs are a matter of having a framework properly seated on a cast and electrically puddling solder in the place where the old rest was. Rests break because they are too thin in the first place or because they are literally chewed off. This frequently happens when rest seats are not deep enough. A rest made from solder is weaker than cast metal. Consequently, a solder rest has to be thicker than its cast counterpart. The dentist must perform significant adjustments on opposing teeth to make the repair succeed.

Chapter 9

ORTHODONTICS

Section 9A—Types of Orthodontic Appliances

9.1. Introduction:

9.1.1. Orthodontic appliances may be removable, fixed, or a combination of both. Most of the time, an appliance can be classified as *fixed* or *removable* depending on its anchorage. (A patient cannot remove a fixed appliance.) Fixed appliances are generally anchored by metal bands cemented to anchoring teeth. A large group of removable orthodontic appliances get anchorage from acrylic resin denture bases retained by wrought wire clasps. The focus of our interest in this Chapter is on simple fixed and removable orthodontic appliances made by dental technicians in the laboratory. The devices described are capable of performing limited, minor tooth movements and holding functions. They do not compare to the highly complex systems of bands and wires assembled by orthodontists in a patient's mouth.

9.1.2. Fixed and removable appliances are further classified as active or passive. *Active devices* are designed to move teeth into a more esthetic and functional alignment in a dental arch. Movement results from forces exerted by spring wire attachments or rubber bands. These spring wire attachments, or rubber bands, have to be "anchored" to stable dentition to make other teeth that are not as firmly anchored change position. One definition of a *passive appliance* is that it holds or maintains teeth in the positions they already occupy. The concept of anchorage is just as important for passive orthodontic appliances as it is for active devices. A passive appliance's anchorage must be more resistant to movement than the teeth the appliance is supposed to stabilize.

Section 9B—Orthodontic Materials

9.2. Orthodontic Wires:

9.2.1. Orthodontic appliances rely heavily on stainless steel wires to passively hold or actively move teeth. The 18-8 and *Elgiloy*® are two types of stainless steel wire frequently used. Both are chrome-nickel-iron alloys. *Elgiloy*® contains substantial amounts of cobalt and molybdenum, and it is supposed to be more resistant to breakage when bent at sharp angles.

9.2.2. The wires are manufactured by being drawn through dies and are supplied in wrought condition. They are available in round, rectangular, and square cross-sections and in various states of springiness. Besides the purchase options already mentioned, orthodontic wires come in a series of graduated sizes, generally measured in thousandths of an inch.

9.2.3. The wires used for the kinds of appliances made in military dental laboratories are ordinarily very springy and round in cross-section. The wire sizes for common holding, moving, and clasping applications vary from .014 to .036 inch. ***NOTE:*** When selecting wire of proper size and temper, it is better to use wire that is too large and too soft rather than wire that is too small and too highly tempered.

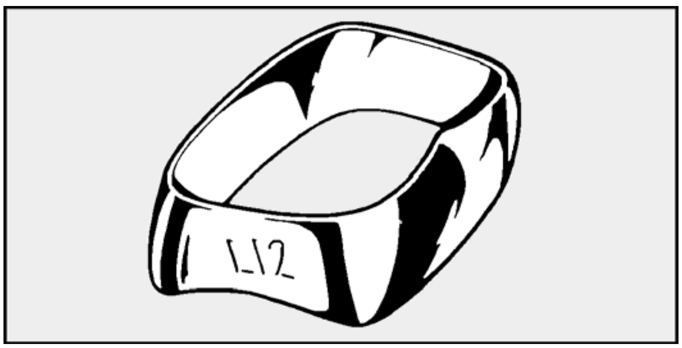
9.3. Orthodontic Bands:

9.3.1. Orthodontic bands are most often made of stainless steel alloys. Molar bands are 0.005 inch (0. 127 mm) thick and 0.180 to 0.250 inch (4.6 to 6.3 mm) wide. Premolar and anterior band materials are 0.003 to 0.004 inch (0.076 mm to 0.100 mm) thick and from 0.13 to 0.18 inch (3.3 to 4.55 mm) wide. The width selected is determined by the height of the clinical crown and the position the band is going to occupy on the tooth.

9.3.2. The use of bands is most often associated with fixed orthodontic appliances. Laboratory made, fixed orthodontic appliances are assembled on casts. Normally, the bands are first placed or fitted onto the necessary teeth by the dentist; then a pickup impression is made. The subsequent cast then has the bands firmly positioned in the correct locations for the appliance to be fabricated. Various attachments and wires can be soldered or welded to bands for purposes of holding or moving teeth.

9.3.3. The finished fixed appliance is then cemented into the patient's mouth. The most commonly used bands are prefabricated bands (stainless steel). Prefabricated bands are preformed to fit maxillary and mandibular teeth. They come closed and do not require soldering or spot-welding to close them. The bands are available in a full range of sizes and are easily adapted to fit almost any tooth's circumference (Figure 9.1).

Figure 9.1. Prefabricated Band.



9.4. Preformed Crowns. Preformed crowns are made of stainless steel. They come in a variety of sizes and shapes to fit almost any tooth in a dental arch. Like orthodontic bands, the use of preformed crowns is also associated with fixed orthodontics appliances. Attachments and wires are fastened to the crowns to form the appliances. The decision to use a preformed crown rather than a band usually depends on whether the natural tooth requires restoration or not. If the natural tooth is badly broken down, a preformed stainless steel crown would probably be used to cover the tooth and retard its deterioration.

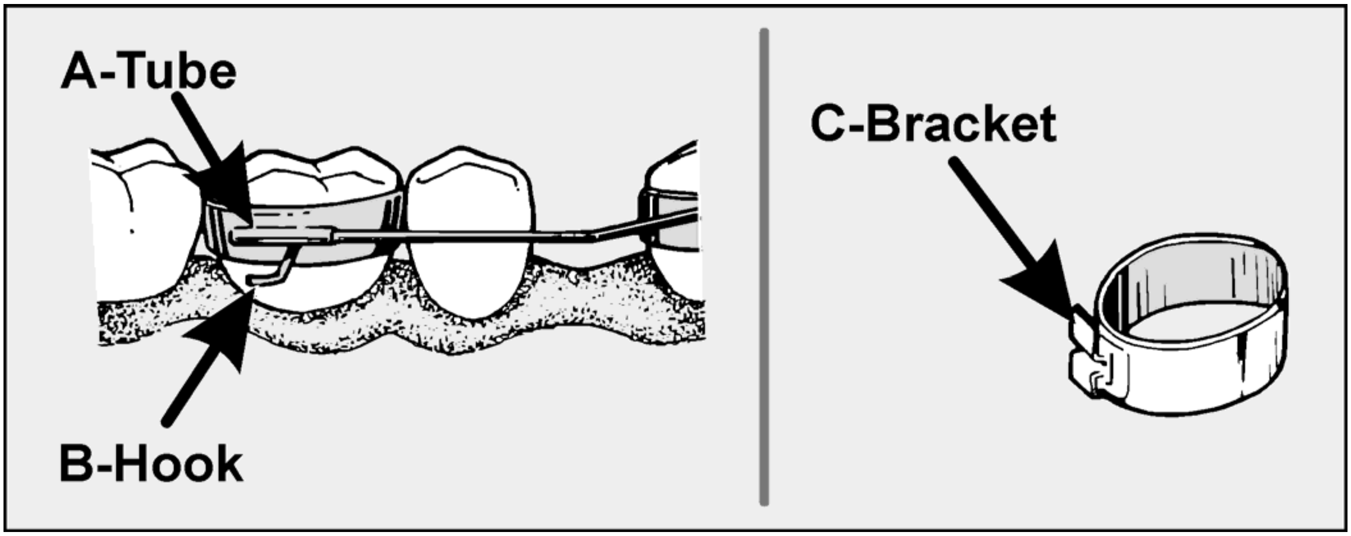
9.5. Attachments for Bands and Crowns. Hooks, eyelets, tubes, brackets, and other attachments may be soldered or welded to bands and crowns to enable the appliance to serve many purposes (Figure 9.2). Most of the time these attachments are chosen from prefabricated, commercially available stocks.

9.6. Acrylic Resin. Autopolymerizing resin is an integral part of many kinds of removable orthodontic appliances. The plastic becomes the resistance or anchorage portion of the appliance against which other elements of the device act to move or hold teeth. Orthodontic self-curing resins are usually molded by the *sprinkle-on* method. Because the polymer powder is exceptionally fine, the polymer mass stays where it is put when wet down with monomer. Autopolymerizing orthodontic resin is dense after it cures. As a result, the plastic is nonporous, cleans well, and is strong.

9.7. Solder. The joining of stainless steel surfaces is usually accomplished by spot-welding or silver soldering. Although the corrosion resistance of silver solders is low compared to gold solders, it is acceptable. Silver solders melt at about 1150 ^{o}F; gold solders fuse at around 1400 ^{o}F. Temperatures in excess of 1250 ^{o}F cause stainless steel wire to soften and lose its springiness.

9.8. Soldering Flux. Silver soldering requires using a fluoride flux. The bond between stainless steel and silver solder is a mechanical one. Besides ridding the stainless steel of its oxide layer, a fluoride flux etches the metal so that solder will bond to it better.

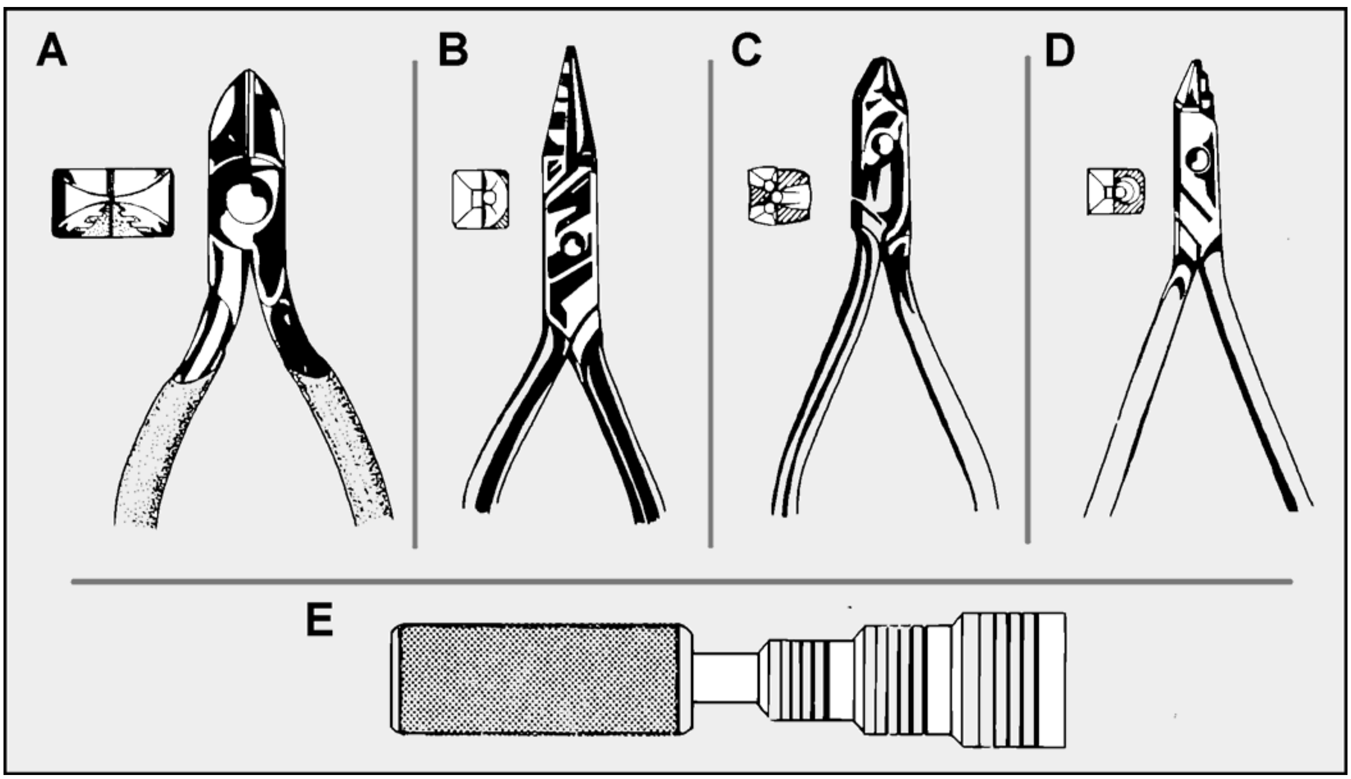
Figure 9.2. Band and Crown Attachments.



Section 9C—Orthodonic Techniques

9.9. Instruments. Instruments used are as indicated in Figure 9.3 and as follows:

Figure 9.3. Basic Instruments.



9.9.1. Wire cutter (Figure 9.3-A).

9.9.2. Bird beak pliers (Figure 9.3-B), 5 inches. This is a universal application type of pliers for making acute or gradual bends. Adequate loops are also possible.

9.9.3. Three-prong wire bending pliers (Figure 9.3-C), 4 3/4 inches. These pliers can make abrupt bends between 0 and 90 degrees without nicking the wire.

9.9.4. Young-loop bending pliers (Figure 9.3-D), Rocky Mountain, #1-47. These pliers are used for consistently accurate bending of uniform curves as required for canine loops, helical loops, etc.

9.9.5. Arch former (Figure 9.3-E). This is a convenient template for making the primary curve in a labial bow.

9.10. Method of Bending Wire:

9.10.1. Gradual bends in orthodontic wire are made with the fingers. Acute bends require the use of pliers as well. The pliers should be regarded as a vise to hold the wire while it is being bent.

9.10.2. Before bending the wire, position the wire on the working cast and mark where the bend should be made with a wax pencil. Hold the wire in the pliers with one hand and bend it downward over a beak of the pliers with the free hand.

9.10.3. Never bend round wire over a sharp-edged beak. Instead, bend it over the rounded beak of the pliers so that the wire does not become nicked.

9.10.4. Before making the next bend, place the wire back on the working cast and check the bend just made. Try to keep all bends at right angles to the long axis of the wire so the torque will be incorporated into the wire and all bends will be in the same plane.

9.10.5. When bending short sections of wire, such as a spring or a clasp, start with the more critical areas (usually toothborne areas). Then bend the easier sections. (This does not apply to a labial bow or helical spring.)

9.10.6. When making a complex series of bends, such as used in a labial bow or helical spring, begin in the center of the wire and work to either end.

9.11. Wire-Bending. Consider the following paragraphs as an exercise in wire-bending and take the time to practice making the different bends, using short pieces of orthodontic wire. A few of the more common wire-bending maneuvers are as follows:

9.11.1. **Closed-End Loop:**

9.11.1.1. Used as the mechanical retention portion of orthodontic wires that are anchored in acrylic. One way to retain the wire in the acrylic is to use a large closed-end loop.

9.11.1.2. To fabricate a closed-end loop, first place the bird beak pliers with the working end facing you and the square beak pointing up. Then firmly grasp the end of a piece of wire with the pliers. The size of the loop will depend on where you place the wire in the jaws of the pliers. The smallest loop is made near the very tip end; the larger loops are made as you move the wire closer to the hinge. Hold the pliers in position and turn the wire around the beak of the pliers (Figure 9.4). With the pliers held still, bend the wire back at a 45-degree angle to complete the closed-end loop.

9.11.2. **Zigzag Bend:**

9.11.2.1. This is another type of wire-bending maneuver that is used for mechanical retention in the acrylic resin.

9.11.2.2. To fabricate the zigzag bend, start with the three-prong pliers facing you and the middle prong facing up. Firmly grasp the wire. Squeeze the wire to make a slight bend in the wire. Reposition the pliers so the middle prong faces down. Make another bend. Repeat these procedures until you reach the desired length of pattern (Figure 9.5).

Figure 9.4. Closed-End Loop.

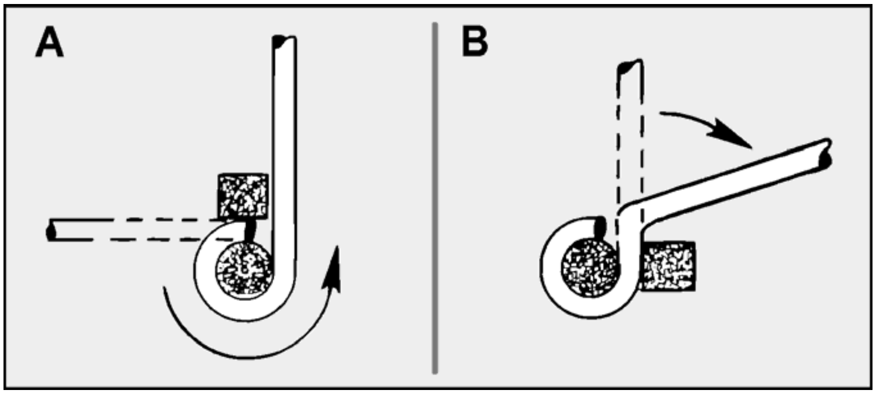
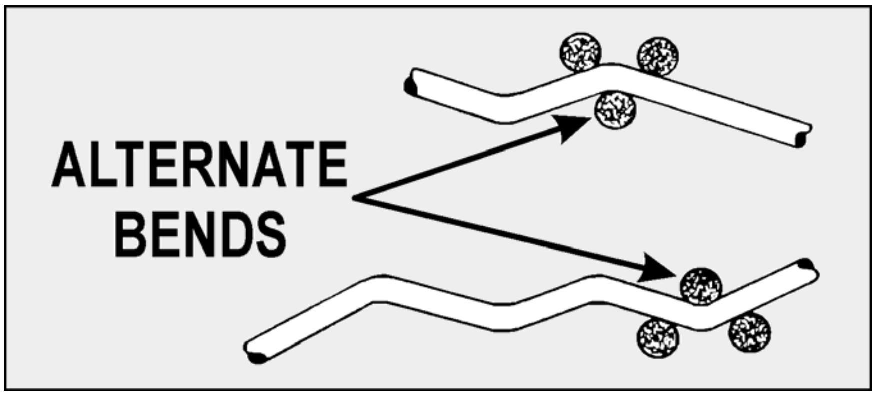


Figure 9.5. Zigzag Bend.



9.11.3. **Right-Angle Bend:**

9.11.3.1. Many times, when making a clasp or spring, the direction of the wire must change abruptly. This is another one of the many uses for three-prong pliers.

9.11.3.2. With the working end of the three-prong pliers facing up, grasp the wire. Squeeze the pliers with one hand and apply finger pressure to the wire with the other until a 90-degree angle has formed (Figure 9.6).

9.11.4. **Semicircular Bend:**

9.11.4.1. A way of making short springs do the work of long springs is to include spiral loops or multiple bends in their design (paragraph 9.17.1). The semicircular bend is one such method.

9.11.4.2. Perform this maneuver in a similar manner to the one used with the closed-end loop, except place the bird beak pliers in the center of the wire. Hold the wire still while you gradually bend it downward until the semicircle is complete (Figure 9.7).

9.11.5. **Helical Bend:**

9.11.5.1. The helical bend, like the semicircular bend, is used in making springs. This is the preferred method of increasing the "spring action" to wire because the helix produces a lighter force over a longer period of time.

Figure 9.6. Right-Angle Bend.

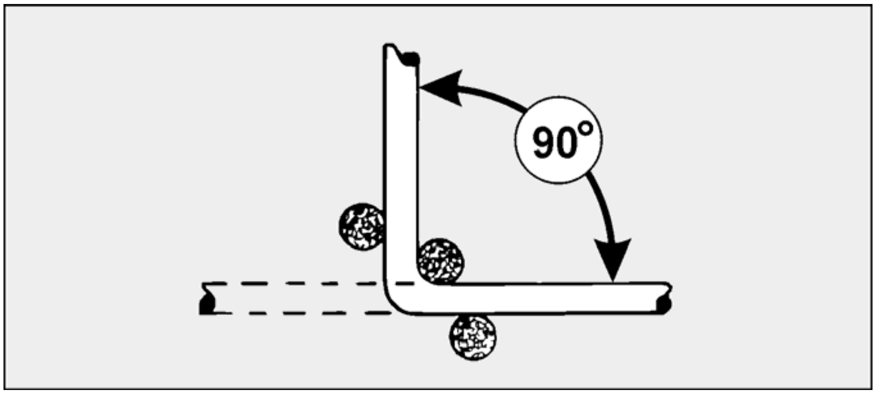
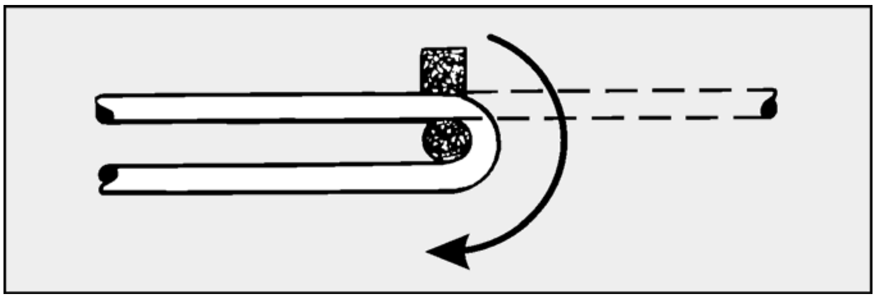
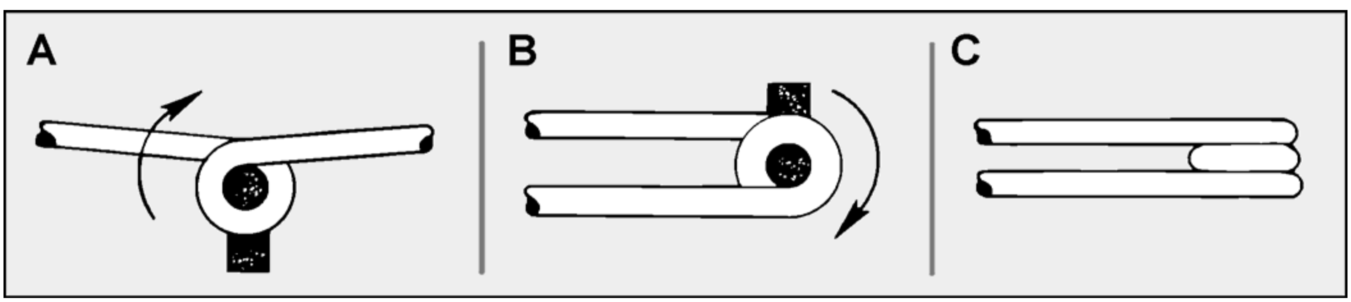


Figure 9.7. Semicircular Bend.



9.11.5.2. Begin by making a semicircular bend in a piece of wire. Reverse the position of the wire within the loop so the working end is facing up and the square end faces down. Bend the wire around until a circle is formed (Figure 9.8). Again, invert the pliers 180 degrees and turn the wire until the helix is complete. A helical bend can be made by using either the bird beak pliers or the Young's loop bending pliers.

Figure 9.8. Helical Bend.

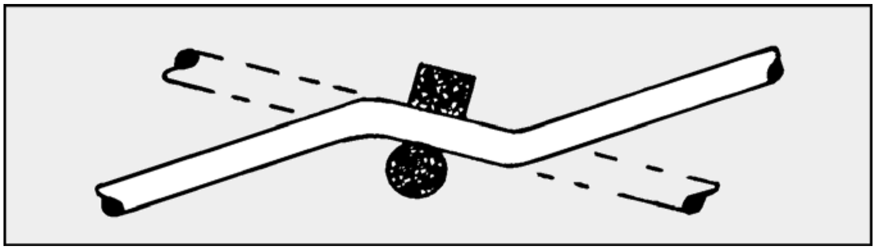


9.11.6. **Deflection Bend:**

9.11.6.1. You may have occasion to use this bend where the wire is needed to contact an isolated tooth or clear the opposing occlusion.

9.11.6.2. Grasp a piece of wire with the bird beak pliers and bend one end of the wire slightly downward against the round beak. With the pliers held firmly, bend the other end of wire slightly upward until the two angles formed are equal (Figure 9.9).

Figure 9.9. Deflection Bend.

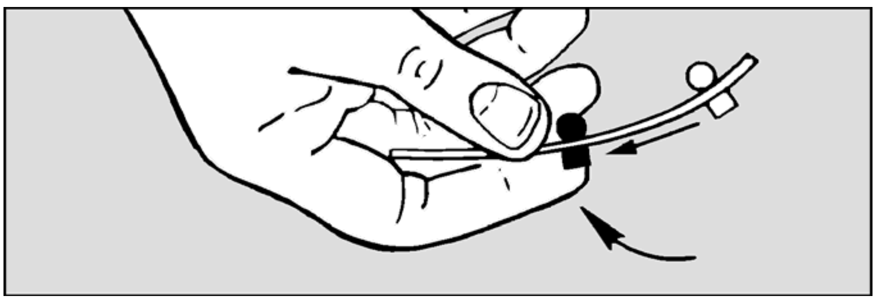


9.11.7. **Smooth-Curve Bend:**

9.11.7.1. This bend is used primarily to adapt orthodontic wire to soft tissue and teeth.

9.11.7.2. Grasp the wire at the point where you want to start the curve. The wire should be close to the hinge to make the largest curve possible. Slowly apply finger pressure around the beak of the pliers and, if necessary, reposition the pliers as you go (Figure 9.10).

Figure 9.10. Smooth-Curve Bend.



9.12. Sprinkle-On Technique for Fabricating Removable Appliance Anchorage. Removable appliance anchorage in the form of a resin denture base is easily made with autopolymerizing orthodontic resin. The procedures for fabricating an acrylic resin base from self-curing orthodontic resin are indicated in Figure 9.11 and as follows:

9.12.1. Survey the cast and block out lingual tooth and tissue undercuts that would prevent placement of the appliance. The presence of some lingual tooth undercut is desirable. Carve blockout wax back 1 to 2 mm gingival to the survey line. Round off any wax ledges created.

9.12.2. Place the working cast in a saturated calcium SDS to remove the air from the cast. Blow off excess water. Air left in the cast could result in air pockets between the resin base and the cast during curing.

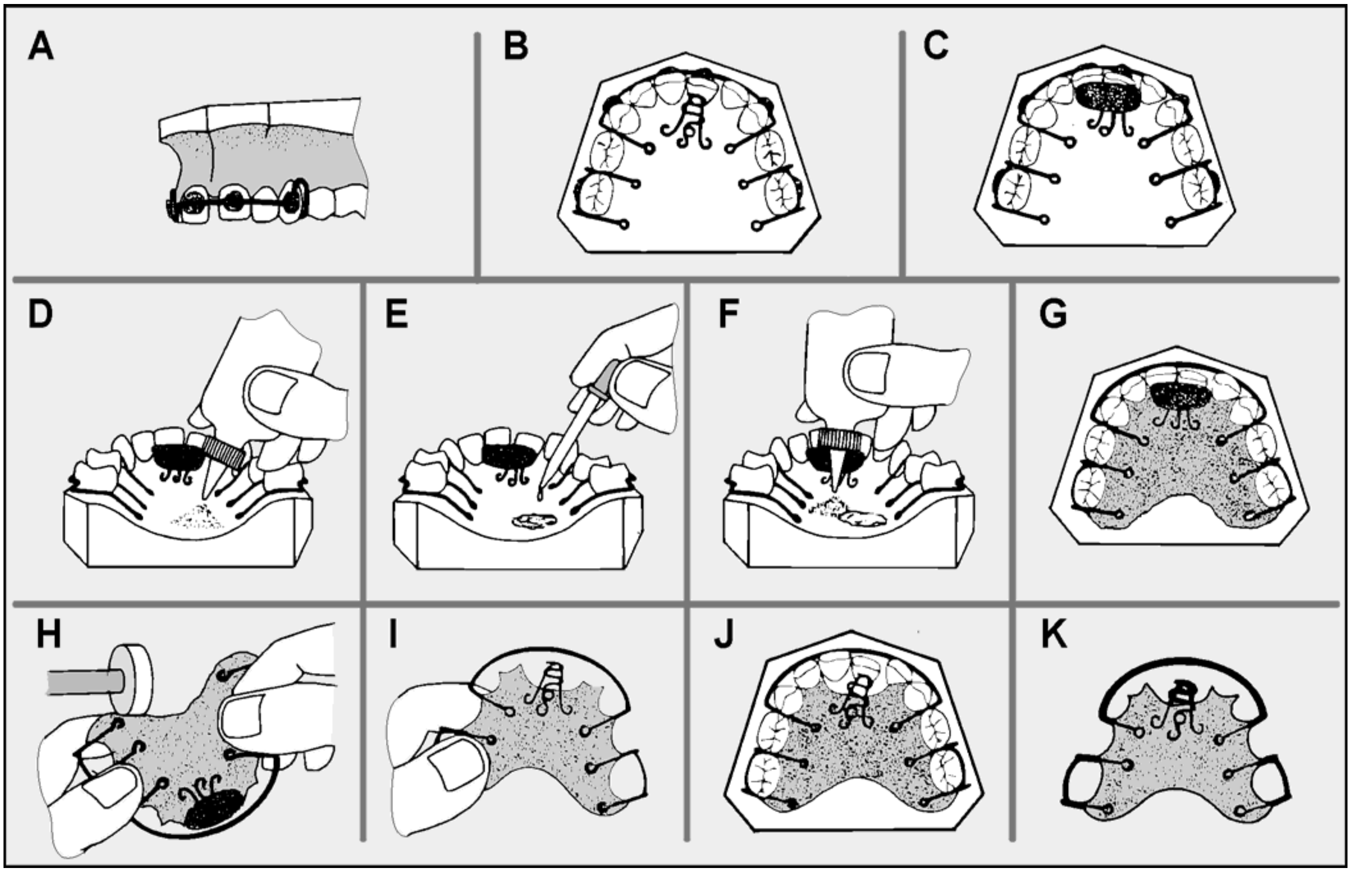
9.12.3. Paint the area of the cast to be covered by acrylic with tinfoil substitute and let it dry.

9.12.4. Secure all springs, guards, bows, and clasps with sticky wax. Do not place wax on the loops that will retain them in the resin. Ensure loops are approximately 0.5 mm off the surface of the cast.

9.12.5. Cover the active portion of all springs with wax to prevent entrapping them in hardened resin. Later, when the wax is removed, the spring will have space to function.

9.12.6. Apply alternate portions of powder and liquid to the desired thickness. To better control the resin, do about a third of the total area at a time. As soon as the surface sheen disappears, add acrylic resin to another third (and so forth). To avoid unnecessary finishing, apply the resin in an even layer, 2 to 3 mm thick.

Figure 9.11. Sprinkle-On Technique for Removable Orthodontic Appliance Anchorage.



9.12.7. After the surface sheen dulls, place the appliance upside down in a pressure pot containing 110 °F water. Placing the cast upside down minimizes porosity caused by air escaping from the cast. Apply 15 psi for 10 minutes as per manufacturer's directions to ensure a dense, well-cured appliance.

9.12.8. When the resin has set, remove the cast from the pressure pot and check the acrylic for flaws. If the cast is satisfactory, remove the appliance from the cast, being careful to avoid distortion. Shape and polish the base as you would the resin base areas of a removable denture. Be careful not to nick the wires or distort them.

9.12.9. After finishing and polishing, the acrylic base rests against soft tissue and the lingual surfaces of the teeth. However, if the appliance is an *active one* and a tooth is going to be moved, *space must be provided between the tooth and the base to allow that movement.* The dentist usually creates such a space with the patient present.

9.13. Fixed Appliance Anchorage. In most cases, depending on the preferences of an individual dentist, you will not have to adapt bands or crowns for fixed orthodontic appliances. The dentist will have done that part of the procedure at chairside in the patient's mouth. The dentist then makes an impression with the band or crown in place. After the impression is removed from the mouth, the dentist seats the band or crown in the impression and sends the assembly to the laboratory. The impression is poured in dental stone. When the cast is separated from the impression, the band or crown will occupy the same position on the dental stone tooth as it did in the mouth. You can now finish the appliance on the cast in terms of attaching wires, tubes, hooks, etc.

9.13.1. **Soldering.** Soldering is defined as the process of joining two pieces of metal by using a third piece of metal whose melting range is lower than those of the two being joined. Orthodontic soldering is most often accomplished using a handheld butane torch. However, orthodontic soldering can be carried out with a Hanau alcohol torch, specially designed orthodontic soldering burner (blowpipe), or gas-air torch with an orthodontic tip. Most of the procedures consist of soldering stainless steel parts together with silver solder.

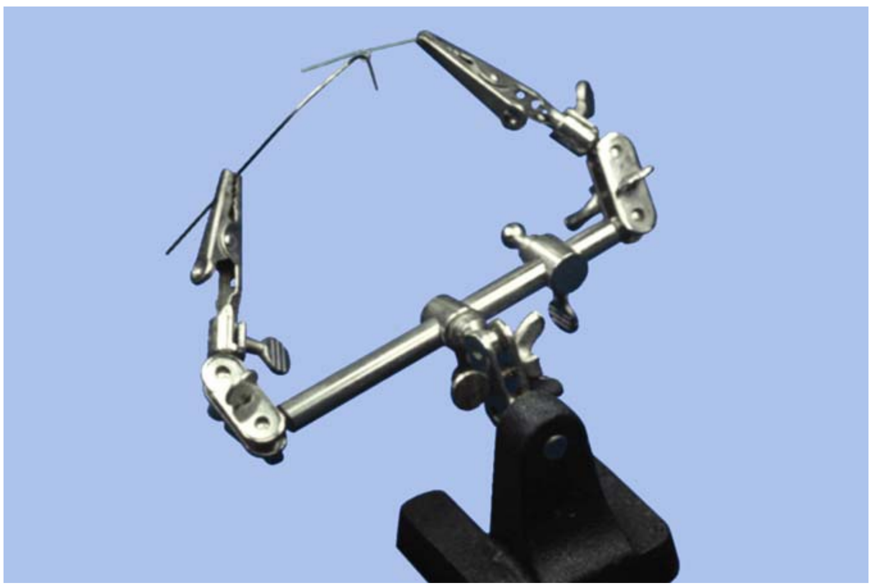
9.13.2. **Soldering Requirements.** Six rules must be observed for successful soldering:

9.13.2.1. The surfaces of the metals to be joined must be clean and as free from oxides as possible.

9.13.2.2. The parts to be joined should be accurately related as follows:

9.13.2.2.1. For wire to wire, use a soldering jig (Figure 9.12).

Figure 9.12. Soldering Jig.



9.13.2.2.2. For wire to band or crown, seat the band or crown on a dental stone cast. Adapt the wire to the cast according to the dentist's prescription. What remains is to solder the wire to the band or crown. Hold the wire immobile with wet tissue molded to the cast or a small amount of stone laid over the wires adjacent to both sides of the area to be soldered. This not only helps to secure the wires, but also helps to protect the cast from unnecessary heat damage from the torch. Another similar method is to relate the wire to the band or crown with investment material (Figure 9.13).

9.13.2.3. The parts to be joined should be in contact with each other. (***EXCEPTION:*** The major exception to this rule is that the soldering techniques used in fixed partial denture construction require a slight space between the parts to be joined.)

9.13.2.4. The soldering of stainless steel requires a fluoride paste flux. Paste flux is easy to place and confine to the exact area where it is needed. It etches the surfaces of the steel and improves bonding. When metals are heated, they acquire a strong affinity for oxygen in the air. Unless provision is made for preventing significant oxidation, an oxide film will develop on the stainless steel and form a barrier between the solder and the metal. When this happens, the solder may ball up and fail to flow. If it does flow, it might not make a strong joint. The flux will protect the surface of the metal by preventing the formation of oxide or by removing any oxide that forms.

Figure 9.13. Soldering a Cantilever Loop to a Band.

9.13.2.5. The joint being soldered must be able to be reached by the flame (accessible). It must also be visible so that the progress of the soldering operation can be observed.

9.13.2.6. Use the reducing part of the flame and perform the soldering procedure quickly. The assembly must be preheated. Only a slight amount of additional heat will be needed to make the solder flow. Do not solder with the tip or outer zone of the flame. When this part of the flame is applied to metal surfaces, oxidation occurs, requiring the application of additional flux. Instead, move inward from the tip of the flame to its reducing zone. Remove the flame from the assembly as soon as the solder flows into the joint. Overheating causes weak joints. Soldering is best done in subdued light. The appearance of the metal and the appearance of the solder are harder to observe in a bright light.

9.13.3. **Soldering Method:**

9.13.3.1. Lay out all materials for maximum convenience and quick availability.

9.13.3.2. Relate the parts to be soldered.

9.13.3.3. Make sure the parts are clean and in contact.

9.13.3.4. Apply flux.

9.13.3.5. Using the reducing part of a flame, heat the two pieces to be joined and observe the action of the fluoride flux. The flux will bubble up and then melt. As the flux melts, it will take on the appearance of liquid glass. Begin to concentrate the flame on the larger of the two pieces. Apply fluxed solder at the proposed place of union. The solder should flow smoothly and promptly. Remove the flame immediately.

9.13.3.6. Take the appliance off the cast. Finish and polish it.

9.14. Spot-Welding. Spot-welding is the process of joining two pieces of metal by using a machine that generates high voltage electric current. The parts to be joined are held together by electrodes. As the electric current passes through the work, resistance builds, heat is generated, metal melts, and a union of the parts occurs. A true weld is formed, and no solder or flux is used. This technique is used only on stainless steel alloys and is less commonly used in most soldering procedures (Figure 9.14).

Figure 9.14. Electric Spot-Welder.

Section 9D—Removable Orthodontic Appliances

9.15. Parts of an Appliance. Removable orthodontic appliances are composed of three distinct parts:

9.15.1. **Effecting Mechanism.** The first part is a device or mechanism that moves teeth into new positions or holds teeth in existing position. These mechanisms consist of active or passive bows along with springs, screws, or rubber bands that mostly have active orthodontic functions.

9.15.2. **Anchorage.** Anchorage for removable orthodontic appliances consists of an autopolymerizing resin base formed to fit both the palate and lingual surfaces of teeth in the maxillary arch, or the lingual aspect of the alveolar process and teeth in the mandibular arch. The effecting mechanism is embedded in the anchorage. Since the anchorage is built to have a great deal of resistance to movement, the effecting mechanism has a solid base from which to push, pull, or hold.

9.15.3. **Retention.** Retention is accomplished by various popular forms of wrought wire clasps embedded in anchorage and adapted to existing natural teeth. The purpose of the clasps is to maintain the anchorage in place. The *Hawley retainer* was the forerunner of the variety of removable appliances presently in use. Most are modifications of the Hawley principle.

9.16. Hawley Retainer. See Figures 9.15 and 9.16 and as follows:

9.16.1. **Effecting Mechanism (Labial Bow).** The method of bending the bow is shown in Figure 9.17. The bow is composed of a bow portion and bilateral canine loops. Wire sizes are .030 to .032 inches.

9.16.1.1. **Bow.** Use an arch-forming template to develop the arch's initial ideal curvature. Then adapt the bow to the rotations and inclinations of individual teeth by bending the wire with the fingers or with the help of the pliers. Start in the center and move towards one side. Bend the other half keeping the wire parallel to the occlusal plane. For best results, be sure the wire contacts the teeth in the middle thirds of the crowns' facial surfaces.

9.16.1.2. **Canine Loop (Vertical Loop).** At about the mesial third of the canine on one side, make a 90-degree bend in the wire toward the gingiva. Next, use wire bending pliers to bend the closing portion of the loop (Figure 9.18). Make the loop long enough to clear the gingival crest, but not so long that it dips into the bottom of the buccal sulcus. The loop's distal upright should descend vertically to the bucco-occlusal embrasure between the canine and first premolar.

Figure 9.15. Hawley Retainer—Occlusal View Showing Anchorage and Clasps.

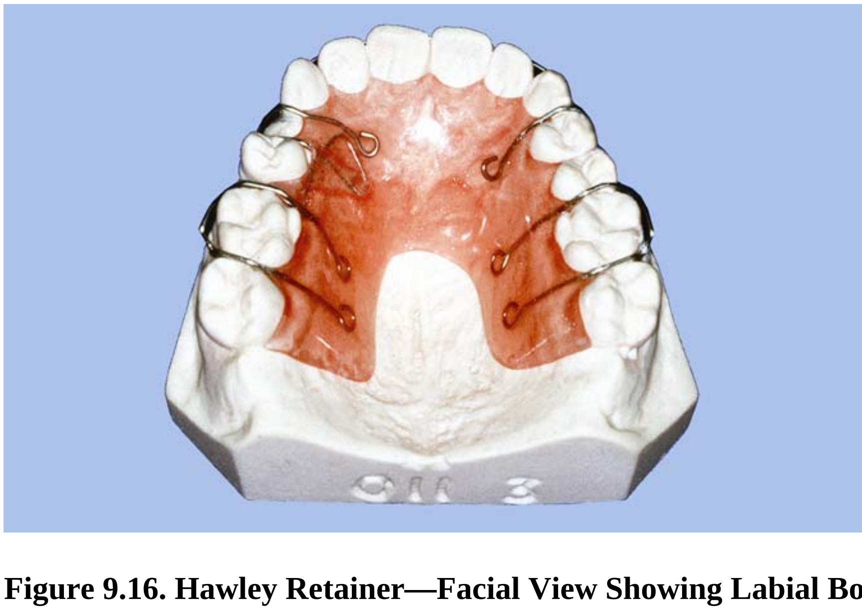


Figure 9.16. Hawley Retainer—Facial View Showing Labial Bow.

9.16.1.3. **Adapting the Wire into the Palatal Area.** Bend the wire into the occlusal embrasure and adapt it to the embrasure as closely as possible. Be certain the wire does not interfere with the occlusion. Shape the remaining wire to the lingual embrasure and extend the wire onto the palate. End the bow with an angled bend or loop for retention in the resin base. The palatal part of the bow should be elevated about 1/2 mm off the cast's surface so it will become firmly embedded in the resin of the anchorage. ***NOTE:*** Repeat the canine loop and palatal adaptation steps for the other side of the bow.

9.16.2. **Retention.** The common clasp forms used for retaining removable orthodontic appliances are the circumferential, Adams, and ball. They are custom bent from wrought wire (Figure 9.19) as follows:

9.16.2.1. **Circumferential Clasp.** The circumferential clasp comes out of an occlusal embrasure area, is adapted to the facial surface of the tooth, and engages a mesial or distal zone of undercut opposite the embrasure of origin. Wire sizes are .028 to .030 inches. It is also common for a circumferential clasp to pass distal to the terminal abutment in a quadrant on the way to a mesiofacial zone of undercut.

Figure 9.17. Bending a Labial Bow.

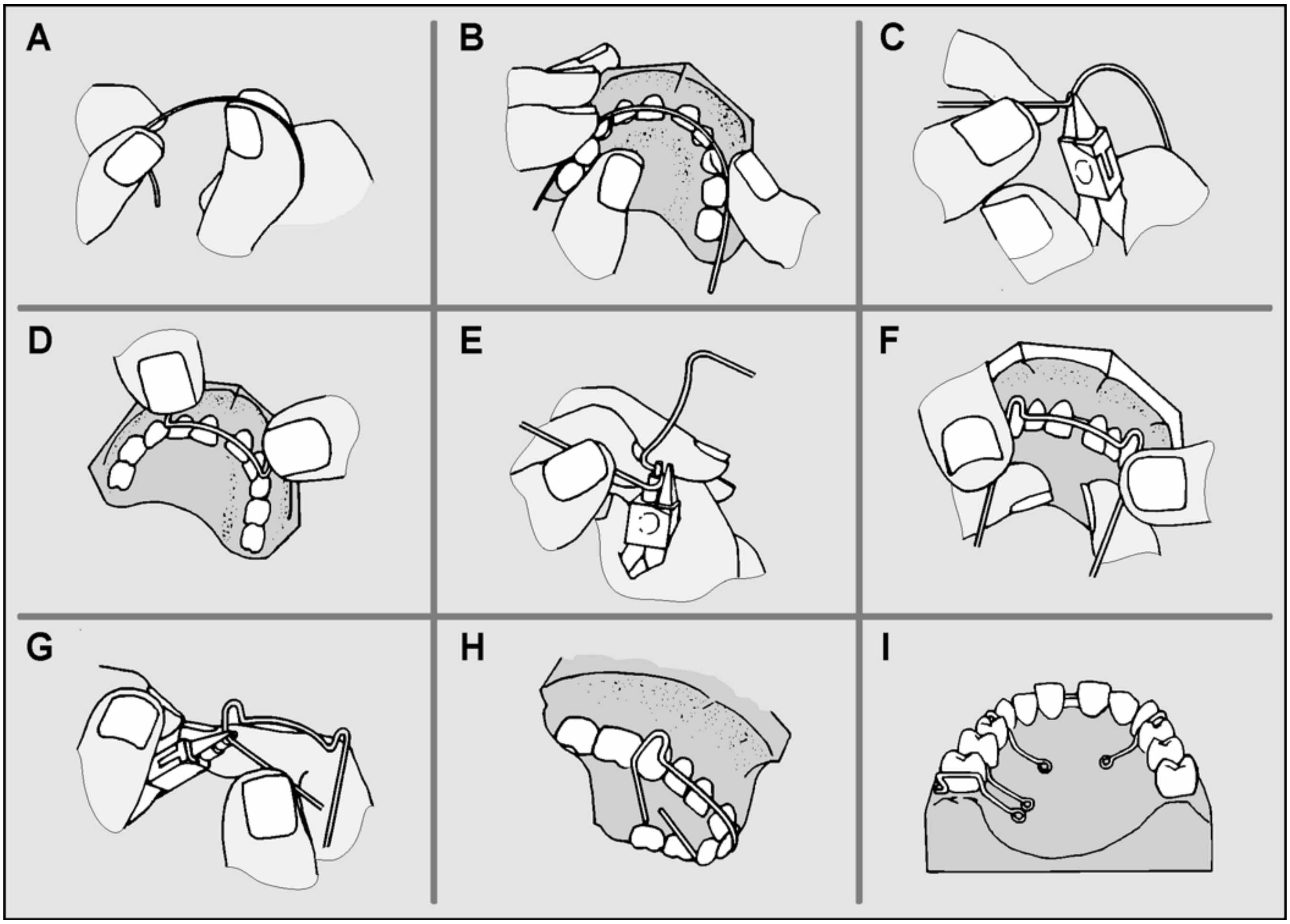


Figure 9.18. Canine (Vertical) Loop.

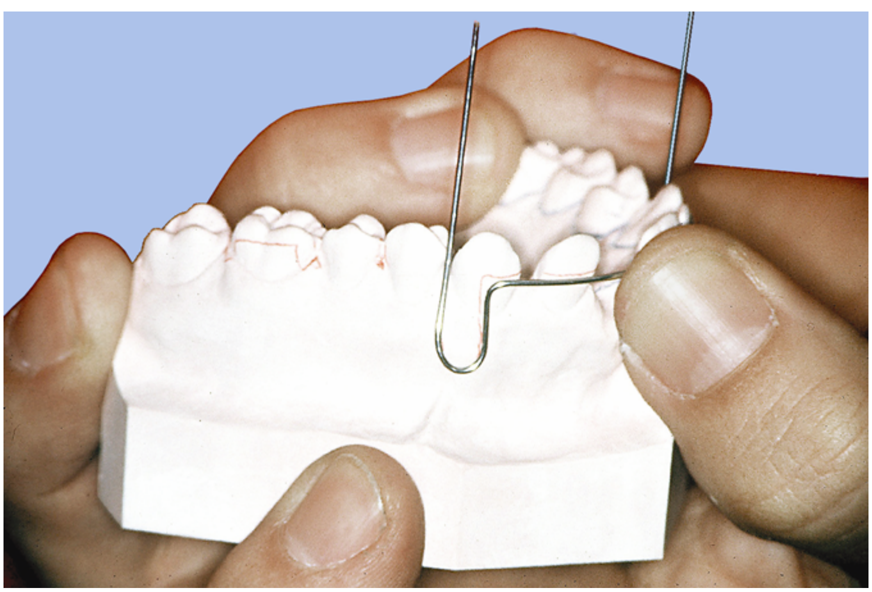
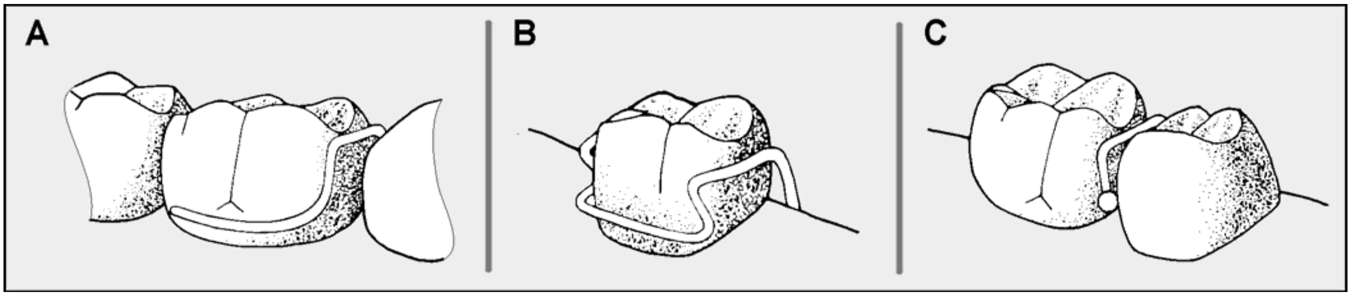
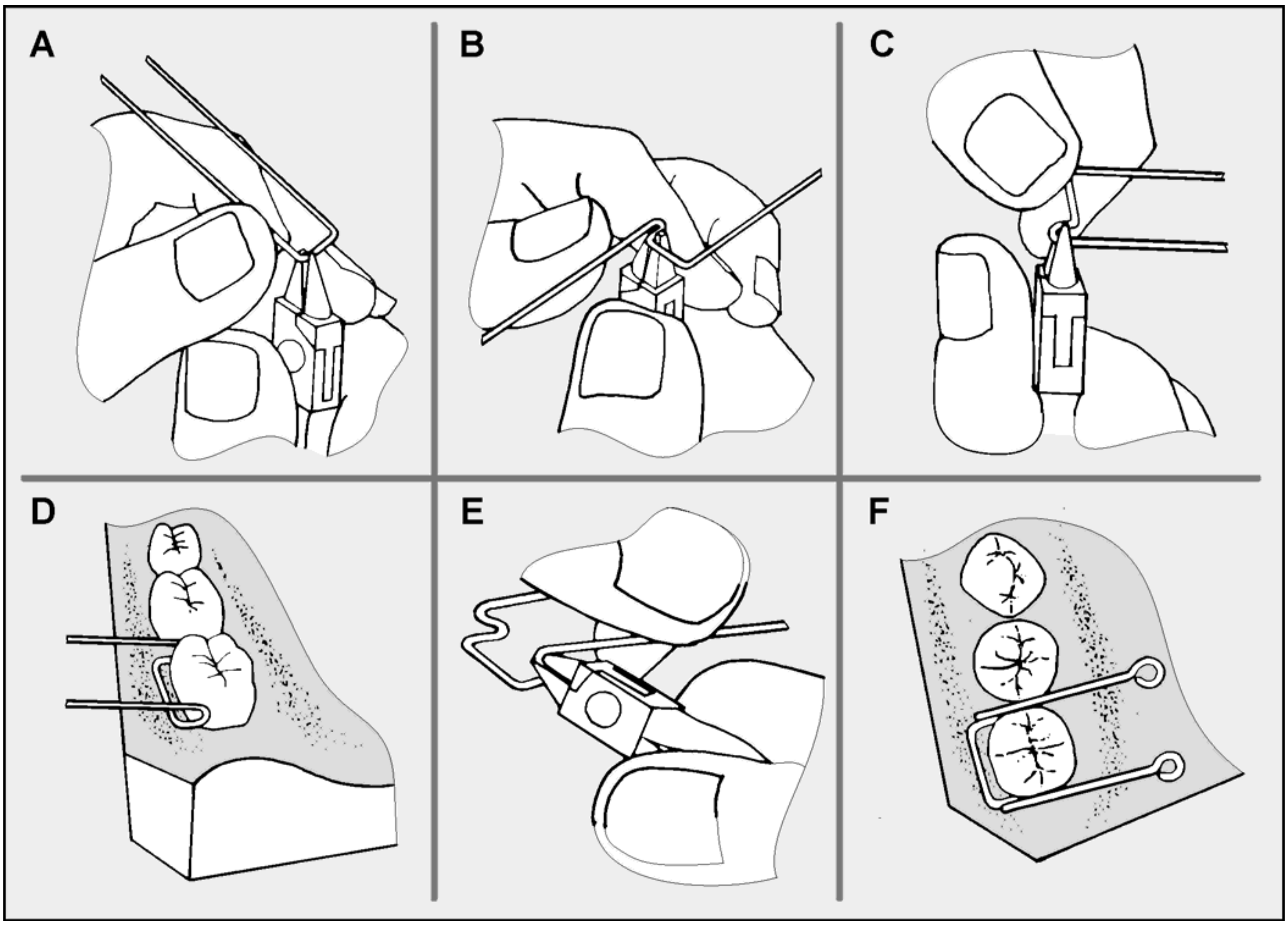


Figure 9.19. Wrought Wire Clasp Types—Circumferential (A), Adams (B), and Ball (C).



9.16.2.2. **Adams Clasp.** The Adams clasp is the most retentive of the wrought wire clasps and is probably the most popular. Wire sizes are .022 to .025 inches. The method of bending this clasp is shown in Figure 9.20. The bending sequence for the Adams clasp is as follows:

Figure 9.20. Bending an Adams Clasp.



9.16.2.2.1. Make a 90-degree bend about 1 1/2 inches from the end of the wire. Lay the wire against the tooth, measure the mesiodistal width, and make another 90-degree bend that parallels the first.

9.16.2.2.2. With a pair of pliers, bend each leg back up to form a loop. Adjust the legs so they fall in the interproximal areas and fit snugly against the tooth. The horizontal part of the wire should cross the middle third of the tooth with no contact. Mark the height of the occlusal embrasure on each leg with a grease pencil.

9.16.2.2.3. Bend each leg into its respective occlusal embrasure and make the wire touch the occlusal aspect of the contact area. The wires should not interfere with the occlusion. Be sure the horizontal bar of the clasp still crosses the middle third of the tooth with no contact.

9.16.2.2.4. Cut off the excess wire and contour the remainder to the palate, ending with an angled bend or loop to provide retention in the acrylic base. Leave about ½ mm space between the cast and the wire.

9.16.2.2.5. Adjust the loops previously adapted to the buccoproximal areas to fit well against the tooth's surface.

9.16.2.3. **Ball Clasp.** This clasp is usually prefabricated and is available in diameters of 0.024 inch (0.6 mm), 0.028 inch (0.7 mm), or 0.040 inch (1.0 mm). It is bent sufficiently to spring into mesio or distofacial undercuts. The ball size increases with an increase in wire size.

9.16.3. **Anchorage:**

9.16.3.1. Block out lingual undercuts on the cast as previously described. Paint the cast with tinfoil substitute. Seal the bow and clasp in place with sticky wax. Develop the resin base, using the "sprinkle-on" method. Place the appliance in a pressure pot to cure. Finish and polish it.

9.16.3.2. If the dentist is going to use the retainer as a passive appliance, leave the resin in contact with the lingual surfaces of the anterior teeth. If the appliance is going to be activated by modifying the bow or closing the canine loops, cut the resin back out of contact with the anteriors to allow their movement. An activated labial bow moves teeth lingually.

9.17. Modifications of the Hawley Retainer. Most of the modifications of the Hawley principle are designed as active appliances. The effecting mechanisms consist of various springs, rubber band systems, screws, and ramps instead of or in addition to a conventional labial bow. Passive retainers sometimes require the use of clear acrylic shields added on the labial bow. This not only gives the wire additional occlusal-gingival stability, but also helps eliminate unwanted tooth rotation in anterior teeth.

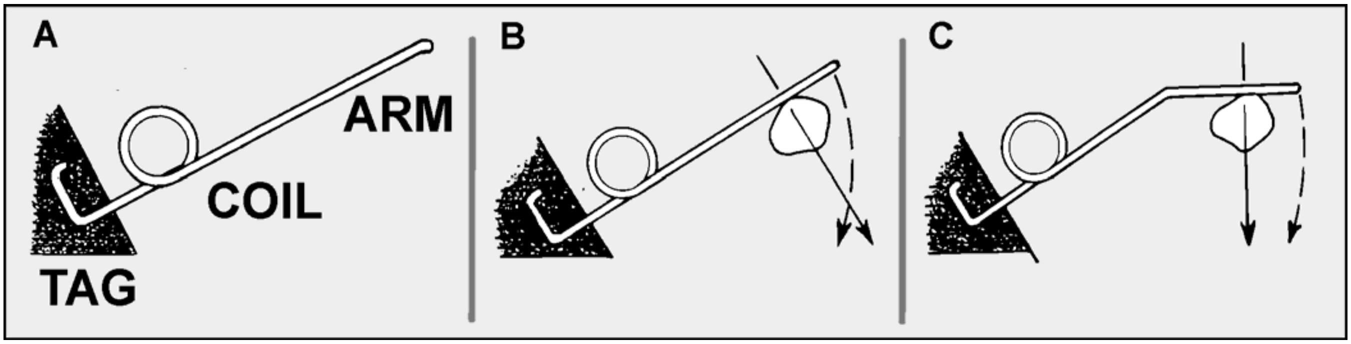
9.17.1. **Springs:**

9.17.1.1. **Overview.** Springs produce force when a wire's attempt to return from a stressed to an unstressed condition is resisted. If a technician makes springs as part of a removable orthodontic appliance, the springs are bent and subsequently positioned on the cast in a passive condition. The dentist activates them before placing the appliance in the patient's mouth. Springs are supposed to produce gentle pressures over as long a route of travel as possible. Long springs are better able to satisfy these requirements than short ones, but space is almost always at a premium in the mouth. A short spring can be made to have the desirable qualities of a long one by incorporating spiral loops or multiple bends into the spring's design:

9.17.1.2. **Helical Loop Springs:**

9.17.1.2.1. The word *helical* means "having the form of a spiral." The basic shape of a helical loop spring is shown in Figure 9.21. It consists of three parts: a *tag* which is embedded in the anchorage; a spiral *coil* which acts to make the spring behave like a longer one without a coil; and an *arm* which contacts a tooth and transmits force to it. Figures 9.21-B and 9.21-C show that the route tooth movement takes is largely a function of how the arm is angled.

Figure 9.21. Helical Loop Spring.

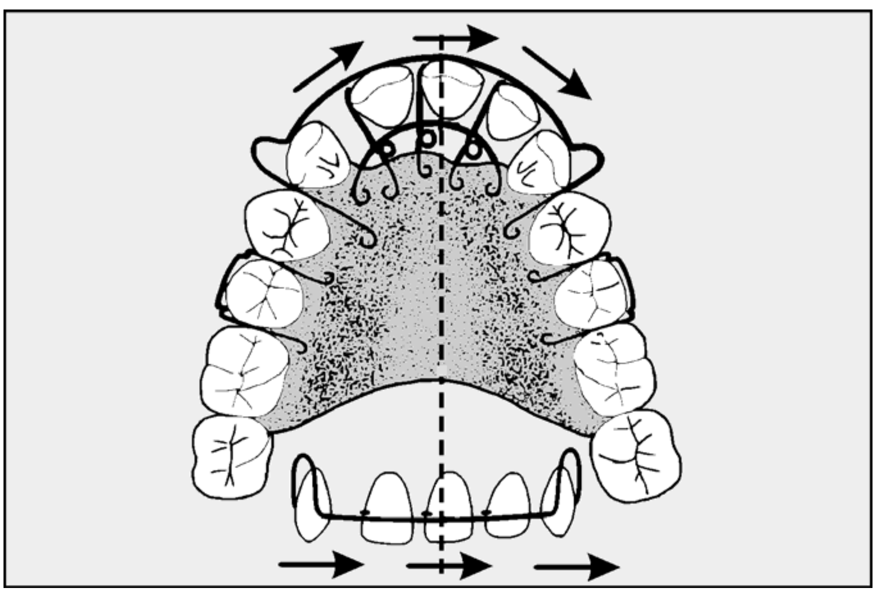


9.17.1.2.2. Notice in Figure 9.21 that the tooth moves at a right angle to the initial point of contact of the spring. It is important to note that the *tag* has to be of sufficient size and bent in a way that holds it in the anchorage and keeps it from twisting in the plastic.

9.17.1.3. **Finger Springs:**

9.17.1.3.1. Finger springs are generally designed to move teeth either mesially or distally. Wire sizes range between .014 and .032 inches. The versions of this spring made with lighter gauge wire are used on anterior teeth (Figure 9.22). Heavier gauge finger springs can perform tasks like retracting or uprighting a molar that has migrated and closed needed space (Figure 9.23). In Figures 9.22 and 9.23, note that the springs are protected by *guards*. If it were not for the guards, the springs would be less likely to maintain proper contact with the teeth they are supposed to move.

Figure 9.22. Finger Springs and Guards for Anterior Tooth Movement.



9.17.1.3.2. In the case of the molar-retracting spring (Figure 9.23), the guard also guides the path of the molar as it moves distally. In Figure 9.22, the labial bow acts to steer or guide the path of incisor movement. The bow itself may be either active or passive.

9.17.1.3.3. Guards for springs can be made two different ways. First, as described above, the guard is placed over top of the spring's arm and guides the path of the tooth and the spring's arm. In this method the guard and spring arm are not imbedded into the acrylic; only the tag is in the acrylic. Another method is to place the guard under the spring's arm, block out the arm and guard with wax, and then cover the entire spring with acrylic (Figure 9.24). With this method, the guard guides the path of the spring arm and the acrylic guides the path of the tooth. When blocking out the spring arm and guard with wax, do not build up the wax any thicker than the thickness of the wire and do not blockout the retentive tag.

Figure 9.23. Finger Spring (A) and Guard (B) for Uprighting a Molar.

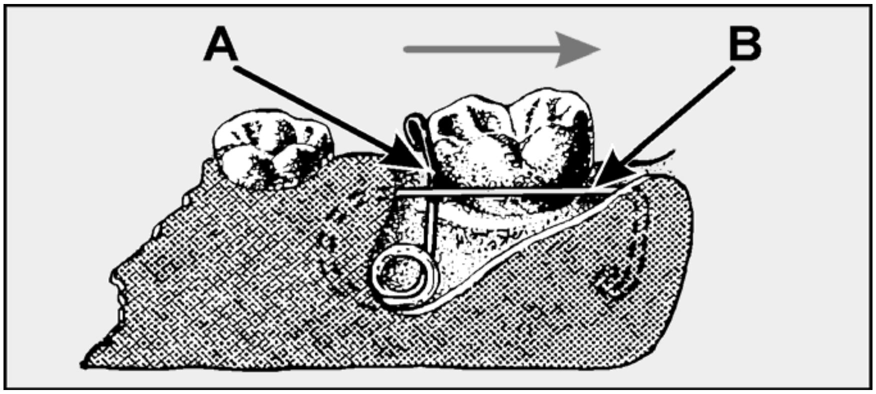
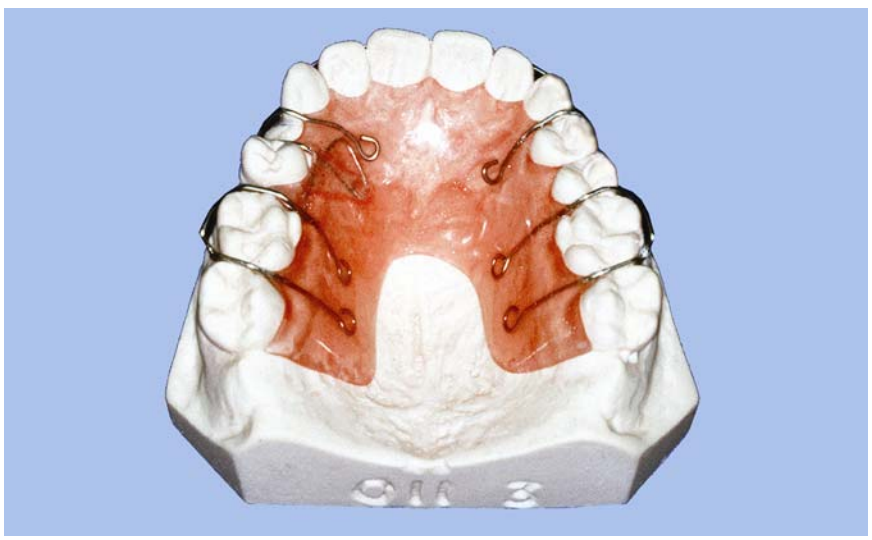


Figure 9.24. Figure Spring With Guard (Alternate Method).



9.17.1.4. **Canine Retractor-Premolar Holder (Figure 9.25).** The finger springs discussed so far are lingually oriented. Although the *canine retractor-premolar holder* is obviously another style of finger spring, it is classified separately because it is facially oriented with respect to the teeth. Wire sizes are .030 to .032 inches. When the spring is anchored at point "A" in Figure 9.25, the spring will retract the canine. If the spring is anchored just distal to the canine, it can be made to prevent the premolar from drifting forward.

9.17.1.5. **"W" Spring (Figure 9.26-A).** Although this spring has a helical loop in it, it takes its name from the terminal series of bends that look somewhat like a "W." Wire sizes are .014 to .020 inches. The "W" spring is mostly used to move teeth facially. Because it rests on inclined tooth surfaces, a guard is constructed over the spring to keep it from sliding along an incline (Figure 9.26-B). Observe the labial bow. It has been bent to stop the central incisor after the tooth has been moved to an acceptable position in the dental arch.

Figure 9.25. Canine Retractor Finger Spring.

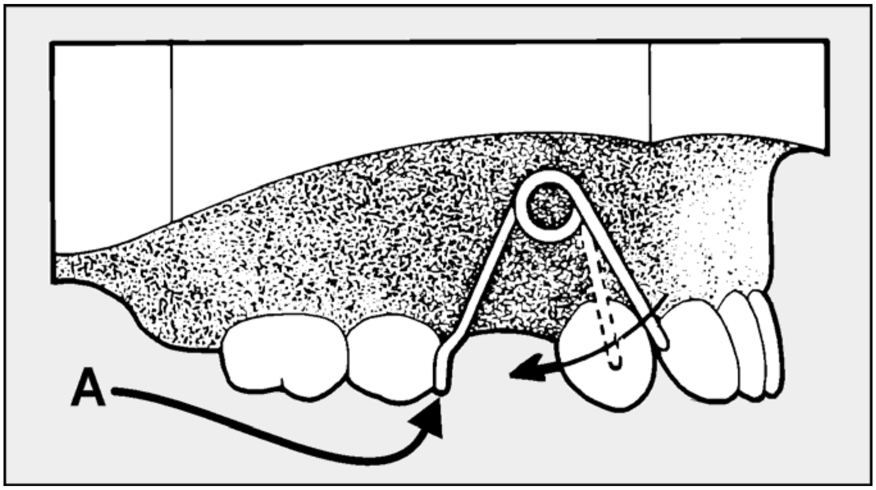
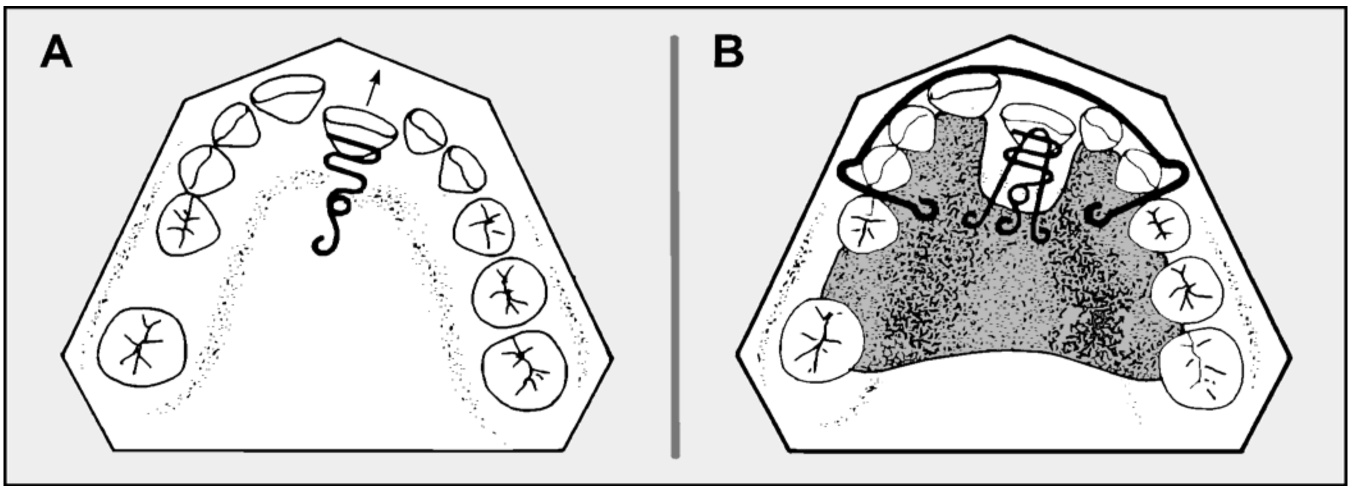


Figure 9.26. "W" Spring and Guard.



9.17.1.6. **Coffin Spring.** As pictured in Figure 9.27, the purpose of this spring is expansion of the posterior segments of the maxillary arch.

9.17.2. **"Booties" Plus Elastics (Figure 9.28):**

9.17.2.1. The "bootie" takes its name from its appearance. It is simply a rubber band anchoring device. The combination of a rubber band and bilateral booties is sometimes used as a substitute for a labial bow to make teeth contact or to move teeth lingually. Wire sizes are .032 to .036 inches.

9.17.2.2. The tags of the booties pass between the canines and first premolars to become embedded in lingual anchorage. The rubber band functions best when it is situated near the incisal third of the teeth. Bend the booties and position them on the cast accordingly. One disadvantage associated with a rubber band is that it tends to migrate gingivally on teeth that have moderate facial inclinations.

9.17.3. **Screws.** Some uses for screws are illustrated in Figure 9.29.

Figure 9.27. Coffin Spring for Arch Expansion.

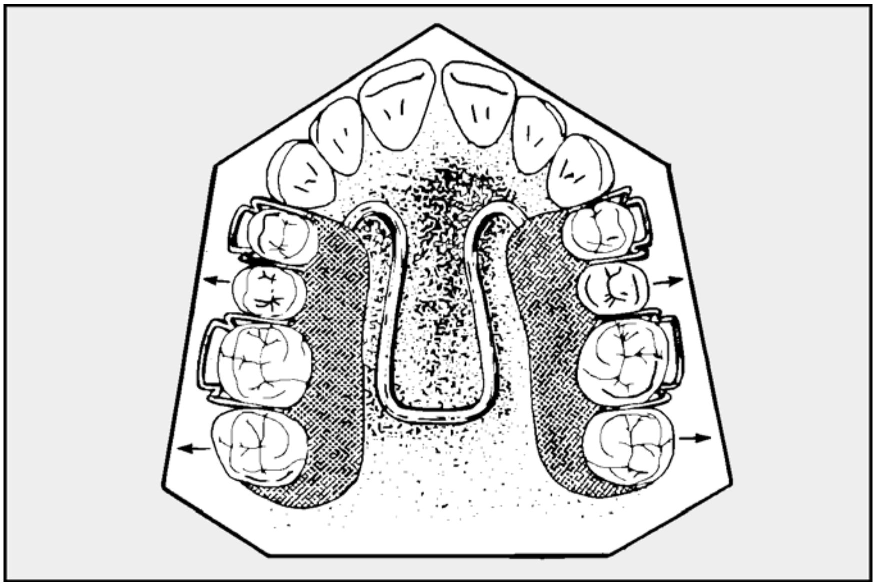


Figure 9.28. Bootie Anchorage.`

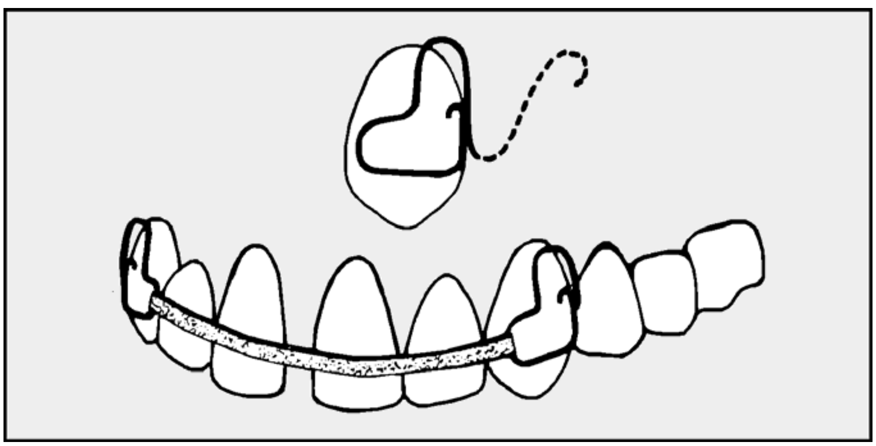
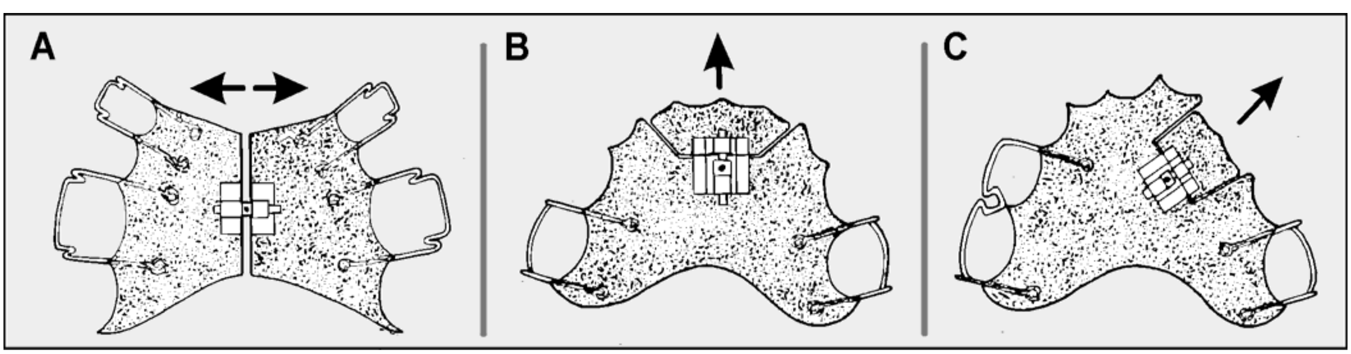


Figure 9.29. Uses for Screws.



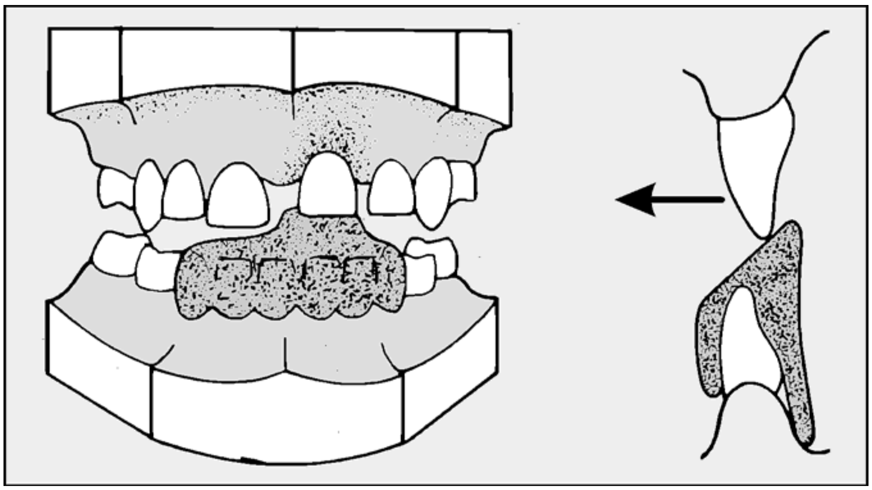
9.17.3.1. The applian ce pictu red in Figure 9.29-A w ill expand a dental arch as th e screw is opened.

9.17.3.2. In Figure 9.29-B, opening the screw should move the four incisors facially.

9.17.3.3. On a more limited basis, the screw arrangement in Figure 9.29-C should move the two teeth anterolaterally.

9.18. Inclined Plane Appliance. An incisal inclined plane appliance is used to move one or two maxillary teeth in crossbite facially (Figure 9.30). It consists of an acrylic resin ramp with a resin substructure adapted to a minimum of four opposing lower teeth that serve as anchorage. The steeper the ramp, the faster the teeth in crossbite will move. However, the angle the ramp forms with the occlusal plane should not exceed 45 degrees. Also, if the bulk of the appliance is responsible for too much separation between the upper and lower teeth, it can cause extreme discomfort in the masticatory muscles or temporomandibular joints.

Figure 9.30. Inclined Plane Appliance.



Section 9E—Fixed Orthodontic Appliances Made in the Dental Laboratory

9.19. Space Maintainers. Space maintainers are orthodontic appliances designed to preserve the space created by the premature loss of a tooth. These appliances are purely passive in nature. Fixed space maintainers may be made of preformed stainless steel crown forms or bands with wire projections of the following type:

9.19.1. Quadrant cantilever loop space maintainers (Figures 9.31 and 9.32).

9.19.2. Lingual archwire space maintainer (Figure 9.33):

9.19.2.1. Lingual archwires are round in cross-section and range from 0.032 to 0.36 inches in diameter (Figure 9.34). Bend the size wire the dentist specifies to the general shape of the dental arch. Adapt the wire to the linguogingival third of the teeth, just above the gingival margins. The objective is to touch the lingual aspect of all teeth in good alignment without special regard for teeth that are grossly out of position.

9.19.2.2. Solder the ends of the archwire to bands on the first permanent molars. The appliance is more versatile if the archwire carries bilateral vertical loops. The loops are directed toward the floor of the mouth and are situated just anterior to the first permanent molars.

Figure 9.31. Cantilever Loop Space Maintainer (Preformed Crown Retainer).

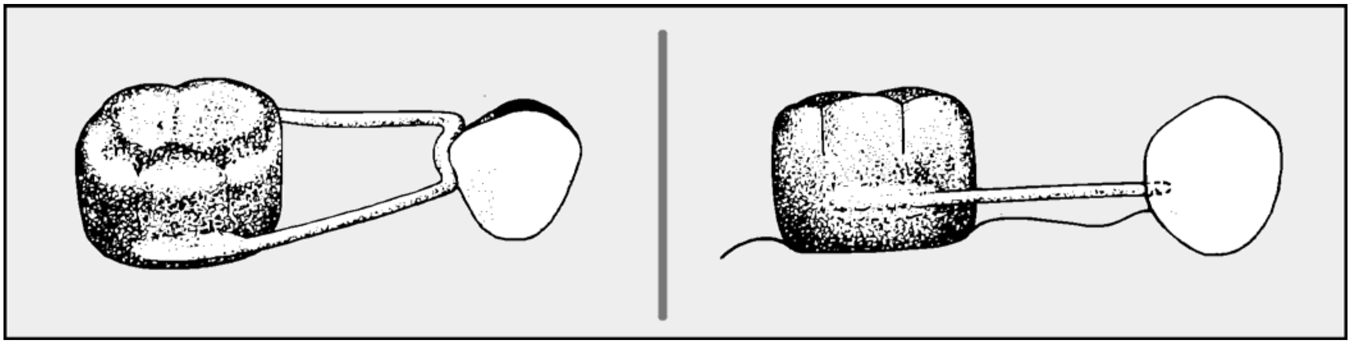


Figure 9.32. Cantilever Loop Space Maintainer (Band Retainer).

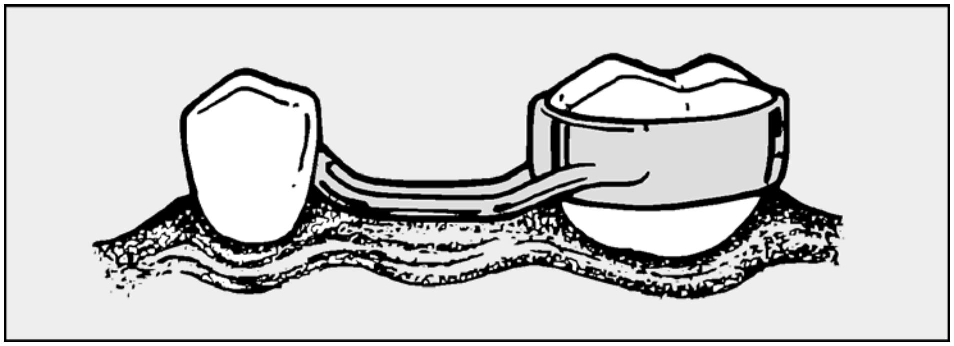
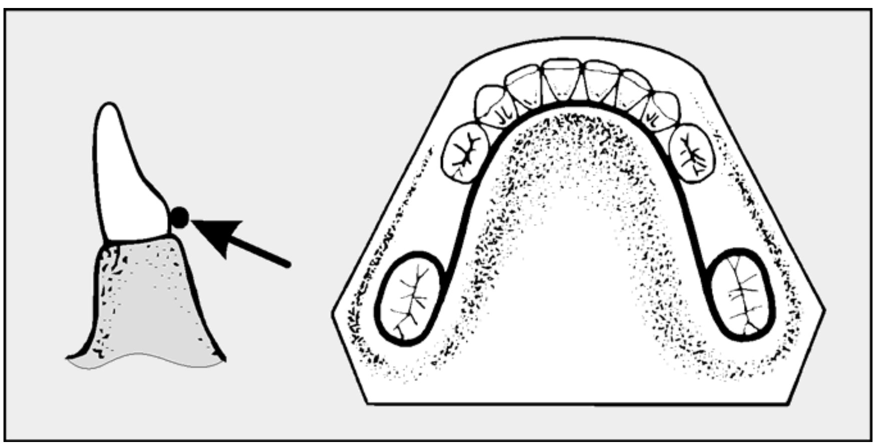


Figure 9.33. Lingual Arch Space Maintainer.



9.20. Space-Closing or Space-Regaining Appliance:

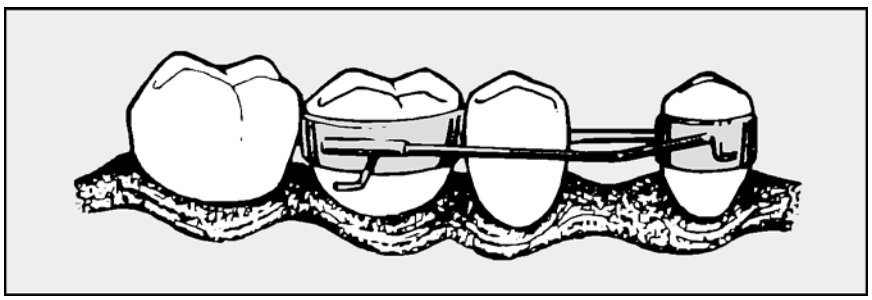
9.20.1. This fixed orthodontic appliance is used with rubber bands to obtain a degree of bodily tooth movement while closing a space (Figure 9.35). The tooth to be moved and the primary anchor tooth are banded. An open- end tube and hook, facing distally, is soldered or welded facial and lingual to the main anchor, banded tooth. Guiding wires are placed into the tubes and welded or soldered to the banded tooth to be moved. Hooks facing mesially area also welded or soldered on the banded tooth to be moved.

9.20.2. Rubber elastics are then placed onto the hooks to obtain movement. When used as a space regaining appliance, no hooks are attached to the bands. Instead, compressed coil springs are threaded onto the guide wires.

Figure 9.34. Wire Sizes for Effecting Mechanisms, Clasp, and Guards.

Wire Sizes for Various Applications (listed in thousandths of an inch)		
	Device	**Wire Size**
Archwires	Labial Bow Lingual Archwire	.030-.032 .032-.036
Springs	Finger Spring (anterior teeth) Finger Spring (posterior teeth) W Spring Cuspid Retractor-Bicuspid Holder Coffin Spring	.014-.028 .025-.032 .014-.020 .030-.032 .032-.036
Clasps	Adams C-Clasp Ball Clasp	.022-.025 .028-.030 .028-.032
Miscellaneous	Spring Guard Booties Space Maintainer Loop	.028-.030 .032-.036 .032-.036

Figure 9.35. Space-Closing or Space-Regaining Appliance.



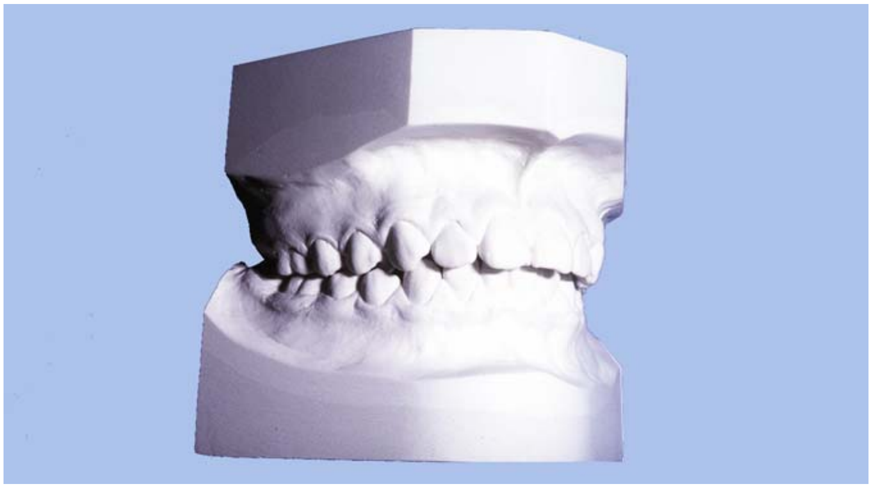
Section 9F—Trimming and Finishing Orthodontic Casts

9.21. Overview:

9.21.1. Orthodontic casts are used as a three-dimensional aid to explain treatment to the patient prior to orthodontic treatment. Orthodontic casts can then be made after treatment is complete to show the amount of change or development that has occurred.

9.21.2. Casts are trimmed and finished differently from removable and fixed prosthetic working casts. The base and sides are trimmed so the heels of the maxillary and mandibular casts can be positioned on a flat surface with the teeth in maximum intercuspation. They can also be turned onto their right or left sides and the teeth will remain in maximum intercuspation (Figure 9.36). ***NOTE:*** The angles and height of the orthodontic cast in the following trimming procedures may vary among dentist. However, the order of the steps should remain the same.

Figure 9.36. Trimmed Orthodontic Casts.



9.22. Procedures:

9.22.1. Following disinfection, pour impressions by the one- or two-step method in orthodontic plaster or dental stone as directed by the dentist (Figure 9.37). Technicians generally use rubber base former molds to form the bases of the cast. This provides for the bulk of stone needed for trimming the cast and eliminates a line of demarcation between the impression and base of the cast.

9.22.2. Remove all nodules and excess stone so the casts may be accurately occluded during certain trimming steps.

9.22.3. Place the maxillary cast on the cast trimmer's table. Stand the cast with its occlusal plane contacting a right angle guide plate. The base of the cast should now be directed toward the trimming wheel. Place a folded, damp paper towel between the guide plate and the stone teeth to reduce the possibility of chipping. Trim the base of the maxillary cast until it is parallel with the occlusal plane and 40 mm in height.

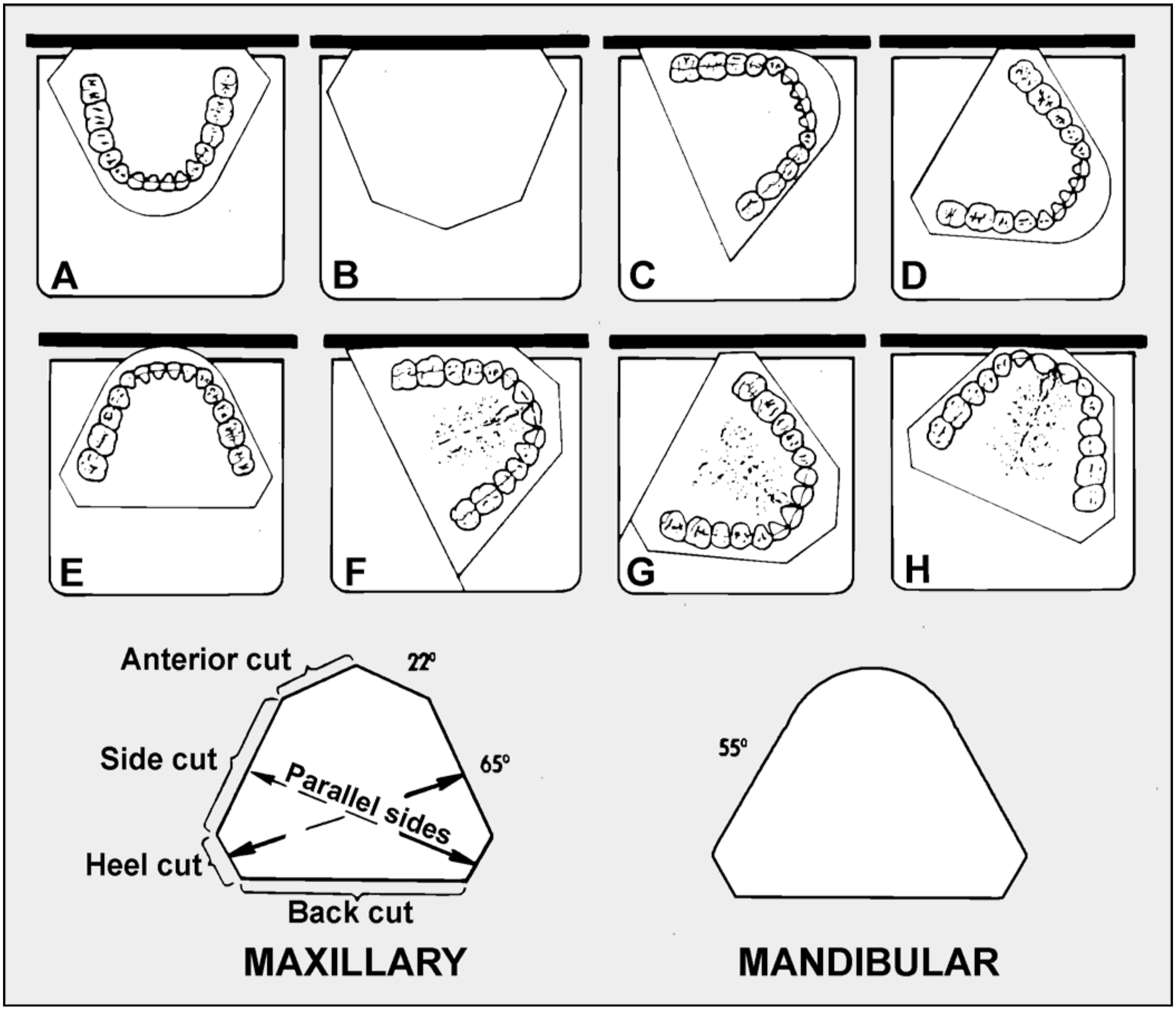
9.22.4. Remove the right angle guide plate and position the maxillary cast on the trimming table so the back of the cast can be trimmed.

9.22.5. Trim the back of the cast *perpendicular* to the median raphe and 6 mm short of the pterygomaxillary notch. For symmetry of the completed cast to be correct, it is critical for the back to be perpendicular to the median raphe. If it is a class II malocclusion case, more space distally will be needed to prevent overtrimming the mandibular cast when it is in occlusion.

9.22.6. Place the back of the maxillary cast against the angulator guide. Set the angulator guide at 65 degrees (Figure 9.37). Trim one side to the deepest part of the mucobuccal fold. Repeat this step for the other side.

9.22.7. Place the back of the maxillary cast against the angulator guide. Set the angulator guide at 22 degrees. Trim the anterior until you reach the depth of the labial vestibule fold and the cut is from the canine eminence to the midline. Repeat this step on the opposite side. The point of the anterior cuts should fall on an imaginary line that follows the median raphe. Use caution to avoid damaging the anterior teeth during this step.

Figure 9.37. Trimming Orthodontic Casts.



9.22.8. Place the mandibular cast in occlusion with the trimmed maxillary cast. The dentist may have supplied an interocclusal record for this purpose. If an interocclusal record is not provided, extreme care must be taken to avoid breaking teeth. If necessary, trim some plaster from the heels of the mandibular cast to get the upper and lower casts together.

9.22.9. With the casts in occlusion, place the base of the maxillary cast again st the right angle guide plate. Trim the base of the mandibular cast until the combined height in occlusion of the casts is 70 mm.

9.22.10. Place the mandibular cast on the trimming table with the maxillary cast in occlusion. Trim the mandibular heel area, using the maxillary cast as a guide. Trim the mandibular cast until the maxillary cast just starts to make contact with the trimming wheel. This should enable the casts to stay in occlusion while on their backs.

9.22.11. Place the back of the mandibular cast against the angulator guide. With the angulation set at 55 degrees, trim one side to the deepest part of the mucobuccal fold. Repeat this for the other side.

9.22.12. Trim the anterior portion of the mandibular cast parallel to its back cut, stopping when you reach the depth of the labial vestibule. Finish the cut by rounding to each canine area. The completed anterior cut should be an evenly rounded symmetrical form that extends from canine to canine area at approximately the deepest part of the labial vestibule fold. Use caution to avoid damaging the anterior teeth during this step.

9.22.13. Place the cast in occlusion with the base of the mandibular cast on the trimming table. Set the angulator guide to 120 degrees. Trim the heel (corners) of both casts until you reach 6 mm from the distobuccal cusp of the most terminal molar. Repeat this step on the opposite side. After completing this step the casts should stay in occlusion while setting on either heel.

9.22.14. After establishing correct height and proper trim, finish all sides of the casts with a fine grit trimming wheel if available.

9.22.15. Rinse the casts under running water. Use a soft toothbrush on the anatomical portion to remove any slurry left from the trimming process. To remove any blobs of material, use a rounded scraper in the mucobuccal fold area and a sharp instrument around the teeth.

9.22.16. Use the finest grained wet-dry sandpaper on a glass slab to remove the cast trimmer marks. Do this under running water, holding the surface of the cast firmly against perfectly flat sandpaper.

9.22.17. Let the cast dry overnight. Fill holes with dry plaster or stone. Add water using a camel hair brush. After the holes are filled, allow the casts to dry thoroughly before stoning or sanding. Use a minimum of water during stoning or sanding. Dip the cast in water and rub dry. Wipe the residue away.

9.22.18. If needed, repeat all of the above to produce an acceptable cast.

9.22.19. After the cast is free of holes and scratches, dry it thoroughly.

9.22.20. Place the patient's name and the date printed on gummed labels on the base of the maxillary and mandibular casts. If a cast marking machine is available, use it instead.

9.22.21. Place the casts in liquid soap for 30 to 45 minutes. Remove the casts from the soap, and rinse them under running water until all excess soap is removed. Polish the casts with a slightly damp cloth, paper towel, or dry chamois and rub them to a high gloss.

Section 9G—Administrative Information

9.23. Forms Adopted. DD Forms 1348-6, **DoD Single Line Item Requisition System Document;** and 2322, **Dental Laboratory Work Authorization.**

GEORGE P. TAYOR, JR., Lt Gen, USAF, MC, CFS
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFPD 47-1, *Dental Services*
AFMAN 37-123, *Management of Records*
AFI 47-101, *Managing Air Force Dental Services*
AFPAM 47-103, Volume 2, *Dental Laboratory Technology—Fixed and Special Prosthodontics*
AFOSH Standard 48-19, *Hazardous Noise Program*
AFOSH Standard 91-32, *Emergency Shower and Eyewash Units*
Air Force Records Disposition Schedule (RDS)

Acronyms and Abbreviations

ADA—American Dental Association
ADL—area dental laboratory
AFOSH—Air Force occupational safety and health
Ag—silver
aha—articulator hinge axis
Al—aluminum
ANSC—American National Standards Institute
Arcon—ARticulator and CONdyle
Au—gold
B—boron
Be—beryllium
BULL—Buccal of the Upper and Lingual of the Lower (Rule)
cm^3—cubic centimeter (equal to 1 millileter)
Co—cobalt
Cr—chromium
Cu—copper
D—distal
DB—distobuccal
DHCW—dental health care workers
DL—distolingual
EPA—Environmental Protection Agency
FDA—Federal Drug administration
Fe—iron
gm—gram
HIV—human immunodeficiency virus
In—indium
Ir—iridium
lb/in^2—pounds per square inch
mha—mandibular hinge axis
MI—maximum intercuspation
mm—millimeter
Mn—manganese

Mo—molybdenum
MT—mandibular transalation
Ni—nickel
O_2—oxygen
OSHA—Occupational Safety and Health Administration
Pd—palladium
PGP—platinium-gold-palladium
PPE—personal protective equipment
psi—pounds per square inch
Pt—platinum
RAP—reinforced acrylic pontic
RPD—removable partial denture
rpm—revolutions per minute
Ru—ruthenium
SDS—saturated calcium sulfate dihydrate solution
Si—silicon
Sn—tin
SSN—Social Security number
Ti—titanium
U.S.P.—United State Pharmacopeia
Zn—zinc

Terms

abrasive—A range of coarse to fine granules with sharp edges used for smoothing, grinding, or polishing.
abrasive paste—An abrasive suspended in a paste commonly used to smooth off small irregularities on denture teeth after gross grinding.
absorption—Taking up a substance into the mass of another.
abutment—
1. On RPDs, it is the tooth on which a clasp is placed to support and retain the RPD.
2. On fixed partial dentures, it is the tooth to which the retainer is cemented.
3. On implants, it is the part that supports and/or retains the prosthesis.

accelerator—A substance that speeds up a chemical reaction.
acid—Any one of a group of corrosive chemicals used to clean oxide layers or surface contaminants from gold castings.
acid etching—
1. In clinical dentistry, treating the enamel, generally with phosphoric acid, by removing approximately 40 microns of rod cross-section for resin retention.
2. As a laboratory procedure, using electrolysis or chemicals to remove a microscopic layer of metal to produce mechanical retention for resin bonding. (Do not confuse with electropolishing, which occurs to a much greater degree.)

acrylic resin—A plastic widely used in dentistry for making denture bases, provisional crowns, custom trays, etc.
acrylic resin impression tray—See custom tray.
acrylic resin veneer—A tooth-colored layer of plastic placed over the facial surface of a metal crown to improve the crown's appearance.

ADA Specification—A detailed description of the qualities and properties required of a dental material as set forward by the American Dental Association (ADA).
adhesion—The sticking together of unlike substances.
adjustment—A modification to a dental prosthesis to enhance fit, function, or appearance.
agar—A gelatin-like substance obtained from certain seaweeds (algae) and used in compounding reversible hydrocolloid impression materials.
Aker's clasp—See circumferential clasp.
alginate—An irreversible type of hydrocolloid made from a salt of alginic acid.
align—To properly position in relation to another object or objects.
alloy—A metal consisting of a mixture of two or more pure metals.
alveolar process—Part of the mandible and maxilla that surrounds and supports the roots of natural teeth.
alveolus—The bony socket holding the root of a tooth by the periodontal ligament.
amalgam—An alloy of mercury, silver, and other metals used as a restorative material.
amorphous—Not having a definite crystalline structure.
anatomic crown—The part of a tooth covered with enamel.
anatomic teeth—Denture teeth with cusp angles of 30 degrees or more.
anneal—To heat a metal, followed by a controlled cooling to remove internal stresses and create a desired degree of toughness, temper, or softness to the metal.
anode—The positive pole of an electric source.
anterior guidance—See mutually protected articulation.
anterior guide pin—The pin fitting into the upper member of the articulator, resting on the anterior guide table, that maintains a selected amount of vertical separation. Also called incisal guide pin.
anterior guide table—Component of the articulator on which the anterior guide pin rests to maintain occlusal vertical dimension and influence articulator movements. Also called incisal guide table.
anterior teeth—The central and lateral incisors and the cuspids of either arch.
anterior tilt—A term used in surveying the master cast; when the cast is tipped on the surveyor table so the anterior part of the cast is lower than the posterior.
anteroposterior—Extending from the front, backward.
anteroposterior curve—The anatomic curve established by the occlusal alignment of the teeth, from the cuspid through the buccal cusps of the posterior teeth, when viewed from the side. Also called the curve of Spee.
antiseptic—Chemical agent applied to tissue to inhibit growth of microorganisms.
apical—Pertaining to the apex or root tip.
apical foramen—The opening at the end of a root of a tooth through which the tooth receives its nerve and blood supply.
approach arm—The part of a bar clasp connecting the retentive portion to an RPD framework.
aqua regia—A mixture of three parts hydrochloric acid and one part nitric acid. Used for removing a layer of gold.
arch—See dental arch.
arch form—The general contour or shape of the arch. Patients' arches are sometimes classified as square, tapering, or ovoid, according to their general shape.
arcon articulator—An articulator having the condyle elements attached to the lower member in the same way condyles are an anatomic feature of the mandible in a human skull.
arrangement—See tooth arrangement.

arrow point (gothic arch angle)—On an articulator, the pointed pattern made by the intersecting working and balancing paths of a stamp cusp as it travels out of maximum intercuspation. The maximum intercuspation (MI) position is the apex of the arrow.
articular disc—The circular-shaped, flat piece of fibrocartilage lying between the condyle of the mandible and the glenoid fossa of the temporal bone.
articulating paper—Colored paper or film, usually supplied in strips, used intraorally and in the laboratory to detect contact between the maxillary and mandibular teeth.
articulation—

1. The place of union or junction of two or more bones of the skeleton.
2. In dentistry, the contact relationship between the occlusal surfaces of the teeth during function.

articulator—A mechanical device representing the temporomandibular joints and jaws to which maxillary and mandibualr casts can be attached for performing prosthodontic procedures.
artificial stone—See dental stone.
asbestos substitute—A strip used to line a casting ring used to invest fixed prosthodontic units; replaced asbestos strips.
asepsis—A pathogen-free condition.
attrition—The wearing away of the biting surfaces of the teeth.
autogenous glaze—A natural glaze.
autopolymerizing resin—Resin whose polymerization is initiated by a chemical activator.
auxiliary lingual bar—An extension from the lingual bar of a mandibular RPD framework used to stabilize loose, periodontally involved anterior teeth. Also called a supplemental Kennedy bar.
axial—Lines, walls, or surfaces parallel with the long axis of a tooth.
axis—An imaginary line passing through a body, around which the body may rotate; for example, transverse horizontal axis.
axis orbital plane—The horizontal plane established by the transverse horizontal axis of the mandible with a point on the inferior border of the right or left bony orbit (orbitale). Can be used as a horizontal reference point; corresponds to the Frankfort plane.
backing—The metal plate constructed to fit the slot or pins of the porcelain facing. May be cast in the laboratory or manufactured.
balanced articulation—The bilateral, simultaneous, anterior, and posterior occlusal contact of teeth in centric and eccentric positions. Also called balanced occlusion.
balanced occlusion—See balanced articulation.
balancing side—See nonworking side.
balancing side occlusal contacts—See nonworking side occlusal contacts.
bar—A major connector used in RPD construction to connect the right and left sides of the framework.
bar clasp—A type of clasp in which the retentive tip approaches the undercut from below the survey line. Also called infrabulge clasp.
basal seat area—See denture foundation area.
base—The part of a removable prosthesis that retains artificial teeth and replaces the alveolar process and gingival tissues. The base of a removable prosthesis is made of metal or denture resin.
base metal—Any metal element that doesn't resist tarnish and corrosion. Any metal that is not noble.
baseplate—See record base.
baseplate wax—A hard, pink wax used for making occlusion rims, waxing dentures, and many other dental procedures.

beading—

1. As in "beading a cast," to score a cast in any desired area to provide a seal between the finished prosthesis and the soft tissue.
2. As in "beading an impression," to rim an impression with a wax strip before pouring so all critical impression landmarks show up in the cast.

bead line—The indentation resulting from beading the cast.

beeswax—The wax derived from the bee's honeycomb; used in many dental waxes.

Bennett Movement—See laterotrusion.

bicuspid or premolar—A tooth having two cusps.

bifurcated—(forked) Having two roots.

bilateral—Having two sides. Any RPD having a major connector is called a bilateral appliance.

biocidal—Destructive to living organisms.

biteplane—See occlusal plane.

blind vent—See chill set.

block out—The process of eliminating undesirable undercut areas of a cast or denture. Most frequently used in preparing a cast for RPD construction. The undercut areas below the survey line on the teeth are blocked out with wax.

blockout tool—A rod used in the surveyor spindle to remove excess wax between the height of contour and the gingival border of abutment teeth on master casts.

blow torch—A device designed to mix gas and air so it can be ignited. The flame is directed on an object to heat or melt the object.

body of a clasp—Connects rest and clasp arms to the minor connector.

boiling point—The temperature at which the vapor pressure of a liquid is equal to the external pressure.

Boley gauge—A caliper-like instrument calibrated in millimeters and used for fine measurements in the laboratory.

bolus—The chewed up mass of food and saliva.

borax or sodium tetraborate—A white crystalline substance used as a flux in soldering and casting procedures.

boxing an impression—Wax wrapped around the impression for confining the dental stone as the cast is poured.

boxing wax—A pliable wax in strip form, used to box an impression.

bracing—The resistance to displacement in a lateral direction from masticatory forces.

bracing arm—See reciprocal arm.

brass—An alloy of about 60 to 70 percent copper; the remainder is zinc.

bridge—See fixed partial denture.

Brinell hardness—An index number denoting the relative surface hardness of a material, usually abbreviated "Bhn." Used in testing softer metals and nonbrittle materials such as gold, copper, and silver.

broken stress fixed partial denture—See interlock fixed partial denture.

bruxism—A clenching of the teeth accompanied by lateral motion in other than chewing movements of the mandible. Grinding or gritting of the teeth usually during sleep or nervous tension. Causes excessive wear of occlusal surfaces.

buccal—Pertaining to the cheek. The surface of the tooth toward the cheek.

buccal frenum—A connecting fold of membrane attaching the cheeks to the alveolar ridge in the bicuspid region of each arch. (plural: buccal frena)

buccal groove—Landmark on the buccal surfaces of mandibular molars, extending vertically from the occlusal surface down toward the cemento-enamel junction.

buccal notch—The V-shaped notch in the impression or denture formed by or for the buccal frenum.
buccinator muscle—The cheek muscle.
buff—To polish by rubbing or by holding the object against a revolving felt wheel impregnated with a polishing agent.
bur—A small rotating instrument used in the dental hand piece for cutting acrylic resin or metal. Also used by the dentist to cut enamel or dentin.
burlew discs—The rubber wheels impregnated with pumice, used for polishing dental restorations.
burn out—See wax elimination.
burn out temperature—The temperature that must be reached to properly eliminate a wax pattern from the mold and expand the mold.
burnish—The drawing or flattening out of a malleable metal through pressure. If a rounded instrument is repeatedly rubbed across the margin of a soft gold casting and the tooth, the gold will be thinned and spread over onto the enamel of the tooth.
butt joint—A type of joint in which the two pieces to be joined touch each other, but do not overlap.
calculus—The hard calcium-like deposit that forms on teeth and on artificial dentures.
cameo surface—The viewable portion of the denture. The part of the denture base normally polished. Includes the facial and lingual surfaces of the teeth.
Camper's line—An imaginary line on a patient's face running from the anterior border of the ala of the nose to the superior border of the tragus of the ear. The dentist uses this line to check the orientation of the occlusal plane of a complete denture.
canine—A tooth having one cusp or point; the third tooth from the midline. So named because it corresponds to the long teeth of a dog. Also called a cuspid.
canine or cuspid eminence—The prominence of labial bone that overlies the root of the upper canine
canine guided articulation—A form of mutually protected articulation in which the canines disengage the posterior teeth during an excursive mandibular movement. Also called cuspid guidance.
cantilever fixed partial denture—A fixed partial denture supported on only one end with one or more abutments.
cap—A term used for the top of a denture flask.
capillary attraction—The characteristic by which, because of surface tension, a liquid in contact with a solid is elevated or depressed as in a capillary tube.
carbon marker—A graphite stick that fits into the surveyor spindle. Used to make a line or mark on the master cast when surveying.
carborundum—A trade name for silicon carbide. Extremely hard blue crystals used as an abrasive in many dental stones and points.
caries—Tooth decay.
carnauba wax—A type of wax obtained from the South American palm tree used in some dental materials.
cast—
1. The positive reproduction of the mouth in stone or similar material on which a prosthetic appliance can be constructed.
2. To produce a shape by thrusting a molten liquid into a mold possessing the desired shape.

cast base—The portion of the removable prosthesis covering the edentulous ridges and supporting artificial teeth; made of metal. Also called metal base denture.
casting—
1. An object formed in a mold
2. The process of forming a casting in a mold.

casting machine—A device designed to hold the investment mold and melted metal that has the capability of forcing the melted metal into the mold by either centrifugal force, air pressure, or vacuum.
catalyst—A substance that accelerates a chemical reaction without affecting the physical properties of the material involved.
cathode—The negative pole of a source of electric current.
cement—Dental luting agents with the dual purpose of holding the casting on a tooth and protecting the pulp against thermal shock.
cementum—A soft, bone-like structure covering the root surface of the tooth.
centigrade—A heat measuring scale calibrated so the freezing temperature of water is 0 degrees and the boiling temperature of water is 100 degrees.
centimeter—A hundredth of a meter; 2.54 centimeters equals 1 inch.
central fossa—The rounded, relatively shallow depression found in molars in the approximate middle of the occlusal surface.
centric occlusion—The occlusion of teeth when the mandible is in centric relation; may or may not coincide with MI.
centric relation—A maxillomandibular relationship in which the condyles articulate with their respective discs in the anterior-superior position of the glenoid fossa against the articular eminences.
centrifugal—A force in a direction from the center, outward.
centripetal—A force in a direction from the periphery toward the center; the opposite of centrifugal.
ceramic—Having to do with the use of porcelain.
ceramic crown—A ceramic restoration restoring a clinical crown without a supporting metal substructure.
ceramo-metal—See metal ceramic restoration.
ceresin—A mineral wax often used as a substitute for beeswax.
cervical—Pertaining to the neck of a tooth.
cervical line—The line where the cementum and enamel join. Also known as the cementoenamel junction.
cervix—The neck of a tooth.
chalk—Calcium carbonate. A powder used for final polishing.
characterization—

1. (Dentures) Anything done to a denture to make it look natural, including staining the denture base, making special tooth arrangements, and staining the denture teeth.
2. (Metal ceramic restorations) Staining and/or modifying the surface texture and shape to make the restoration look natural.

checked tooth—A tooth with a hairline crack.
chewing cycle—See masticatory cycle
chill set—A riser or vent that does not extend outside the mold.
Christensen's phenomenon—The space occurring between opposing occlusal surfaces during mandibular protrusion. The space occurs because of disclusion of posterior teeth in protrusion due to condylar guidance.
chroma—Saturation of a hue.
chuck—The lathe attachment that grips the various burs, abrasive wheels, or buffing wheels.
circumferential clasp—A clasp that approaches the undercut portion of a tooth from above the survey line.
clasp—The part of RPD that partly encircles the abutment tooth and helps to retain, support, and stabilize the appliance.

clasp arms—The shoulders and tips of a clasp; the part of the clasp that extends from the body out to the tip.
clasp shoulder—The part of the clasp arm that connects the body to the retentive terminal; the portion of the clasp arm closest to the body.
cleft palate—An opening in the palate in the hard or soft palate or in both. An acquired cleft palate is caused by surgery, disease, or accident. A congenital cleft palate is present at birth.
clinical crown—That part of a crown visible in the mouth above the gum line.
closed bite—Slang for decreased occlusal vertical dimension.
coalescence—The result of firing porcelain at an extremely high temperature.
cohesion—The molecular attraction by which the particles of a body are united throughout their mass.
cold cure—The polymerization of acrylic resins at room temperature. See autopolymerizing resin.
cold flow—A change in shape or dimension at a temperature lower than the normal softening point of the material.
collar—The neck of an artificial tooth below the cervical line used to embed and retain the tooth in a denture base.
combination clasp—A circumferential clasp assembly having one cast arm and one wrought wire arm.
compensating curve—The combination of the two curves made when the denture teeth are set on anteroposterior and lateral curves for purposes of achieving a balanced articulation.
complete denture—A dental prosthesis replacing all natural dentition and the associated structures of the maxilla or mandible.
compression molding—The method of denture molding employing a two-piece split mold. Acrylic resin dough is placed between the two halves of the mold, compressed, and cured under pressure.
concave—Curving inward; dished in.
condensation—The process of making a substance more compact.
conductivity—The property of conducting heat or electricity. Silver and copper are two of the best conductors.
condylar guidance—A device on an articulator intended to produce guidance in the articulator's movements similar to that produced by the paths of the condyles in the temporomandibular joints.
condylar guide inclination—The angle formed by the inclination of a condylar guidecontrol surface of an articulator to a specified reference plane; for example, horizontal condylar guide inclination.
condylar indication—The scale on the articulator measuring the amount of condylar inclination.
condylar path—The path of the mandibular condyle in the temporomandibular joint during mandibular movement.
condyle—The rounded articular surface at the articular end of a bone. In the temporomandibular joint, it is football shaped and found on the end of the condyloid process of the mandible.
condyle head—See condyle.
congenital—A condition occurring in the offspring before birth.
connective tissues—The tissues that bind together and support the various structures of the body.
connector—

1. In RPDs, a part of the framework that serves to connect two parts with another. Connectors are divided into major and minor.
2. In fixed prosthodontics, the portion of a fixed partial that connecting the retainers and the pontics.

contact surface—The area on a tooth touching an adjacent tooth. Normally found on both mesial and distal surfaces of all teeth except the third molars. Also called contact area.
continuous bar connector—A type of lower RPD that employs a second or auxilliary bar with a lingual bar. Also called a continuous bar retainer and double lingual bar.

contour—
1. (noun) The shape of a surface.
2. (verb) To shape into a desired form.

convex—A surface curved outward toward the viewer.
cope—The upper half of a denture flask.
coping—A thin covering or crown.
copper band—The hollow cylinders of thin copper in various diameters used to make impressions for crowns and inlays.
coronal—Pertaining to the crown portion of a tooth.
creep—To change shape permanently due to prolonged stress or exposure to high temperatures.
crest of the ridge—The high point of the alveolar ridge.
crossbite—See reverse articulation.
cross-section—A cut section of an object made so the cut is perpendicular to the object's long axis.
crown—
1. In anatomy, the part of the tooth covered by enamel.
2. In the laboratory, an artificial replacement that restores missing tooth structure with a metal or ceramic restoration.

crucible—The heat resistant container used to hold the metal while it is melted in preparation for casting.
crucible former—The device used to hold the sprued wax pattern upright in the casting ring when it is invested. Shaped to form a funnel for the gold as it enters the mold. Sometimes erroneously called a sprue former.
crushing strength—The amount of pressure required to crumble or crush a material.
crystallization—The solidification of a gaseous or liquid substance.
cure of denture—See polymerization.
Curve of Spee—See anteroposterior curve.
cusp—A cone-shaped elevation on the occlusal surface of a molar or bicuspid and on the incisal edge of the cuspid.
cuspid—See canine.
cuspid line—The vertical line the dentist scribes on the record rims to indicate the position the cuspid is to occupy in the setup.
custom tray—An impression tray made on a preliminary cast used to make the final impression.
cyanoacrylate—A quick setting adhesive. Also called super glue.
dappen dish—A glass medicine dish.
debubblizer—A wetting agent used to lower surface tension of the water in an investment so it flows more easily over the wax pattern.
decalcification—The loss or removal of calcium salts from calcified tissues. Characterized by areas of white, splotchy opacity on the surfaces of teeth.
deciduous tooth—A tooth that will be replaced by a permanent tooth.
decreased occlusal vertical dimension—A reduction in the distance between two points when the teeth are in occlusal contact. Also called closed bite.
deflask—The removal of the denture from the mold in the flask.
dehydrate—To remove the moisture from a substance.
density—The mass of a substance per unit volume.
dental arch—A term given to the horseshoe-like arrangement of either the upper or lower teeth or the residual ridge.

dental implant—A prosthetic device implanted within the bone to provide retention and support for a fixed or removable appliance.
dental plaster—A gypsum refined by grinding and heating.
dental stone—A specially calcined gypsum physically different from dental plaster in that the grains are nonporous and the product is stronger.
dental wax—Any of the various waxes used in dentistry.
dental wrought wire—An alloy in wire form manufactured by drawing it through die plates of varying diameters.
dentin—The tissue of the tooth underlying the enamel of the crown that makes up the bulk of the substance of the tooth.
dentition—The natural teeth as a unit.
dentulous—With teeth; as opposed to edentulous (without teeth). Also called dentate.
denture—See complete denture.
denture base material—The material of which the denture is made; exclusive of the teeth.
denture border—

1. The margin of the denture base at the junction of the polished surface and the impression surface.
2. The peripheral border of a denture base at the facial, lingual, and posterior limits. Also called peripheral roll.

denture foundation area—The surfaces of the oral structures available to support a denture.
denture staining—The process of adding pigments to the facial flange of the denture to more closely simulate natural mouth tissue.
deoxidizing—To remove oxides from the surface of a gold alloy by heating the alloy in an acid or other proprietary agent. Also called pickling.
deoxidizing investment—See reducing investment.
desiccate—To make dry; to remove all moisture.
desirable undercut—The part of an abutment tooth below the survey line that can be engaged by the clasp tip to retain the RPD.
developmental groove—A groove formed by the union of two lobes during the development of the crown of a tooth.
devitrification—To eliminate vitreous (glass) characteristics partly or wholly; to recrystallize.
diagnosis—The determination of the nature of the disease condition present in a patient.
diagnostic cast—A reproduction of the mouth for the purpose of study and treatment planning.
diamond point—Small mounted points impregnated with diamond particles, used in the dental hand piece.
diastema—A space between the teeth.
diatoric—A channel placed in the denture tooth as a mechanical means of retaining it in the denture base.
die—The positive reproduction of a prepared tooth in any suitable substance.
dimensional stability—The ability of a material to retain its size and form.
direct current—The current in which the electricity flows along a conductor in one direction.
direct inlay technique—The method of inlay construction in which the wax pattern is made on the tooth in the mouth by the dentist.
direct retainer—The part of an RPD appliance designed to directly resist dislodgement; for example, the clasp.
disc—A flat circular plate, usually impregnated with an abrasive agent, used in the laboratory to smooth and polish. The abrasive agent may be silica, garnet, emery, or some other agent.
disclude—Separation of the maxillary and mandibular teeth.

disinfectant—An agent that kills infecting agents; for example, phenol.
distal—A surface facing away from the midline of the mouth; the distal surface of a tooth.
double lingual bar—See continuous bar connector.
dough—The moldable mixture formed by combining acrylic resin powder and liquid.
dovetail—A widened portion of a prepared cavity used to increase retention.
dowel—A post, usually made of metal, fitted into the prepared root canal of a natural tooth. Also called post and core.
drag—A term for the lower half of a denture flask.
dry heat—The heat of a flame (as opposed to moist heat from a water bath).
ductility—The property of a metal that permits it to be drawn into a wire without breaking.
duplicate cast—A cast produced from an impression of another cast.
duplicating a cast—The process of producing a duplicate cast.
duplicating material—A substance such as hydrocolloid used to make an impression so an accurate copy of the cast can be produced.
eccentric—Any position of the mandible other than its normal position.
edentulous—Without teeth; may be an area, arch, or entire mouth.
elastic—Susceptible to being stretched, compressed, or distorted and then tends to resume the original shape.
elastic limit—The extent to which a material may be deformed and still returned to its original form after removal of the force.
electric current—The flow of electrons from one point to another.
electrode—Either pole of an electric mechanism.
electrolyte—The liquid used in electroplating.
electroplating—The process of covering the surface of an object with a thin coating of metal by means of electrolysis.
electropolishing—The removal of a minute layer of metal by electrolysis to produce a bright surface.
elongation—The amount a metal will stretch before breaking.
embrasure—The space defined by surfaces of two adjacent teeth. The space is divided into occlusal/incisal, facial, lingual, and gingival areas.
emergence profile—The contour of a tooth or restoration, such as a crown on a natural tooth or dental implant abutment, as it relates to the adjacent tissues.
emery—An abrasive substance used as a coating on paper discs used to smooth and polish.
eminence—A prominence or projection, especially on the surface of a bone.
enamel—The white, compact, and very hard substance that covers and protects the dentin of the crown of teeth.
enamel rod—The microscopic prisms, held together by an intercementing substance and forming the bulk of the enamel.
endodontia—The branch of dentistry dealing with diagnosing and treating nonvital teeth.
envelope of motion—The three-dimensional space made by the mandibular border movements in which all unstrained mandibular movement occurs.
equilibration of occlusion—See occlusal equilibration.
erosion—The superficial wearing away of tooth substance due to chemical agents. Most often seen on labial and buccal surfaces.
esthetics—Harmony of form, color, and arrangement. The quality of a pleasing appearance.
etiology—The causative factors which produce a disease.

eugenol—
1. An aromatic oil derived from clove oil to relieve pulpal pain.
2. May also be combined with zinc oxide to make a temporary sedative cement.
3. A principal ingredient in zinc oxide eugenol impression pastes.

excursion—The movement occurring when the mandible moves away from MI.
external or lateral—Surfaces farther from the medial plane.
extracoronal—Outside of the crown portion of a natural tooth.
extraoral—Outside of the mouth.
extrinsic—Outside, as opposed to intrinsic or inside.
extrinsic coloring—Coloring from without; applying color to the external surface of a prosthesis.
extrusion—The movement of teeth beyond the natural occlusal plane; may be accompanied by a similar movement of their supporting tissues and/or bone.
face form—The outline of the face from an anterior view.
face profile—The outline of the face from the side or lateral view.
facebow—A device used to record the relationship between the maxillae and the temporomandibular joints and to transfer this relationship to the articulator.
facebow fork—A device used to attach the facebow to an occlusion rim, or to index the maxillary teeth, for a facebow transfer.

facial—
1. Pertaining to the face.
2. The surface of the tooth or appliance nearest the lips or cheeks. Used synonymously for the words buccal and labial.

facing—The thin veneer of porcelain or resin that closely fits a metal backing; used in fixed dentures and RPDs.
facial moulage—A negative reproduction of the face made out of artificial stone, plaster of paris, or other similar materials.
female attachment—See matrix.
festooning—Shaping and contouring a denture wax-up or the cured denture base to simulate natural tissue.
fin—A flash of excess metal that results from a fracture in the investment mold.
fineness—The proportion of pure gold in a gold alloy; the parts per 1,000 of gold.

finish line—
1. On an artificial tooth, the raised line in the cervical region used as a guide to trim the wax on the denture base material.
2. In RPDs, the special preparation placed in the metal to form a definite sharp junction between the metal and acrylic resin.

finishing—
1. The process of smoothing and trimming a prosthesis before its final polish.
2. The entire procedure of smoothing and polishing.

first molar—The 6-year molar. The sixth tooth from the midline.
fissure, dental—A fault in the surface of a tooth caused by the imperfect joining of the enamel of the different lobes.
fistula—An abnormal passage resulting from incomplete healing.
fixed bridge—See fixed partial denture.
fixed partial denture—A fixed dental prosthesis, cemented to the prepared teeth or attached to implants, restoring one or more, but fewer than all of the missing natural teeth.

fixture—
1. Something fixed or attached.
2. The intraosseous portion of a dental implant.

flange—The part of the denture base that extends on the facial or lingual surface from the finish lines of the teeth to the periphery.

flash—
1. The overflow of denture base material that results from over-packing a denture mold.
2. The thin metal fins that sometimes occur on castings.

flash point—The temperature at which a vapor ignites.

flask—
1. A metal case or tube used in investing procedures. Holds the casts and the investment during the packing and curing phases of denture construction. The metal ring used to invest a wax pattern.
2. To flask or surround; to invest.

flasking—The process of investing a waxed pattern to create a mold.

flat plane tooth—See nonanatomic teeth.

flexible—Capable of being bent without breaking.

flexure line—See vibrating line.

flow—Deformation of a material under loading.

flow on wax—To melt and apply the wax in liquid form.

flux—
1. A substance used to increase fluidity and prevent or reduce oxidization of a molten metal.
2. Any substance applied to the surfaces to be joined by soldering to clean and free them from oxides and promote union.

foil—An extremely thin, pliable sheet of metal, usually of variable thickness.

foramen—An opening in a bone or tooth allowing for the entrance or exit of blood vessels and nerves; for example, the apical foramen in the tooth.

fossa—An anatomical pit, groove, or depression.

fovea palatina—Two small pits or depressions in the posterior aspect of the palate, one on each side of the midline at or near the attachment of the soft palate to the hard palate.

fox plate—A device occasionally used by dentists to establish the occlusal plane on occlusion rims. Used to compare with arbitrary lines or planes on the head; for example, Camper's line.

framework—The metal skeleton of an RPD or metal-ceramic fixed partial denture.

Frankfort horizontal plane—A horizontal plane represented in profile by a line between the lowest point on the margin of the orbit to the highest point on the margin of the auditory meatus. It nearly parallels the upper member of an articulator, making it a useful plane of orientation for setting denture teeth.

freehand waxing—A method of waxing in which wax is flowed from an instrument directly onto the refractory cast to form the RPD framework.

freeway space—See interocclusal rest space.

frenum—See frenulum. (Plural: frenums or frena.)

frenulum—The small band or fold of connective tissue covered with mucous membrane that attaches the tongue, lips, and cheeks to adjacent structures.

friable—Capable of being easily crumbled into small pieces; brittle.

frontal bone—The bone that forms the front part of thecranium.

fulcrum—The support on which a lever rests when a force is applied. In RPDs, an abutment tooth may act as a fulcrum for the appliance.

fulcrum line—An imaginary line through the abutment teeth around which an RPD would rock if not prevented from doing so.
functional mandibular movements—All natural, proper, and characteristic movements of the mandible made during speaking, chewing, yawning, swallowing, etc.
furnace—
1. burnout—The gas or electric oven used to eliminate the wax from a mold.
2. porcelain—A specially constructed oven used to fuse dental porcelain.

fusible—Able to be melted.
fusion temperature—The highest temperature to which an alloy can safely be exposed in the soldering process. Usually close to the lower limit of the melting range.
gauge—A measure of the thickness or diameter of an object.
galvanic current—A current of electricity produced by chemical action between two metals suspended in liquid.
garnet—An abrasive, glass-like coating on paper discs used for smoothing and polishing.
gelatin—The solidification of a liquid substance in which a gel forms and acts as a matrix between the undissolved particles. Alginate gels as it sets.
gingiva—The gum tissue.
gingival crevice—The shallow fissure formed by the attachment of the gingiva to the crown of the tooth.
gingivectomy—The removal of the gingival tissue from around the necks of the teeth.
gingivitis—An inflammation of the gingiva.
glaze—The final firing of porcelain in which the surface is vitrified and a high gloss is imparted to the material.
gold—A noble metal used extensively in dentistry, most commonly in the form of an alloy.
gold alloy—An alloy consisting of gold mixed with other metals, such as silver, platinum, copper, and palladium.
grain—The basic unit for the apothecaries' avoirdupois and troy systems of weight. A troy grain is 1/24 of a pennyweight.
grain growth—The merging of smaller grains into larger grains of metal during prolonged heating of the appliance at excessively high heat. This process produces a brittle metal.
gram—A unit of weight in the metric system, equal to approximately 15 grains in the apothecaries' system of weight.
groove—A long narrow depression on the surface of a tooth, such as the indentation between two cusps.
group function—Multiple contact relations between the maxillary and mandibular teeth in lateral movements on the working side; simultaneous contact of several teeth act as a group to distribute occlusal forces. Also called unilateral balance.
gypsum—The natural hydrated form of calcium sulfonate.
half flasking—The process of investing the denture in the lower or first half of the denture flask.
hamular notch—See pterygomaxillary notch.
handpiece or straight handpiece—The instrument used to hold and spin burs and mounted points in dental operations.
hard palate—The anterior two-thirds of the roof of the mouth composed of relatively hard, unyielding tissue.
hardening heat treatment—See tempering.
heat soaking—The process of allowing the invested inlay or RPD to remain in the oven at the burnout temperature for a prescribed length of time to remove all carbon and properly expand the mold.

heat treatment—In its broadest sense, the annealing or tempering of an alloy. (Sometimes the term heat treatment is confined solely to the tempering.)
heel of a denture—The posterior extremities of a denture. The heel corresponds with the retromolar pad area of the lower denture and the tuberosity area of the upper denture.
height of contour—The greatest circumference of the crown of a tooth.
high lip line—The horizontal line the dentist marks on the occlusion rim to indicate the approximate level of the upper lip when the patient smiles. Used to help select the length of the anterior teeth.
highly adjustable articulator—An articulator that allows replication of three dimensional movement of recorded mandibular motion.
hinge axis—See transverse horizontal axis.
hinge joint—A joint that moves in only two directions, such as the knee joint.
horizontal overlap—The projection of teeth beyond their antagonists in a horizontal direction. Also called overjet.
hue—The basic color. White, black and grays possess no hue.
humidor—A container used to maintain a humid atmosphere.
hydration—The addition of water to a substance. Plaster that has absorbed water from the air is said to be hydrated.
hydrocal—A form of gypsum that is harder and more durable than ordinary dental plaster.
hydrocolloid—An impression material used extensively in dentistry. It may be reversible agar type or irreversible alginate type.
hydrocolloid, irreversible, alginate type—An impression material supplied as a powder to be mixed with water. It can only be used once; hence, the name "irreversible."
hygienic pontic—A pontic that is easier to clean because it has a domed or rounded cervical form and does not have contact with the ridge. Generally used in the posterior where esthetics are of no concern.
hyperplasia—The abnormal overgrowth of a part. Increase in size and number of cells.
hyperplastic tissue—Excessive tissue proliferation, usually as a response to chronic irritation.
immediate denture—A complete denture or RPD fabricated for placement immediately following the removal of natural teeth.
implant—See dental implant.
impression—A negative reproduction of a given area.
impression paste—A material usually supplied as a base and a hardener to be mixed together and used as a corrective impression material.
impression plaster—Plaster of paris made expressly for impressions of the mouth. It contains accelerators and, usually, coloring and flavoring agents. It may also contain starch.
impression tray or stock tray—See stock impression tray.
impression tray, individual—See custom tray.
impression, final—An impression used to form the master cast.
impression, functional—An impression that captures supporting structures in the form they will assume during mastication.
impression, pickup—An impression in which an object is lifted off the teeth by the impression material. When the cast is poured, the object will be seated in its proper place on the cast.
impression, two-piece—An impression taken in two separate steps with (usually) two separate types of impression materials.
incisal—The cutting edge of the anterior teeth.
incisal edge—The biting edge of an anterior tooth.
incisal pin—See anterior guide pin.
incisal rest—A rigid extension of an RPD that contacts a tooth at the incisal edge.

incisal table—See anterior guide table.
incisive foramen—An exit hole for blood vessels and nerves found behind the maxillary central incisors in the midline. The foramen is covered by the incisive papilla.
incisive papilla—A small pad of tissue located at the midline just behind the crest of the maxillary ridge which protects the vessels and nerves as they exit from the incisive foramen.
incisor—Teeth with cutting edges; the centrals and laterals.
inclination—Deviation of the long axis of a tooth with respect to a vertical line of reference. The four basic directions of inclination are described as facial, lingual, distal, and mesial.
inclined plane—A surface that slopes at an angle from the horizontal plane.
index—A guide, usually of a rigid material, used to reposition teeth or other parts in some original position.
indirect inlay technique—A method of waxing the pattern on a die outside of the mouth.
indirect retainers—A part of an RPD framework located on the opposite side of the fulcrum line from tipping forces and designed to counteract those forces.
induction casting machine—A specially constructed casting machine that melts metal by using an electric current of extremely high frequency.
induction current—The process of generating an electric current in a conductor using a magnetic field.
inferior—Below**.**
infrabulge—The area on a tooth below the survey line.
infrabulge clasp—See bar clasp.
ingot—Gold supplied in the form of one or two pennyweight (1.55 or 3.1 grams) pieces. Some of the base metal alloys are supplied in small cylinders and are also called ingots.
initial set—The first hardening of a gypsum product.
injection flask—A denture flask designed to permit compression molding of an acrylic resin denture with a sprue leading into the mold.
injection molding—The method of denture molding by adapting a plastic material into a closed mold by forcing or pressing the material through sprue channels.
inlay—A restoration made to fit inside a prepared tooth cavity and cemented into place.
insertion—

1. The attachment point for a muscle in the bone or other structure to be moved.
2. See placement.

intaglio surface—The portion of the denture or other restoration having its contour determined by the impression; the internal or reversal surface of an object. Also called internal surface or tissue surface.
interarch distance—The interridge distance; the vertical distance between the maxillary and mandibular edentulous arches under specified conditions. Also called intermaxillary space.
intercondylar distance—The distance between the rotational centers of two condyles.
interdigitation—See maximum intercuspation (MI).
interim prosthesis—A fixed or removable prosthesis, designed to enhance esthetics, stabilization, and/or function for a limited period of time, after which it is replaced by a permanent prosthesis.
interlock—A device connecting a fixed unit or a removable prosthesis to another fixed unit.
interlock fixed partial denture—A fixed partial denture constructed in two pieces containing a matrix and patrix. Also called broken stress fixed partial denture.
intermaxillary space—See interarch distance.
intermediate abutment—A natural tooth located between terminal abutments serving to support a fixed or removable prosthesis.
internal or medial—Surfaces toward the medial plane.

interocclusal rest space—The difference between the vertical dimension at rest and the vertical dimension in occlusion. Also called freeway space.
interproximal—Between adjoining tooth surfaces.
interproximal space—The space between two adjacent teeth.
intraoral—Within the mouth.
intraoral tracing—A tracing made within the mouth.
intrinsic coloring—Coloring from within; the incorporation of a colorant within the material of a prosthesis or restoration.
inverted spruing—A method of spruing a cast RPD in which a hole is made in the investment model so the sprue approaches the wax pattern from underneath.
invest—To envelop or embed an object in an investment material.
investment—

1. The gypsum material used to enclose a denture wax pattern in the flask, forming a mold.
2. In fixed or removable prosthetics, a heat resistant material used to enclose a wax pattern before wax elimination.

investment cast—See refractory cast.
jacket crown—See ceramic crown or resin crown.
jaw—A common name for the maxillae or mandible.
jaw relation—See maxillomandibular relationship.
Kennedy classification—A system of classifying partially edentulous arches based on the pattern of tooth loss.
key—

1. The preparation, such as a groove made in an object, against which a stone matrix is poured. The hardened stone matrix can then be removed and returned to its original position as often as desired.
2. To prepare a surface with a cut or groove.

Knoop hardness—A surface hardness test using a diamond stylus.
labial—Pertaining to the lips. The surface of an anterior tooth opposite the lips.
labial bar—The metal piece or major connector connecting the right and left sides of a lower RPD. Contoured to the labial tissue anterior to the lower teeth.
labial frenum—The connective tissue attaching the upper or lower lip to the alveolar ridge at or near the midline.
labial notch—The V-shaped indentation in an impression or denture, formed by or for the labial frenum.
lamina dura—The layer of compact bone forming the wall of a tooth socket.
land area—The portion of a dental cast extending beyond the impression's replica surface, laterally defining the area between the end of the replica's surface and the cast.
lateral condylar path—The path of the condyle in the temporomandibular fossa when the mandible moves laterally.
lateral incisor—An anterior tooth located just distal to the central incisor. The second tooth from the midline.
lateral interocclusal record—A jaw relationship record of the teeth with the mandible in a functional position.
laterotrusion—Condylar movement on the working side in the horizontal plane. This term may be used in combination with terms describing condylar movements in other planes; for example, laterodetrusion, lateroprotrusion, lateroretrusion, and laterosurtrusion.
ledging—The process or method of forming a ledge in the blockout wax on an abutment tooth. The ledge is created in the exact area where the retentive tip of the clasp is to be placed.

lesion—Any hurt, wound, or local degeneration.
leverage—A mechanical principle in which force is multiplied by extending the lifting force farther from and on the opposite side of the fulcrum from the object to be moved.
line angle—The angle formed by the union of two surfaces of a tooth. The junction of the mesial surface with the labial surface of an incisor is called the mesiolabial line angle.
lingual—Pertaining to the tongue. The surface of a tooth or prosthesis next to the tongue is the lingual surface.
lingual bar—The metal piece of a major connector used to connect the right and left sides of a lower RPD. It is contoured to the lingual tissue behind and below the anterior teeth.
lingual flange—The part of a denture or impression extending from about the crest of the ridge to the periphery on the lingual surface.
lingual frenum—The band of tissue attaching the tongue to the floor of the mouth.
lingual notch—

1. The indentation on the lingual periphery of a lower impression made by the lingual frenum.
2. An indentation provided in the same area of the denture to allow free movement of the lingual frenum.

lingual plate—The solid plate of metal that is continuous with the lingual bar and rests against the lingual surfaces of the anterior teeth. It functions as a connector and sometimes as a periodontal splint for loose teeth.
lingual rest—A rest on an RPD placed on the lingual surface of an anterior tooth. Sometimes used on the free end of a cantilever fixed partial denture.
lingualized articulation—A denture occlusion using anatomic maxillary teeth against nonanatomic mandibular teeth. Also called lingualized occlusion.
long axis—An imaginary line passing lengthwise through the center of a tooth.
low fusing alloy—Any one of the alloys that melt at very low temperatures.
major connector—A part of an RPD framework connecting one side of the appliance with the other. A lingual bar is an example.
male attachment—See patrix.
malleability—The property of a metal that permits it to be extended in all directions without breaking.
malocclusion—Defective occlusion or deviation from normal occlusion.
malposition—Incorrect positioning of teeth.
mamelons—Small elevations of enamel present on incisors as they erupt; quickly worn down during mastication.
mandible—The lower jaw.
mandibular—To refer to the mandible or lower jaw.
mandibular translation—The translatory (medio-lateral) movement of the mandible when viewed in the frontal plane.
mandrel—The spindle or shank that fits into the lathe chuck or handpiece and holds a stone or disc.
margin—

1. A border or boundary, as between a tooth and a restoration.
2. The outer edge of a crown, inlay, or onlay.

marginal ridge—The elevations of enamel forming the mesial and distal boundaries of the occlusal surfaces of the posterior teeth and the mesial and distal boundaries of the lingual surfaces of the anterior teeth.
masking—The process of applying an opaque covering to camouflage the metal component of a prosthesis. Also called opaqueing.

masseter muscle—A muscle of mastication that extends from the external surface of the angle of the mandible to the zygomatic process.
master cast—The positive reproduction in stone made from the final impression.
master impression—The negative impression from which the master cast is made.
mastication—The chewing of food.
masticatory cycle—A three-dimensional representation of mandibular movement produced during the chewing of food. Also called chewing cycle.
matrix—
1. The mold in which something is formed to use as a relationship record. See index.
2. The portion of a dental attachment system that receives the patrix. Also called female attachment.

maxilla—The upper jaw.
maxillary—To refer to the maxilla or upper jaw.
maxillary orthopedic appliance (biteguard)—See maxillary orthotic appliance.
maxillary orthotic appliance—An acrylic resin appliance designed to cover the occlusal and incisal surfaces of the maxillary teeth of a dental arch to stabilize the teeth and/or provide a flat platform for unobstructed excursion glides of the mandible.
maxillary tuberosity—An area in the form of a bulge at the posterior end of the maxillary alveolar ridge.
maxillofacial prosthetics—A subspecialty of prosthodontics where prostheses are fabricated to replace missing or damaged head and neck structures; for example, artificial eyes, ears, noses, or obturator dentures.
maxillomandibular relationship—Any spatial relationship of the maxilla to the mandible. Also called jaw relation.
maxillomandibular relationship record or registration—A record of the relationship of the mandible to the maxillae.
maximum intercuspation (MI)—The complete intercuspation of the opposing teeth independent of condylar position.
medial raphe—The fibrous tissue extending along the middle of the hard palate.
median line—
1. An imaginary line extending through the middle of the face.
2. The midline of a cast.

median (medial)—Toward the middle.
median plane—The plane dividing the body in equal left and right halves.
melting point—The point at which a pure metal becomes molten, or changes from a solid to a liquid.
melting range of an alloy—The interval between the temperature at which the alloy begins to melt (solidus) and the temperature at which it is completely molten (liquidus).
mental foramen—A foramen on the facial surface of the mandible near the roots of the bicuspids, through which the mental vessels and nerves pass.
mesial—The surface of a tooth nearest the midline in a normal occlusion.
metal—A substance that, to some degree, is malleable and ductile and conducts heat and electricity.
metal base denture—See cast base.
metal ceramic restoration—A fixed restoration consisting of a metal alloy substructure covered with a veneer of porcelain. Also known as porcelain-fused-to-metal and ceramo-metal restorations.
metamerism—The phenomenon occuring when the color of two objects match in one lighting condition, but do not match in others.
methyl-methacrylate—The chemical name for synthetic acrylic resin. One of its most common uses is as denture base material for complete dentures and RPDs.

metric system—A decimal system of weights and measures. The basic units are the meter for length and grams for weight or mass.
midline—The imaginary line through the middle of an object, dividing the object into equal parts.
milliampere—One-thousandth (1/1000) of an ampere.
millimeter—A unit of length in the metric system equal to 1,000 microns or one-thousandth of a meter.
mill in—
1. The procedure of refining occluding surfaces through the use of abrasive materials.
2. The machining of boxes or other forms in cast restorations to be used as retainers for fixed or removable prostheses.

minor connector—The part of an RPD uniting clasps and rests to the remainder of the framework.
modeling plastic impression compound—A thermoplastic dental impression material.
modulus of elasticity—A measure of the elasticity of a material determined by its ratio of stress to strain. As the modulus of elasticity rises, the material becomes more rigid.
molars—The teeth situated in the posterior region of the mouth. The teeth behind the premolars.
mold—
1. The hollow form or matrix in which an object is cast or shaped.
2. The shape of an artificial tooth.

monomer—A chemical compound that can undergo polymerization. The most common is methyl methacrylate liquid.
morphology, tooth—The study of the form and structure of a tooth.
mounting—
1. The laboratory procedure of attaching a cast to an articulator.
2. The relationship of dental casts to each other and the instrument to which they are attached.

mounting plate—The removable metal, resin, or plastic piece that attaches the dental casts to the upper and lower members of the articulator.
mucolabial fold—The junction between the cheek and the alveolar mucosa of the upper or lower jaw.
mucous membrane—The soft tissue outlining the mouth.
mutually protected articulation—An occlusal scheme in which the posterior teeth prevent excessive contact of the anterior teeth in MI and the anterior teeth disengage the posterior teeth in all mandibular excursive movements.
mutually protected occlusion—See mutually protected articulation.
mylohyoid ridge—An oblique ridge on the lingual surface of the mandible that extends from the level of the roots of the last molar teeth and serves as a bony attachment for the mylohyoid muscles forming the floor of the mouth.
nasal bone—The two small bones forming the arch of the nose.
nasolabial fold—The crease between the nose and the upper lip.
noble metal—A metal not readily oxidized at ordinary temperatures or by heating; for example, gold or platinum.
non-noble—A metal that is expected to form oxides or sulfides; for example, silver or tin.
nonanatomic teeth—Artificial teeth that do not conform to the anatomy of natural teeth. Also called flat-plane or zero-degree teeth.
nonprecious—Metals or alloys that are not scarce and do not possess a high intrinsic value. Examples are nickel and chromium. The term "nonprecious" is regarded by many as less technically correct than the preferred term "base metal."
nonworking side—The side of the mandible that moves toward the median line in a lateral excursion. The side opposite the side toward which the mandible moves. Also called balancing side.

nonworking side occlusal contacts—Contacts of the teeth on the side opposite the side toward which the mandible moves in articulation. Also called balancing side occlusal contacts.
oblique ridge—The transverse ridge of enamel crossing the occlusal surface of the upper molars from mesiolingual to distofacial.
obturator—A prosthesis used to close an abnormal opening between the oral and nasal cavities.
occipital bone—The bone forming the posterior portion and base of the skull.
occlude—To bring together; to bring the upper and lower teeth together.
occlusal equilibration—

1. To equalize.
2 To remove high spots and areas of interference. To adjust the contact areas between the upper and lower teeth so each tooth carries an equal share of the occlusal load.

occlusal plane—The plane established by the occlusal surfaces of the bicuspids and molars of both the upper and lower jaws in opposition. May also refer to the same plane established in the occlusion rims.
occlusal rest—The part of the RPD that contacts the occlusal surface of the tooth.
occlusal surface—The biting, grinding, or chewing surfaces of molars and bicuspids.
occlusal vertical dimension—The distance measured between two points when the occluding members are in contact. Also called vertical dimension of occlusion.
occlusion—

1. The act or process of closure or of being closed or shut off.
2. The static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth.

occlusion rim—See record rim.
opaqueing—See masking.
open bite—Slang for open occlusal relationship.
open occlusal relationship—The lack of tooth contact in an occluding position. Also called open bite.
orbitale—The lowest point in the margin of the orbit (directly below the pupil when the eye is open and the patient is looking straight ahead) that may readily be felt under the skin. Can be used as a reference point for making a facebow record.
orientation of occlusal plane—The position the occlusal plane is to occupy between the upper and lower ridges.
origin—The fixed point of attachment of a muscle.
oven, burnout—See furnace.
overdenture—A prosthesis that covers and is partially supported by natural teeth, tooth roots, and/or dental implants.
overjet—See horizontal overlap.
overjet principle—The spruing method used to reduce casting turbulence in an RPD mold. In this system, the sprue leads exit the main sprue below its tip.
ovoid arch form—A dental arch that is oval or round in outline.
oxidation—The process of heating a metal substructure in a porcelain furnace to cleanse the porcelain-bearing surfaces of contaminants and produce an oxide layer for porcelain bonding. Also called degassing.
oxidize—To combine with oxygen; for example, iron rust or brass tarnish.
oxypropane torch—A blowtorch mixing propane gas and pure oxygen to produce a much hotter flame than either natural gas and air or propane and air.
packing a denture—To place the acrylic dough in the mold and close the flask.
palatal bar connector—A major connector of an RPD that crosses the palate and is characterized by being relatively narrow anteroposteriorly.

palate—The roof of the mouth; classified into both hard and soft palate areas.
palatine bone—The paired bones forming the posterior one-third of the hard palate.
pantograph—An instrument used to graphically record in one or more planes paths of mandibular movement and provide information for the adjustment of an articulator.
papillary hyperplasia—Abnormal tissue growth found on the hard palate.
paraffin—A white, waxy hydrocarbon distilled from coal or petroleum and used to compound several dental waxes.
parafunctional mandibular movement—Disordered movement of the mandible; for example, movements associated with tension, emotion, or aggression.
parietal bone—The two quadrilateral bones forming the sides of the skull.
partial veneer crown—A restoration restoring all but one coronal surface of a tooth, usually not covering the facial surface.
Passavant's cushion or pad—A small bulge of soft tissue on the posterior and lateral walls of the nasopharynx at the level of the hard palate. Aids in closing the opening between the nasal and oral cavities when swallowing.
Passavant's ridge—See Passavant's cushion or pad.
passive—

1. Not active or in operation.
2. Resistant to corrosion.
3. Existing or occurring without being active, direct, or open.

passivity—The quality or condition of inactivity or rest assumed by the teeth, tissues, and denture when an RPD is in place, but not under masticatory pressure.
pathogen—Any disease producing agent; for example, a virus, bacterium, or microorganism.
pathogenic—Capable of producing disease.
path of insertion—See path of placement.
path of placement—The specific direction in which a prosthesis is placed on the abutment teeth.
patrix—The extension of a dental attachment system that fits into a matrix. Also called male attachment.
pennyweight—See Troy weight.
periapical—The area around the apex or root tip of a tooth.
periodontics—The branch of dentistry dealing with the science and treatment of the tissues and bone surrounding the teeth.
periodontium—Collectively**,** the tissues surrounding and supporting the tooth.
periosteum—The tough fibrous membrane covering the outer surface of all bone except at articular surfaces.
peripheral roll—See denture border.
petrolatum—A lubricant used as a separator in many dental laboratory procedures.
phonation—Action constituting a source of vocal sound.
phonetics—

1. The science or study of speech sounds and their production, transmission, and reception.
2. The symbols representing the speech sounds of a language. A denture patient's ability to say "s" and "ch" clearly with the appliance in place.

physiology—The branch of biology dealing with the functions and activities of living organisms and their parts, including all physical and chemical processes.
physiologic rest position—The position of the mandible where all the masticatory muscles are in a relaxed state.
pier abutment—See intermediate abutment.

pigment—A finely ground powder used to impart color to a material.
placement—The process of directing a prosthesis to a desired location; the introduction of prosthesis into the patient's mouth. Also called insertion.
plaster of paris—A white, powdery, slightly hydrated calcium sulfate used to make casts and molds when combined with water to form a quick setting paste.
plastic—

1. Capable of being shaped or formed.
2. Pertaining to the alteration of living tissues.
3. Any of numerous organic synthetic or processed materials that are generally thermoplastic or thermosetting polymers. They can be cast, extruded, molded, drawn, or laminated into films, filaments, and objects.

pit—A depression usually found where several developmental lines intersect.
point angle—The angle made on a tooth by the convergence of three planes or surfaces.
polishing agent—Any material used to impart a luster to a surface.
polymer—Compound (powder) composed of smaller organic units. Most common in dentistry is methyl methacrylate powder.
polymerization—The reaction that takes place between the powder and liquid during the curing of acrylic resin. Characterized by joining together molecules of small molecular weights to a compound of large molecular weight.
pontic—The part or parts of a fixed partial denture replacing a missing tooth or teeth, usually restoring function and space occupied by the natural crown.
porcelain—A ceramic material. In dentistry, most porcelains are glasses and are used in the fabrication of teeth for dentures, pontics, facings, metal ceramic restorations, and other restorations.
porcelain fused to metal restoration—See metal ceramic restoration.
porous—Pitted; not dense. Containing voids and bubbles.
porosity—The presence of voids or pores within a structure.
post—

1. A retention mechanism for acrylic resin teeth used on an RPD.
2. The portion of a dowel (post and core) restoration that extends into the root portion of a tooth.

posterior—Situated in back of or behind.
posterior palatal seal—See postpalatal seal
postpalatal seal—An elevation of acrylic resin on the tissue side of the posterior border of a maxillary appliance for the purpose of sealing it against the resilient soft tissue in the palate.
posterior tilt—When a cast is surveyed with the posterior part of the cast lower than the anterior.
posterior teeth—Premolars and molars.
precious metal—A metal containing primarily elements of the platinum group, gold, and silver.
precious metal alloy—An alloy predominantly composed of elements considered precious.
precision attachment—A retainer consisting of a metal receptacle (matrix) and a closely fitting part (patrix). The matrix is usually contained within the normal or expanded contours of the crown on the abutment tooth; the patrix is attached to a pontic or RPD framework.
preliminary cast—A cast formed from the preliminary impression used for the purpose of diagnosis, treatment planning, or the fabrication of a custom tray.
preliminary impression—A negative reproduction made to form a preliminary cast.
process—

1. A prominence or projection of bone.
2. In dentistry, any technical procedure that incorporates a number of steps; for example, the procedure of polymerization of dental resins for prostheses or bases.

prognosis—A forecast of the probable outcome of an illness.
propane—A flammable gas found in petroleum and natural gas.
prophylaxis—The removal of calculus and stains from the teeth.
proportional limit—The amount of stress a metal will stand before it is permanently stretched or bent; a measure of the strength and toughness of an alloy.
prosthesis—An artificial replacement for a lost part of the body. In dentistry, it is used in the more limited sense of a strictly dental replacement. (Plural: prostheses.)
prosthodontics—The branch of dentistry pertaining to the restoration and maintenance of oral function, comfort, appearance, and health of the patient by the restoration of natural teeth and/or the replacement of missing teeth and contiguous oral and maxillofacial tissues with artificial substitutes.
protrude—To project forward.
protrusion—

1. The act of protruding something forward.
2. In dentistry, a position of the mandible anterior to centric relation.

protrusive interocclusal record—A registration of the mandible in relation to the maxillae when both condyles are advanced in the temporal fossa.
protrusive articulation—Occlusal contact relationships between maxillary and mandibular teeth when the mandible moves into a forward position.
protruberance—A projecting part; bulge.
proximal—

1. Situated close to.
2. Next to or nearest the point of attachment or origin—a central point.

proximal tooth surface—The surface of a tooth that lies next to another tooth.
pterygomaxillary notch—The notch formed by the junction of pterygoid hamulus of the sphenoid bone and maxilla. Located just posterior to the maxillary tuberosity. Also called hamular notch.
pulp—The connective tissue found in the pulp chamber and canals and made up of arteries, veins, nerves, and lymph tissue.
pumice—A type of volcanic glass used as an abrasive agent in many polishing procedures.
quadrant—One of the four sections of the dental arches, divided at the midline.
quench—To cool suddenly by plunging into a liquid.
quick cure resin—See autopolymerizing resin.
ramus—The ascending part of the mandible.
rational posterior teeth—See nonanatomic teeth.
rebase—Complete replacement of the denture base, saving only the denture teeth.
reciprocal arm—The rigid arm of the clasp located on the tooth so as to oppose any pressure exerted by the retentive arm. Acts to stabilize the appliance and resist lateral displacement. Also called a bracing arm.
reciprocity—The state of being inversely related or proportioned; opposite.
record base—An interim denture base used to support the record rim material for recording maxillomandibular records.
record rim—The occlusal surfaces fabricated on a record base for the purpose of making maxillomandibular relationship records and/or arranging teeth. Also called occlusion rim.
reducing zone of a flame—The zone of a flame least apt to cause oxidation of the metal when melting or soldering.
reducing investment—A specially made investment that contains fine graphite or copper particles to prevent oxidization of the casting. Also called deoxidizing investment.
refractory cast—A cast made of a heat resisting material. Also called investment cast.

reinforced acrylic pontic (RAP)—An anterior acrylic resin denture tooth attached to a specially constructed retentive site on an RPD framework.

relief—

1. The reduction or elimination of undesirable pressure or force from a specific region; for example, the scraping of a working cast to better fit a facing to the ridge.
2. Material added to a cast to relieve the pressure over specific areas in the mouth. Also added to the master cast before duplicating it to create a raised area on the refractory cast.

reline—The replacement of the tissue surface of the denture to make it fit more accurately.

removable partial denture (RPD)—A dental prosthesis that artificially replaces teeth and associated structures in a partially edentulous dental arch and can be removed and replaced by the patient.

reservoir—

1. An area where extra supply or stock is collected or accumulated.
2. In dentistry, an attachment to the sprue to provide additional molten metal when the casting begins to solidify and shrink.

resin—

1. A gummy substance obtained from various trees used to make many dental materials.
2. A broad term used to describe natural or synthetic materials that form plastic materials after poly-merization.

resin, denture—See acrylic resin.

resin crown—A resin restoration restoring a clinical crown without a metal substructure.

resorption—The loss of tissue substance by physiologic or pathologic processes. The roots of the primary teeth are resorbed naturally.

rest—A supporting device of an RPD lying on the occlusal or incisal surface of a tooth..

rest position—See physiologic rest position.

rest seat preparation—The preparation made on a tooth to accommodate an occlusal or incisal rest.

retainer—Any type of device used for the stabilization or retention of a prosthesis. In RPDs, a clasp is called a direct retainer. In fixed partial dentures, an abutment casting is called a retainer.

retention of a clasp—The property that enables a clasp to resist dislodgement.

retromolar pad—The soft tissue pad at the posterior extremity of the mandibular ridge.

retrusion of the mandible—A backward movement of the mandible.

reverse curve—A curve of occlusion defined by the cusp tips and incisal edges which, when viewed in the sagittal plane, is curved upward or superiorly.

reverse articulation—An occlusal relationship in which the mandibular teeth are located facial to the opposing maxillary teeth. The maxillary buccal cusps are positioned in the central fossa of the mandibular teeth. Also called crossbite.

reversible hydrocolloid—An impression material containing agar which can be softened to a jelly-like consistency and cooled to a solid to make an impression or duplicate a cast. This procedure can be repeated by reheating; hence the name “reversible.”

rhomboidal—The shape of an oblique-angled parallelogram with only the opposite sides equal. The occlusal outline of the maxillary molars are rhomboidal.

ridge—

1. An elevated body part; a long, narrow, raised crest.
2. A linear elevation of enamel on the surface of a tooth; for example, a marginal ridge.
3. (Alveolar ridge) The area of the upper and lower jaws formerly occupied by the natural teeth.

ridge contour—The shape of the alveolar ridge with reference to its height, width, and degree of slope.

ridge lap—The area of an artificial tooth that normally overlaps the alveolar ridge. On the inner surface of the denture tooth, it corresponds approximately to the location of the collar on the facial surface.

ridge relationship—The position of the upper and lower ridges relative to each other.
ridge resorption—The resorption of the alveolar bone once teeth are no longer present, resulting in a progressively flatter ridge.
ring—A metal cylinder used to confine the investment when investing the pattern for a fixed wax pattern or an RPD framework pattern.
Roach clasp—See bar clasp.
Rockwell hardness—A measurement of the hardness of metals that are too hard for the Brinell needle.
root—The portion of the tooth covered with cementum.
root canal—The small channel running through the tooth's root, connecting the pulp chamber and the root-end opening.
rouge, jeweler's—A red powder usually in cake form used on a buff or chamois wheel to impart a high luster to metal.
rubber points/wheels—Rubber impregnated with abrasive used for smoothing ground surfaces.
rugae—The elevated folds or wrinkles of soft tissue situated in the anterior part of the palate.
safeside disk—An abrasive disk having one smooth side so it does not damage or scratch adjacent surfaces or structures.
sagittal plane (mid)—The plane dividing the body vertically into two equal halves.
sandpaper disks—Various size disks with different grits of sandpaper on their surface used for smoothing and polishing in the laboratory.
sanitary pontic—See hygienic pontic.
sanitization—A process that removes gross debris and reduces the number of microorganisms on nonliving material.
saturated calcium sulfate dihydrate solution (SDS)—A clear, true solution of water and a maximum amount of dissolved dihydrate (set) gypsum product.
second half-flasking—Completion of the investing process in the top half of the denture flask.
semirigid fixed partial denture—See interlock fixed partial denture.
separating medium—An agent used between two surfaces to prevent them from sticking together.
serrated—Indented with many shallow crosscuts.
setting expansion—The dimensional increase that occurs concurrent with the hardening of various materials, such as plaster of paris, dental stone, die stone, and dental casting investment.
setting time—The time necessary to harden or solidify.
setup—See tooth arrangement.
shade—A particular hue or variation of a primary hue, such as a greenish shade of yellow.
shelf life—The period of time a material can be stored without losing its useful properties.
shellac base—A record base constructed using a shellac-based wafer that has been adapted to the cast with heat.
sideshift—Articulator simulation of mandibular translation.
slurry—A fluid mixture of a liquid and undissolved solid. Used to accelerate the setting time of dental stone.
soft palate—The movable part of the palatal anatomy posterior to the hard palate.
solder—
1. A fusible metal alloy used to unite the edges or surfaces of two pieces of metal.
2. The act of uniting two pieces of metal by the proper alloy of metals.

soluble—Capable of being dissolved.
solute—In a solution, the dissolved solution is called the solute. In salt water, the water is the solvent and the salt is the solute. See solvent.

solvent—A substance capable of dissolving another substance; for example, water is the solvent of salt. See solute.

spatula—

1. An instrument designed for mixing; a flat, knife-like instrument used for mixing plaster, hydrocal, and investment.
2. An instrument that can be heated for working with wax.

specific gravity—The weight of a substance as compared to the weight of exactly the same volume of water. The standard formula is 1 cm^3 of water at 4 ^oC = 1.

sphenoid bone—The irregular, wedge-shaped bone at the base of the skull.

spindle, surveyor—The perpendicular part of the surveyor containing a chuck that holds the interchangeable tools.

splint—

1. A rigid or flexible device that keeps a displaced or movable part in position.
2. A rigid or flexible material used to protect, immobilize, or restrict motion in a part.

split remounting plate—A device consisting of two machined metal plates. One part is embedded in the cast, and the other is embedded into the articulator mounting. The cast can then be removed from the mounting and accurately replaced.

sprue—

1. The channel or hole through which plastic or metal is poured or cast into a reservoir and then into a mold.
2. The cast metal or plastic that connects a casting to the residual sprue button.

sprue base—See crucible former.

sprue button—The material remaining in the reservoir of the mold after casting.

sprue former —A wax, plastic, or metal pattern used to form the channel or channels to allow molten metal to flow into a mold to make a casting.

square arch form—A dental arch roughly square in outline, particularly in the anterior region.

stability—The property of resistance to tipping and rocking of a prosthesis.

stabilized record base—A record base lined with an impression material to increase its stability.

stent—An appliance, usually of acrylic resin, used to reposition soft tissue.

sterilization—The process by which all forms of life within an environment, including viruses and spores, are totally destroyed.

stock impression tray—A device with a handle used to confine and hold an impression material as it is carried to place in the mouth to make an impression.

stone—See dental stone.

stone cap—See stone core.

stone core—The layer of stone placed over the incisal and occlusal surfaces of the teeth in the top half of the flask to facilitate deflasking. Same as stone cap.

strain—The deformation of a material caused by an external force.

stress—The forces within a substance opposing an external force.

stress breaker—See interlock fixed partial denture.

strut—A name often given to a minor connector.

sublingual—The area under the tongue.

sulcus—

1. A furrow, fissure, or groove.
2. In dentistry, a linear depression in the surface of a tooth, the surfaces of which meet at an angle. A sulcus is always found along the surface of a developmental line.

sulfuric acid—An acid made up of hydrogen, sulfur, and oxygen. Mixed with water in equal parts, it is used as a deoxidizing solution for gold.
superior—Above.
supernumerary tooth—An extra tooth; one in excess of the normal number.
support—
1. To hold up or serve as a foundation or prop for.
2. The foundation area on which a dental prosthesis rests.

suprabulge—The area above the survey line on an abutment tooth.
suprabulge clasps—See circumferential clasp.
supraerupted tooth—A tooth that has emerged past the occlusal plane.
surgical guide—Any prosthesis prepared for insertion during a surgical procedure and intended for short use. Also called surgical template and surgical prosthesis.
surveying—
1. To analyze the master cast for favorable and unfavorable undercut conditions.
2. To establish the path of insertion, using a dental surveying instrument.

surveyor—An instrument used to locate and mark the greatest circumference of one or several abutment teeth at a given tilt of the cast. Used to locate soft tissue undercuts at a given tilt.
suture line—A junction line where the bones of the cranium unite.
swage—To shape a piece of metal between a die and counterdie.
symphysis, mandibular—The immovable dense midline junction of the right and left halves of the adult mandible.
T-clasp—A vertical, projection-type clasp formed approximately in the shape of a "T."
tang—The connector between the clasp body and the frame of the appliance.
tapered arch form—A dental arch which, in outline, is between an oval and a square arch.
tapered blockout tool—The tapered, cylindrical-shaped surveyor tool used to carve the undercut wax on the proximal surface of an abutment tooth on the master cast. The taper ensures the rigid part of the metal framework does not enter an undercut adjacent to an edentulous space.
tempering—The procedure of imparting a desired degree of hardness to a metal. Also called heat hardening treatment.
template—
1. A pattern, mold, or gauge used as a guide to form a piece being made.
2. A flattened or curved plate, usually of metal, used as a guide in arranging artificial teeth.

temporal bone—The irregular-shaped bone at the side and base of the skull.
temporomandibular joint—The joint formed by the condyle of the mandible, temporal bone, and associated soft tissues.
tendons—The heavy fibrous bundles attaching a muscle to bone.
tensile strength—A measure of resistance to breakage from a stretching or pulling force.
thermal expansion—The increase in the size of a material when it is heated.
thermoplastic—A material that softens under heat and solidifies when it is cooled without chemical change.
thirty-degree (30^o) teeth—An anatomical type of artificial posterior teeth. The manufacturer claims the cusp incline forms a 30-degree angle with a horizontal plane.
three-quarter veneer—See partial veneer crown.
Ticonium Premium 100—An alloy characterized by a lower melting range than any of the other chrome dental alloys—nickel, chromium, and beryllium.
tilt—The position of the cast on the surveyor table relative to a horizontal plane.
tooth arrangement—The placement of teeth on a denture with definite objectives in mind.

tissue-borne—A partial denture where all the masticatory stresses are borne by the soft tissues of the mouth.
tooth-borne—A partial denture where all the masticatory forces are carried by the abutment teeth.
tooth-supported base—A denture base restoring an edentulous region with abutment teeth at each end for support. The tissue it covers is not used as support.
torque—A twisting force.
torus—

1. A smooth, rounded, anatomical proturberance.
2. Torus mandibularis—found on the lingual surface of the body of the mandible. There may be several tori (plural), usually in the area of the midline backward to about the bicuspids.
3. Torus palatinus—found midline on the hard palate.

translatory (sliding) motion—The motion of a rigid body in which a straight line passing through any two points always remains parallel to its initial position. The motion may be described as a sliding or gliding motion.
transverse horizontal axis—An imaginary line around which the mandible may rotate within the sagittal plane. Also called hinge axis.
transverse plane—The plane that divides the top horizontally from the bottom.
transverse ridge—The ridge of enamel formed at the junction of the buccal and lingual ridges on the occlusal surface of a molar or bicuspid.
trapezoid—A four-sided plane figure with two parallel sides. The occlusal surface of the lower first molar is trapezoidal in outline.
trauma—A wound or injury, whether physical or psychic.
treatment partial—See interim prosthesis.
treatment plan—An outline of the various clinical steps in the proper sequence to be followed for restoring a mouth to health and function.
trial packing—The process of filling the mold with acrylic resin dough several successive times before the final closure to ensure an adequate amount of the material is present.
trial record base—See record base.
triangular ridge—The ridge of enamel that extends from the tip of the cusp down onto the occlusal surface of the bicuspids and molars.
trial placement—The process of checking the trial denture in the patient's mouth for accuracy and the suitability and arrangement of the teeth. Also called try-in.
trifurcated—Having three roots.
troy weight—A system of weights used for weighing gold. The basic unit is the grain; 24 grains are equal to 1 pennyweight.
tube tooth—An artificial tooth containing a vertical channel that fits over a metal post and secures the tooth to the appliance.
tubercule—A nodule or small eminence.
tuberosity—See maxillary tuberosity.
twenty-degree (20^o) teeth—A trade name denoting an artificial posterior teeth with 20-degree cusp angles.
undercut—The portion of the surface of an object that is below the height of contour in relationship to the path of placement.
undercut gauge—A tool for the surveyor that is shaped to measure the amount of undercut on a tooth in thousandths of an inch.
undesirable undercut—Any area that cannot be used for retention and may interfere with insertion and removal of the prosthesis.

unilateral balanced occlusion—See group function.
vacuum fired—To bake porcelain in a vacuum.
vacuum mixing—A method of mixing a material in asubatmospheric pressure.
value—The dimension of a color denoting relative blackness or whiteness.
vault—The palate or roof of the mouth.
veneer—A thin layer.
vertical dimension of occlusion—See occlusal vertical dimension.
vertical overlap—

1. The distance teeth lap over their antagonists as measured vertically. May also be used to describe the vertical relations of opposing cusps.
2. The vertical relationship of the incisal edges of the maxillary incisors to the mandibular incisors when the teeth are in maximum intercuspation.

vestibule—The part of the mouth between the cheeks or lips and the alveolar ridge.
vibrating line—An imaginary line in the soft palate marking the junction between the movable and immovable tissues. Also called flexure line.
vibrator—A mechanical device used to remove air pockets from a mix of plaster or stone.
Vicker's hardness—A range of hardness measured by the indentation made by a square-based, pyramidal diamond point under various loads.
viscosity—A measure of a liquid's resistance to flow or its relative fluidity.
vitrification—The process of making a homogenous, glassy substance by heat and fusion.
volatile—To quickly evaporate.
volatility—The ability to become gaseous or vaporize into gas.
volt—The unit of electrical pressure that forces the current through the circuit.
vomer—The bone forming the lower and posterior portions of the septum of the nose.
warpage—The loss of an original shape or contour.
watt—A unit of electrical power obtained by multiplying the voltage by the amperage.
wax—There are many different types of waxes are used in dentistry, and each is compounded to produce certain physical properties for a specific purpose. Wax is manufactured in various forms, such as baseplate, boxing, inlay, and sticky.
wax elimination—The use of heat to remove a wax pattern from the mold.
wax pattern—Wax that has been formed into the size and shape desired in the finished prosthesis and used to form the mold in the investment.
wax-up (noun)—The finished wax pattern for any dental prosthesis.
wax-up (verb)—

1. To smooth and finish the wax on a complete denture.
2. To flow and carve a wax pattern for a fixed restoration.
3. To contour the wax for any dental prosthesis.

weld—A process for joining metals, using heat and pressure or pressure alone.
working cast—The cast of an entire dental arch or section of an arch on which the laboratory work is accomplished.
working articulation—Occlusal contacts of teeth on the side toward which the mandible has moved. Also called working occlusion.
working side—The side toward which the mandible moves in a lateral excursion.
xerostomia—Dryness of the mouth caused from the lack of a normal amount of saliva.
yield strength—The amount of stress required to produce a particular offset that is chosen. A value of 0.2 percent plastic strain is often used (called 2 percent offset).
zero-degree (0^o) teeth—See nonanatomic teeth.

zinc oxide—A powder incorporated with eugenol or a similar oil to form a mild antiseptic and analgesic paste; a constituent of most impression pastes.

zygomatic processes, temporal and maxillary—The bony extensions of the temporal and maxillary bones that unite with the zygomatic bone to form the zygomatic arch.

Attachment 2

PREFIXES AND SUFFIXES

A2.1. Prefixes. Prefixes are one or more syllables placed before words or roots of words to show various kinds of relationships. They are never used independently, but, they modify the meaning when they are added to verbs, adjectives, or nouns. Figure A2.1 lists prefixes to help you understand dental terminology.

Figure A2.1. Prefixes of Dental Terms.

Prefix	Translation	Example
a- ("an" before a vowel)	without, lack of	Anemia—lack of blood
ab-	away from	Abrade—to wear away
ad-	to, toward, nearer to	adhesion—sticking to
ambi-	both	ambidextrous—ability to use both hands
ante-	before, forward	anterior—situated in front of
anti-	against, opposed to, reversed	antiflux—prevents the flow of solder
bi-	twice, double	bilateral—both sides
circum-	around, about	circumference—surrounding
com-	with, together	compression—pressing together
con-	with, together	condense—pack together
contra-	against, opposite	contralateral—opposite side
de-	away from	dehydrate—remove water from
dia-	through, apart, across, completely	diagnosis—complete knowledge
dis-	reversal, apart from, separation	dissect—cut apart
dys-	bad, difficult, disordered	dysfunction—impaired function

e-, ex-	out, away from	edentulous—without teeth extrude—to elevate
ec-	out from	eccentric—away from center
em-, en-	in	embed—to cover over
endo- within		endodont—within tooth
epi-	upon, on	epidermis—on skin
extra- outside		extracoronal—outside coronal portion
hyper-	over, above, excessive	hyperplasia—abnormal increase in tissue cells
hypo-	under, below, deficient	hypocalcification—reduced calcification
im-	in, into	immersion—act of dipping in
in- not		incompatible—not compatible
infra- below		infraorbital—below eye
inter- between		interocclusal—between occlusal surfaces
intra-	within	intraoral—within the mouth
meta-	beyond, after, change	metamorphosis—change of form
para-	beside, by side	parafunction—beyond normal function
per-	through, excessive	permeate—pass through
peri-	around	periapical—surrounding the apical area
post-	after, behind	posterior—situated behind
pre-	before, in front of	preoperative—before surgery
pro-	before, in front of	prognosis—forecast

re-	back, again, contrary	rebase—replacing base material
retro-	backward, located behind	retrognathic—posterior relationship of the mandible
sub-	under	subgingival—below the gingiva
super-	above, upper, excessive	supernatant—floating above the surface
supra-	above, upon	supragingival—above the gingiva
syn-	together, with	synarthrosis—articulation of joints together
trans-	across	transplant—to remove and plant in another place
ultra-	beyond, in	ultraviolet—beyond violet end of spectrum

A2.2. Suffixes. Suffixes are the one or more syllables or elements added to the root or stem of a word to alter the meaning or indicate the intended part of speech. The suffixes in Figure A2.2 are often used in dental terminology.

Figure A2.2. Suffixes of Dental Terms.

Suffix	**Use**	**Examples**
-al, -c	add to nouns to make adjectives expressing relationship, concern, or pertaining to	cervical—pertaining to the cervix, traumatic—pertaining to trauma
-ent	add to verbs to make adjectives or nouns of agency	recipient—one who receives; concurrent—happening at the same time
-form, -oid	add to nouns to make adjectives expressing resemblance	fusiform—resembling a fusion, metaloid—resembling metal
-ia, -ty	add to adjectives or nouns to make nouns expressing a quality of condition	ductility—condition of being ductile

-ible, -ile	add to verbs to make adjectives expressing ability or capacity	flexible—capable of being bent, contractile—ability to contract
-id	add to verbs or nouns to make adjectives expressing state or condition	fluid—state of being liquid
-ist, -or, -er	add to verbs to make nouns expressing agent or person concerned	Prosthodontist—a dentist practicing prosthodontics, connector—the part that connects other parts
-ize, -ate	add to nouns or adjectives to make verbs expressing to use and act like, to subject to, to make into	oxidize—to form an oxide, impersonate—-act like
-ma, -mata, -men -mina, -ment, -ure	add to verbs to make nouns expressing a result of action or an object of action	trauma—injury, foramina—openings, arrangement—position of artificial teeth
-olus, -olum, -culus, -culum, -cule, -cle	add to nouns to make them diminutive	alveolus—bony socket of a tooth, miniscule—very small, molecule—little mass
-ous	add to nouns to make adjectives expressing material	Ferrous—composed of iron, amorphous—not definite form, porous—full of pores
-sia, -y	add to verbs to make nouns expressing an action, process, or condition	Anesthesia—lack of feeling, oily—resembling oil
-tic	add to verbs to make adjectives showing relationships	caustic—referring to burn

Attachment 3

PACKING AND SHIPPING CASES TO DENTAL LABORATORIES

A3.1. Overview:

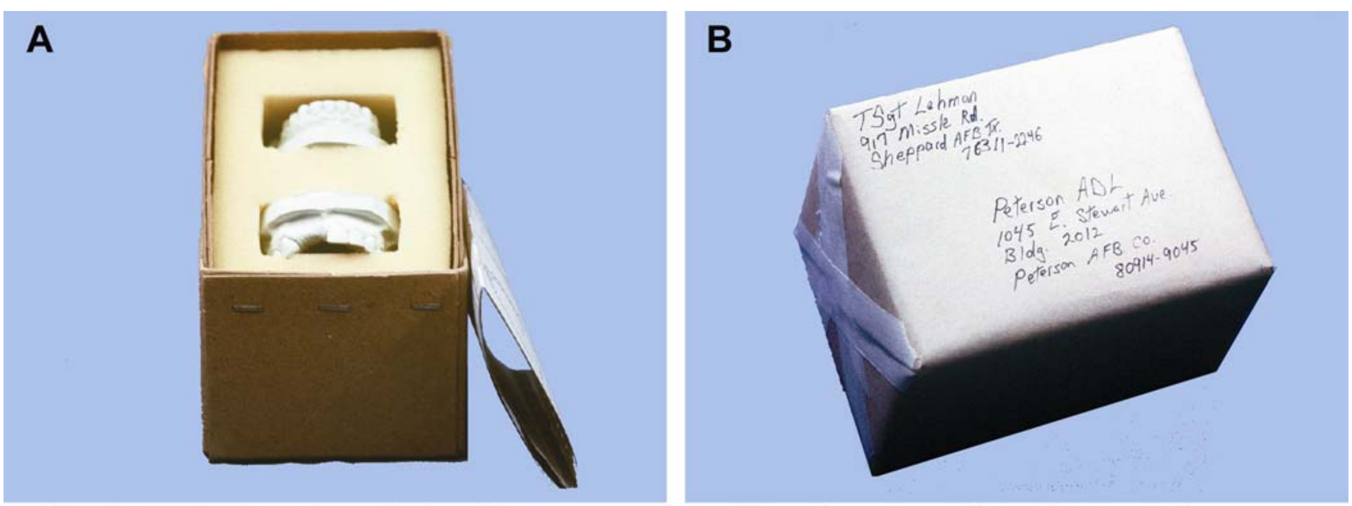
A3.1.1. Cases sent to a base dental laboratory or area dental laboratory (ADL) must be packaged properly to ensure every effort is taken to eliminate damage or loss. The time and effort the dentist or laboratory technician puts into packaging each case is an investment in quality fabrication of a prosthesis. Time, effort, and money are lost if a cast is damaged or misrouted due to inadequate packing or shipping procedures. Guidelines and procedures in this attachment are set up to help eliminate the possible loss or damage of a case.

A3.1.2. Always make sure any contaminated item has been disinfected and placed in a sealed bag before shipping. Packing and shipping the casts are significant parts of prosthodontic service. These jobs must be done properly to ensure maximum care is given to each case as follows:

A3.2. Packing Materials:

A3.2.1. **Mailing Boxes.** The shipping container must be *crush proof* and *shock resistant,* and it must *prevent movement* of the contents during shipment. Two-piece cardboard boxes reinforced by metal staples on the corners are the standard mailing cartons to be used. These boxes have a polyurethane foam insert ideal for mailing casts (Figure A3.1). The three-piece inserts (which include top and bottom covers) come with the center portion slotted with two rectangular openings.

Figure A3.1. Packing and Shipping Boxes.



Casts packed and ready to ship | Boxed, wrapped, and secured

A3.2.2. **Small Plastic Bottles.** Film containers or pharmacy bottles make good containers for protecting smaller items, such as dies and completed crown and fixed partial dentures. These items should be packed in the container with gauze or cotton balls.

A3.2.3. **Insulation.** Supplementary insulation may be obtained with the use of styrofoam beans, air bubble plastic sheets, or foam sheets.

A3.3. Methods for Packing and Shipping Dental Materials:

A3.3.1. **Casts.** The preferred method is a standard mailing box with inserts. Make sure the patient's name is written in *waterproof* ink on the back of each cast. All items accompanying the cast, such as stone straps, jaw relationship records, small plastic containers, etc., must also be marked. To prevent the adhesion of packing materials, the cast must be dry prior to packing. (It is possible for cotton to stick to a cast when the cast is wet or damp.) Place only two casts in the box and pack them base to base (Figure A3.1). ***NOTE:*** Most casts broken in shipment either have too many items in the box or the casts are packed with the teeth facing each other.

A3.3.2. **Dies.** Ensure the margins on all dies have been marked with a red wax pencil prior to shipment. Do not ship dies mounted in the master cast. Remove the dies from the master cast and place them individually in a small plastic bottle filled with cotton. This container should be placed in the opening opposite the cast. To avoid using two mailing boxes for the case, use smaller containers and place them in the same box with the master and opposing casts.

A3.3.3. **Impressions.** Normally, impressions are not shipped. However, due to the durability of polyvinylsiloxanne, it may be sent with the case. When another type of material is used, make a second pour of the impression and send that cast also. The second pour or duplicate cast should be a solid working cast, leaving the tissue areas intact.

A3.3.4. **Completed Prostheses.** To avoid desiccation of acrylic prostheses, package complete dentures, partial dentures, and all acrylic appliances in a self-sealing plastic bag with a wet cotton ball. When shipping RPD frameworks, always place them on the master or duplicate cast to avoid any damage to the framework or cast. When shipping crowns or fixed partial dentures, separate the restorations from the dies and place them individually in a small plastic container filled with cotton. Ensure restorations are well cushioned to avoid movement during shipment.

A3.3.5. **Completion**. Once a case is packed, place a prescription form (DD Form 2322, **Dental Laboratory Work Authorization**) in each box so the contents can be identified. Place the copy of the DD Form 2322 on top of the foam in the box to avoid wrinkling or tearing the form. Wrap the box with paper and secure it with mailing tape (Figure A3.1). When you use more than one box on a case, wrap the boxes together as a single unit. These actions prevent the boxes from being separated and decrease the possibility of loss. Never apply any kind of tape directly to the mailing boxes; only tape over the wrapping paper in order to avoid damage to the box. Questions about mailing restrictions can best be answered by mailroom or post office personnel.

A3.4. Jaw Relation Records:

A3.4.1. Jaw relation records are fragile, come in many different shapes and sizes, and require care when packed for shipment. The preferred jaw relations are those set chemically, not in thermoplastic. Gypsum products, zinc oxide-eugenol pastes, and acrylic resin products are safe for shipping when properly packaged.

A3.4.2. Wax cannot be used as a registration material because the container must go through temperature fluctuations during shipment. This causes the wax index or registration to distort, rendering it inaccurate.

A3.4.3. All of the jaw relation records mentioned so far are intraoral records. There is a particular form of articulation record that uses *stone straps* external to opposing casts. ADLs prefer stone straps rather than intraoral records. Partially edentulous cases that cannot be hand articulated with certainty should be mounted.

A3.4.3.1. **Fabricating Stone Straps:**

A3.4.3.1.1. Using a large pear-shaped acrylic bur, place two indexing dimples in each side of the maxillary cast in the art portion of the base (Figure A3.2). Repeat this step for the mandibular cast as well. Using an interocclusal jaw relation record provided by the dentist, hand articulate the casts. Reinforce this assembly with steel wires or burs and compound. Apply separator to the indices and surrounding area. Use wet tissues to block out the anatomical portions in the area the straps will occupy.

A3.4.3.1.2. Fashion a rectangle of dental stone about 10 mm thick to cover the four pairs of indices. After the stone is set, remove the stone straps and disassemble the casts. Remove all traces of compound left on the casts. Hand articulate the casts, using the stone straps to verify their reliability as an articulation record.

Figure A3.2. Stone Strap Fabrication.

A3.4.3.2. **Packing Jaw Relation Records.** Place the record bases on the master cast and wrap them securely with a suitable packing material before placing them in the foam inserts. Ship small jaw relation records (covering only a few teeth) in a small plastic bottle. Place stone straps in the mailing boxes alongside the foam inserts.

A3.5. Articulators. Do not *mail* articulators to another base dental laboratory or ADL because proper packing is difficult and there are alternative procedures that can be successful. Instead of shipping an articulator, use a facebow mounting of the maxillary cast to relate the casts to a certain articulator. If a Whip-Mix 2000-series articulator is used, both the maxillary and mandibular cast may be mounted and sent. Make sure the receiving laboratory has the same type of articulator. If the lab does not have the Whip-Mix 2000-series articulator, mount only the maxillary cast on an articulator that is similar to one at the receiving laboratory. When the dentist provides appropriate jaw relation records or articulator settings, it is possible to program an alternative articulator as well as the original.

A3.6. Checklist for Case Submission. Before mailing cases to dental laboratories, ask yourself the following questions:

A3.6.1. For DD Form 2322 (according to AFI 47-101, *Managing Air Force Dental Services,* Attachment 15):

A3.6.1.1. Are mold, shade, shade guide type, and staining characteristics included?

A3.6.1.2. Are desired fabrication materials adequately described?

A3.6.1.3. Is the desired design adequately described? Does the description include pontic design, porcelain metal junction location, type of margin, occlusal table design, and other characteristics; for example, diastema closure?

A3.6.1.4. Is the form signed with provider's payroll signature?

A3.6.2. For casts:

A3.6.2.1. Are they dense and poured of improved stone?

A3.6.2.2. Are they properly trimmed, not tapered?

A3.6.2.3. Is the base of adequate thickness and free of voids?

A3.6.2.4. Is the tongue space clean and smooth?

A3.6.2.5. Have all nodules been removed, especially from rest seats, guide planes, tissues to be covered by the prosthesis, and occlusal surfaces?

A3.6.2.6. Is there evidence that plaque or debris was still remaining on teeth at the time of the impression? (If the answer is yes, the impression should be remade.)

A3.6.2.7. Is there evidence that alginate stuck to teeth during impression procedure? (If the answer is yes, the impression should be remade.)

A3.6.2.8. Were full arch impressions made?

A3.6.2.9. Were impressions accurate in all details?

A3.6.3. For dies:

A3.6.3.1. Are dies stable and completely seated?

A3.6.3.2. Can the base of the die be visualized to ensure complete seating?

A3.6.3.3. Are dies trimmed properly with margins, not deeply undercut?

A3.6.3.4. Are undercuts and defects blocked out?

A3.6.3.5. Was a die spacer placed without covering margins?

A3.6.3.6. Is die spacer material compatible with technique and materials used by the fabricating lab?

A3.6.3.7. Are margins accurately marked with wax pencil prior to placing the die hardener over the margin?

A3.6.3.8. Are pins clean, smooth, free of glue, and properly placed?

A3.6.4. Is the master impression and second pour (or solid cast) of master impression included? (The second pour does not need to be separated.)

A3.6.5. Is there a means of accurately relating maxillary and mandibular casts to one another?

A3.6.5.1. If casts can be hand articulated, are pencil lines drawn to mark the relationship? ***NOTE:*** If casts can not be hand articulated, use a rigid, trimmed, polyvinylsiloxane interocclusal record to relate teeth-to-teeth or use lateral stone straps to relate casts. This is essential if record bases were used to record jaw relations.

A3.6.5.2. When the casts are together, are they free from interferences such as heels touching or stone nodules on the occlusal surfaces?

A3.6.6. If a facebow transfer is necessary:

A3.6.6.1. Are the articulator model and condylar settings written on DD Form 2322?

A3.6.6.2. Is the maxillary cast still attached to the mounting plate?

A3.6.7. For enclosures:

A3.6.7.1. Are RAPs, tube teeth, and facings properly prepared?

A3.6.7.2. Is there clearance?

A3.6.7.3. Do they contact the ridge properly?

A3.6.7.4. Is the stone matrix prepared properly, clear of rest and plating areas?

A3.6.7.5. Have slots been left for the ADL to cut?

A3.6.8. For esthetic guides:

A3.6.8.1. Are diagnostic casts, wax-ups, custom shade tabs, etc., included? Are they noted on DD Form 2322?

A3.6.8.2. Have drawings or descriptions of desired special characteristics been provided?

A3.6.9. For disinfection procedures:

A3.6.9.1. Have all casts and enclosures been disinfected appropriately according to OSHA and ADA guidelines?

A3.6.9.2. Have the casts and enclosures been wrapped in plastic or bagged to prevent them from contacting shipping box foam?

Attachment 4

DENTURE TOOTH MANAGEMENT

A4.1. Overview. Denture teeth may be stocked in varieties and quantities appropriate to local usage. A denture tooth stock management system should be established to order and stock the teeth. The dental laboratory officer or noncommissioned officer in charge (NCOIC) determines what those local requirements are and how the teeth are managed.

A4.2. Procurement of Denture Teeth:

A4.2.1. The Defense Supply Center (part of the Defense Logistics Agency) negotiates contracts and initiates blanket purchase order agreements with major tooth manufacturers for denture teeth. Copies of these contracts should be available to all command and base dental surgeons, area dental laboratory officers, base medical materiel managers, and base contracting officers. Orders should only be placed from current contracts.

A4.2.2. These contracts are for a period of 1 year. The contractor must reach an agreement with the dealers in the vicinity of each base dental facility. If there is no participating dealer in the vicinity, continental United States (CONUS) dental facilities may order directly from the manufacturer or principal depot.

A4.2.3. The contracts should contain an exchange privilege that allows return of individual teeth or broken sets to the dealer or manufacturer. Further, the exchange privilege that the local dealer implements should be thoroughly understood by all concerned.

A4.2.4. Overseas bases that have no available dealer for the manufacturer of choice may order directly from the manufacturer's principal depot in the CONUS.

A4.3. Requesting Denture Teeth:

A4.3.1. The NCOIC requests denture teeth on preprinted blank order forms supplied by manufacturers who have negotiated contracts with the Department of Defense (DoD). These order forms include all required information except the quantity per unit of issue; the person initiating the request fills in the required quantity.

A4.3.2. When requesting items, add up the quantities and prepare DD Form 1348-6, **DoD Single Line Item Requisition System Document,** as a cover sheet to complete the request to the medical materiel manager. The information on the cover sheet should include a simplified basic nomenclature, unit of issue, quantity, and price for the total order. Include plastic and porcelain teeth on the same request if they are made by the same manufacturer. If not, prepare a separate request.

A4.3.3. Send the original and three copies of the request to the medical materiel manager who will prepare the proper purchase documents from data on the cover sheet, assign a document number, and process the request and order forms for purchase action.

A4.4. Stocking Denture Teeth. Use the following guidelines to manage the stock of denture teeth:

A4.4.1. Establish a file folder entitled "Denture Tooth Management" at each dental facility with stock level sheets (based on estimated usage or historical data) and orders due in and received. Use the individual manufacturer's order forms for this purpose. Maintain a file at each facility where dental laboratories keep stocks of denture teeth. Make comparison between order forms to determine the usage of any tooth stocked and balance the stock levels to avoid being over or under stocked.

A4.4.2. Cut off the previous year's file and start a new one on 1 October of each year. Carry forward the most current stock level sheets and all orders due in to the current year's files. Dispose of contents that remain in the previous year's file according to AFMAN 37-123 and the Air Force RDS.

A4.4.3. Review stock level sheets annually. Date and initial each review. Adjust levels any time expenditure rates change. When adjustments are made, reaccomplish the stock level sheets.

A4.4.4. Make use of the service stock level method (maximum amount to be maintained). Place orders as needed to keep stock on hand at the established levels. Use the exchange privilege to the maximum (paragraph A4.2.3). Date orders for teeth when they are submitted. When orders are received, verify them against the manufacturer or dealer invoice and date and initial the invoice.

A4.4.5. Maintain the file in a single folder where possible. To provide easy comparison and usage data, arrange orders due in or received in a chronological sequence.

A4.5. Storage of Denture Teeth. For reasons of economy and efficiency, denture teeth will be stored in tooth cabinets.

A4.5.1. Tooth storage cabinets can be ordered from medical logistics, using the following nonmenclature and stock number: cabinet, tooth assortment, compartmented, NSN 6520-00-511-0010.

A4.5.2. Locally constructed cabinets may be used if each set of teeth can be segregated in an individual compartment. A properly designed cabinet should have:

A4.5.2.1. Compartmented space for each stock level of teeth.

A4.5.2.2. Space for a moderate increase in stock levels and broken sets of teeth.

A4.5.2.3. Drawers that allow ready access to all compartments.

A4.4.2.4. Labels on drawers and compartments.

A4.5.3. Arrange sets of teeth in the cabinet, using shade as the primary index. Follow the same sequence as the stock level sheets. Segregate maxillary and mandibular anteriors and posteriors for each type of tooth. File broken sets in the same drawer with complete sets to keep the breaking of complete sets to a minimum and to identify exchange options.

Attachment 5

SUBJECT INDEX

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