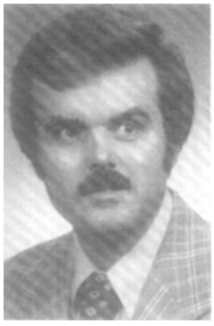

Dr. McNamara

The Fränkel appliance (FR-2): Model preparation and appliance construction

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This article describes the steps involved in the construction of a Fränkel FR-2 appliance, which is currently gaining popularity among orthodontists in the United States. Included is a description of proper impression technique and construction bite registration. The preparation of the working models by the clinician prior to sending them to a laboratory is outlined. In addition, a complete description of the fabrication of the FR-2 appliance is presented.

Key words: Functional regulator, Fränkel, construction, bite registration, impressions

The functional regulator[1–10] is a removable orthodontic appliance developed by Professor Rolf Fränkel of the German Democratic Republic. This appliance is used during the mixed and early permanent dentition stages to effect changes in anteroposterior, transverse, and vertical jaw relationships. The Fränkel appliance, as it is more commonly termed, has two main treatment effects. First, it serves as a template against which the craniofacial muscles function. The framework of the appliance provides an artificial balancing of the environment, thereby promoting more normal patterns of muscle activity. The second effect of the Fränkel appliance is its influence on skeletal and dental development. The Fränkel appliance removes muscle forces in the labial and buccal areas that restrict skeletal growth, thereby providing an environment which maximizes skeletal growth.

Four main types of functional regulator have been described by Fränkel (Tables I and II). Although Fränkel most often has advocated the use of the FR-1 appliance for the treatment of Class II malocclusion, we believe that the FR-2 appliance (which differs only slightly from the FR-1) is the appliance of choice in Class II treatment. The main difference between the two types of appliance is the addition of a lingual wire behind the upper incisors in the FR-2 which acts to prevent incisor tipping during treatment.

It has been only during the last three years that Fränkel has had the opportunity to use fixed appliances routinely in his clinic. Since his functional approach was developed more

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Table I. Types of functional regulators (classic)

FR-1	Class I and Class II, Division 1
FR-2	Class II, Division 2
FR-3	Class III
FR-4	Open-bite

Table II. Types of functional regulators (current)

FR-2	Class II, Division 1 and Class II, Division 2; some open-bites
FR-3	Class III
FR-4	Some open-bites
FR-1	Some open-bites; Class I

than 20 years ago, some parts of all Fränkel appliances were designed to move teeth. In addition, Fränkel also has used removable palatal plates with finger springs to protrude and align incisors, particularly in cases of Class II, Division 2 malocclusion. When integrating the Fränkel appliance into a practice in which the orthodontist uses fixed appliances, tooth movement, when it is necessary, can be accomplished by using fixed appliances and functional orthopedic requirements can be fulfilled by using the Fränkel appliance. For example, a short phase of fixed appliance therapy can be used to align and position the incisors prior to the use of the Fränkel appliance in both Class II, Division 1 and Class II, Division 2 malocclusions. (This is necessary in about one half of all Class II cases.) In addition to extraoral traction to the permanent maxillary first molars and first premolars, a transpalatal arch and/or separators can be used to create the interdental spacing necessary to allow lodging of the wires of the appliance between the teeth, thus stabilizing the appliance against the maxillary dentition.

A typical sequence of orthodontic treatment incorporating Fränkel therapy consists of three phases: (1) an initial phase of fixed appliance therapy to idealize the position of the incisors, (2) an orthopedic phase in which the Fränkel appliance is used to establish skeletal and muscular harmony, and (3) a final fixed appliance phase to position and detail the dentition.

The main purpose of this article is to discuss in detail the preparation of the work models and the fabrication of the FR-2 appliance. However, some preliminary comments will be made regarding impression technique and construction bite registration since they pertain directly to the proper fabrication of the functional regulator. No attempt will be made in this article to discuss in detail the rationale of the appliance or treatment results.

Parts of the appliance

The FR-2 (Figs. 1 and 2) is composed of acrylic and wire. The base of operation of the appliance is the buccal vestibule. The vestibular (buccal) shields and the lower labial pads act in this area to restrain the musculature and to remove restricting muscular forces from the dentition.

Six wire components are visible on the exterior surfaces of the appliance: the upper labial wire, the canine extensions, the upper lingual wire, the cross-over wire to the lower

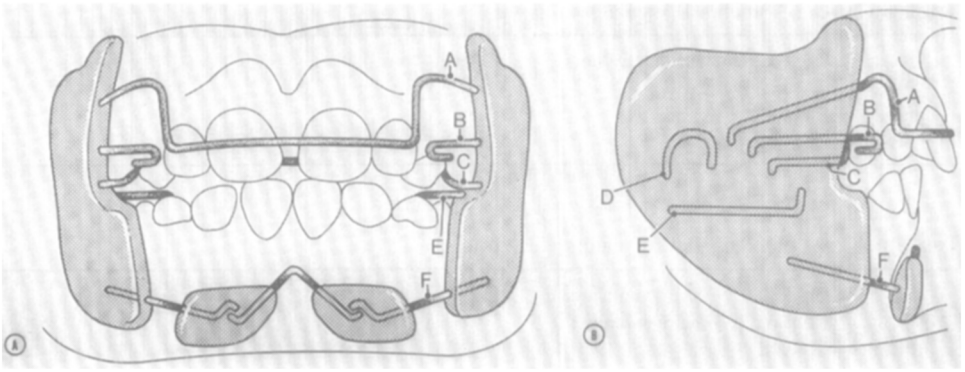

Fig. 1. Schematic illustration of the Fränkel appliance. **Left,** Frontal view. **Right,** Lateral view. The wire components of the appliance are: *A,* upper labial wire; *B,* canine extensions; *C,* lingual wire; *D,* occlusal rest-palatal bow wire; *E,* extension of cross-over wire to lower lingual shield; *F,* support wires for lower labial pads.

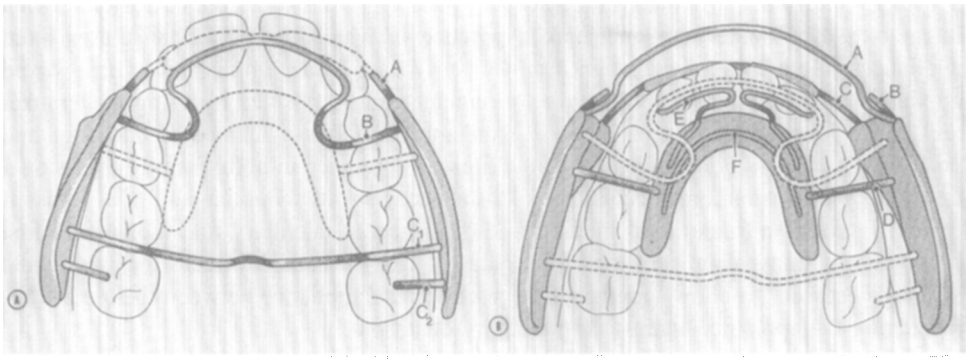

Fig. 2. Schematic view of FR-2. **Left,** Maxillary view. The maxillary wires include: *A,* canine extensions; *B,* upper lingual wire; *C,* palatal bow (C_1) and occlusal rest (C_2). **Right,** Mandibular view. The wires shown in this view include: *A,* upper labial wire; *B,* canine arms; *C,* support wires for lower labial pads; *D,* cross-over wire; *E,* lower lingual springs; *F,* support wire for lingual pad.

lingual shield, and the support wires for the lower labial pads from the frontal view (Fig. 1, *A*). From the lateral view (Fig. 1, *B*), a portion of the palatal bow–occlusal rest wire is also visible, embedded in the vestibular shield. In the maxillary and mandibular views of the FR-2 (Fig. 2, *A* and *B*), the orientation of the wires relative to each other can be observed. Also shown in these drawings is the relationship between the lower labial pads and the lower lingual pad. These pads serve as a guide for the establishment of the altered mandibular postural position used in the correction of Class II malocclusion. Since these pads are tissue-borne rather than tooth-borne, they act as tactile reminders to the patient to position his or her jaw anteriorly.

Impression technique

Successful Fränkel therapy depends upon the fit and comfort of the appliance; thus, proper impression technique is of the utmost importance. When in place, the edges of the

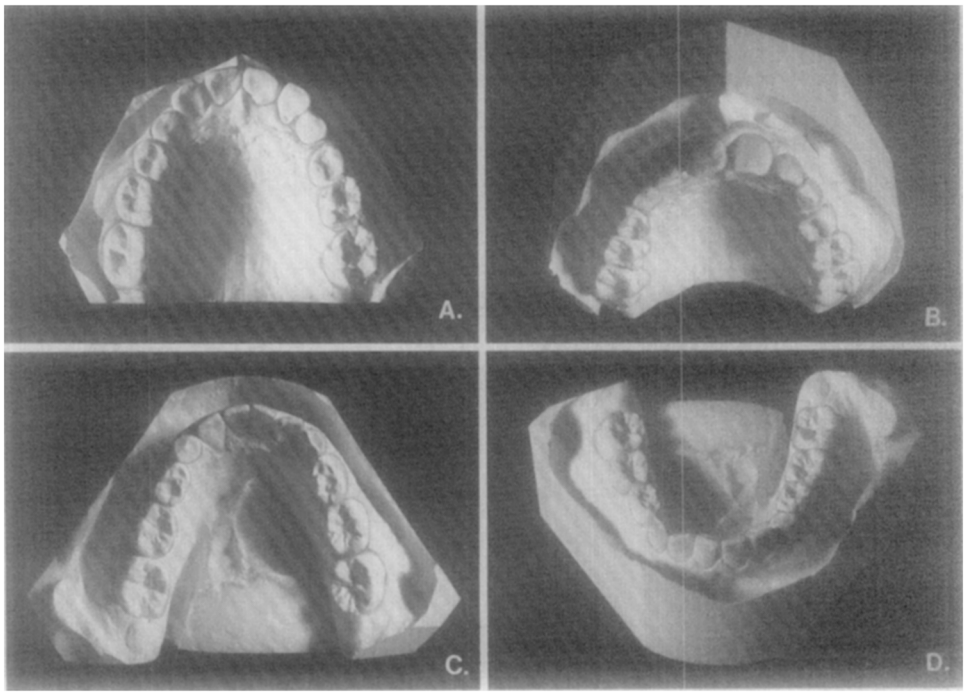

Fig. 3. Rough trim of work model. **A** and **B,** Maxillary views. **C** and **D,** Mandibular views. Note the amount of lateral extension of the base of the model away from the apical area.

vestibular shields and lip pads gently contact the soft tissue. A properly fabricated appliance will have superior and inferior borders on the buccal shields that will slightly encroach on the patient's resting vestibular sulcus, vertically and horizontally. Therefore, an impression tray which does not cause overextension or lateral distortion of the associated soft tissue should be used. Lateral distortion of the soft tissue prevents the proper extension of the flange of the impression tray deep into the vestibular sulcus and in the anterior lingual region. Those Styrofoam trays or overextended trays which tend to distort the mucous membrane, areas of muscle attachment, or the lingual frenum should not be used.

To date, two types of tray have proven quite satisfactory. A thermal-sensitive acrylic tray is the more easily used. This tray can be softened in hot water, placed in the mouth, and molded to the configuration of the dental arches. A custom tray which is fabricated for the individual case can also be used. Both of these tray types minimize the distortion of the underlying soft tissue. Because of the close fit of the tray, much less impression material is needed when thermal-sensitive or custom trays are used than when conventional orthodontic trays are used.

Construction bite

A proper construction bite is essential to good appliance fabrication. The construction bite, usually taken with a horseshoe wafer of medium hard wax, must orient the upper and lower dental arches in all three planes of space (horizontal, vertical, and transverse). Any arbitrary adjustments in work model orientation during appliance fabrication will produce

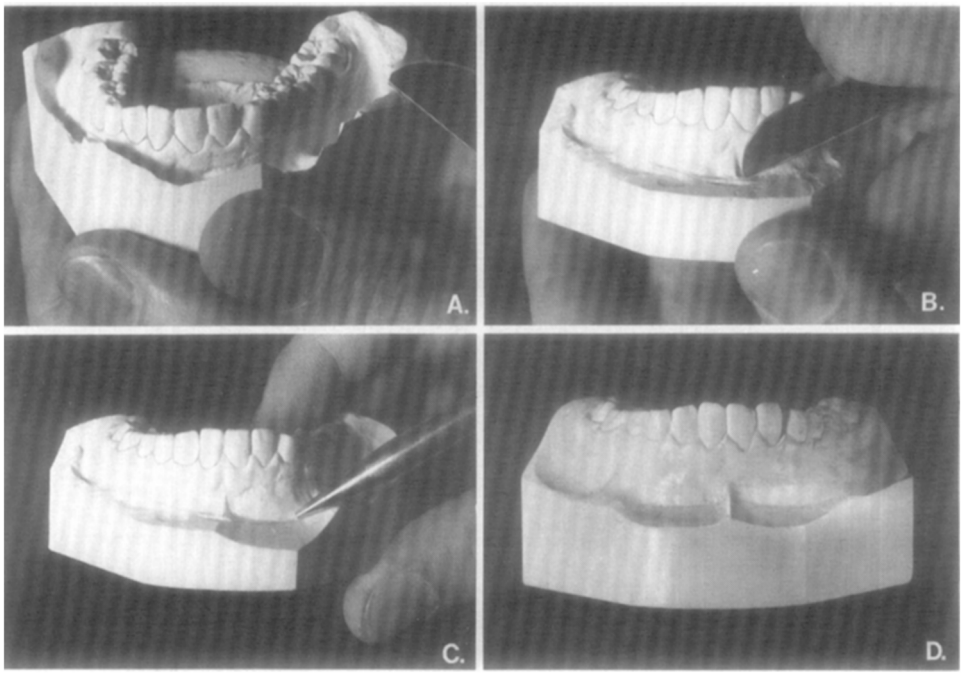

Fig. 4. Preparation of the work model. **A,** Initial removal of the flash with the laboratory knife. **B,** Flash removed down to the level of the sulcus determined by the impression. **C,** Preliminary carving of the lower labial area. **D,** Final carving and contouring of the lower labial area.

a Fränkel appliance that will not fit the patient and/or will cause unwanted treatment results.

In the treatment of Class II cases, Fränkel states that the mandible should not be brought forward more than 2.5 to 3.0 mm., with only enough vertical opening for the cross-over wires to pass through the interocclusal area.[8] However, it has been our experience that a mandibular advancement of 4 to 6 mm. is easily tolerated by most patients. For most Class II problems, this amount of advancement will place the incisors in an edge-to-edge relationship. For more severe cases, the mandible will have to be advanced again after 4 to 6 months of full-time wear either by splitting the buccal shields and advancing the lower labial and lingual pads as a unit or by constructing a new appliance.

When the mandible is advanced during fabrication of the construction bite, most cases will provide a vertical clearance of several millimeters at the deciduous first molar area because of incisor disclusion. If advancement of the mandible 4 to 6 mm. does *not* provide at least 2.5 to 3.5 mm. of clearance at the deciduous first molar area, the construction bite must be opened additionally to provide this clearance.

In taking the construction bite for a patient with an open-bite tendency, one or two sections of a tongue blade can be used to approximate the amount of posterior bite opening necessary to allow for the occlusal passage of the wires.[11] This will necessitate a slight anterior open-bite in the bite registration.

It is also important to relate the mandible to the maxilla in the transverse dimension with the construction bite. Most cases are symmetrical and require equal bilateral ad-

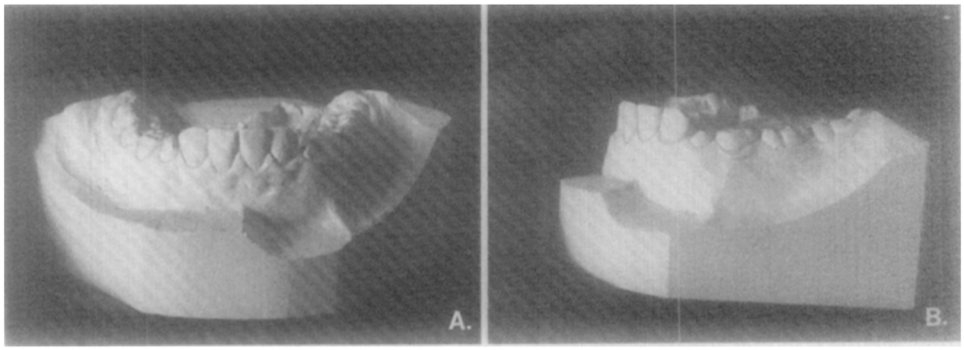

Fig. 5. Carving of the lower labial region. **A,** Frontal view. **B,** Sagittal view. In this case, 4 to 5 mm. of plaster was removed inferiorly so that the bottom of the lower labial pads would be at least 12 mm. below the gingival margin of the incisors.

vancement; therefore, in the absence of a dental asymmetry, the dental midlines will coincide. If the dental midlines are asymmetrical (e.g., early loss of a deciduous canine), the construction bite should reflect symmetrical mandibular advancement and a dental midline asymmetry, the latter of which will be corrected later with fixed appliances. An asymmetrical skeletal midline of the mandible should also be corrected in the construction bite.

Preparation of work models

After the impressions have been taken, they are poured in either plaster or stone with sufficient base to allow for trimming in a manner similar to that used for orthodontic study models. An inadequate base can preclude the proper carving of the model at a later stage. The models can then be roughly trimmed with the working bite in place. The clinician should make sure that the distance from the lateral extension of the base of the model to the alveolar surface is at least 5 mm. (Fig. 3). This will allow for the proper application of wax relief and acrylic at a later time. Also, one should not trim the posterolateral corners of the model bases too severely, since doing so will make the placement of the wax relief in the region of the last molar difficult.

If a close-fitting impression tray is used (for example, a thermal-sensitive tray or a custom tray), a close approximation of the mucosa will be obtained. The first step in trimming the mandibular work model is to remove the flash with either a laboratory knife or a rotary instrument until the extensions of the vestibule have been reached (Fig. 4, *A* and *B*).

Even the best-fitting tray does not give adequate extension in the lower labial region. Thus, it is necessary to modify the contours of this area manually so that the proper inferior and posterior extensions of the lower labial pads can be achieved. The lower labial region should be carved with a pear-shaped carbide bur and a laboratory knife in the manner illustrated in Fig. 4, *B* to *D*. The extension of the lower labial relief is usually 12 mm. below the lower border of the gingival margin, so that the lower labial wire will lie approximately 7 mm. below the gingival margin of the incisors. The lower labial extension in the anterior region of the model shown in Fig. 4 is excellent and requires removal of only 2 to 3 mm. of plaster during the carving process. Fig. 5 illustrates a more typical

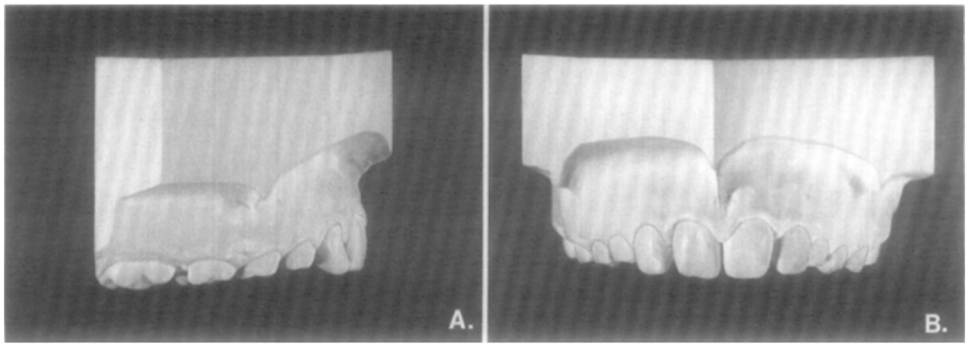

Fig. 6. Final preparation of the maxillary cast. **A,** Sagittal view. **B,** Frontal view. Note the extension in the vestibular area and in the region of the canine eminence.

example of the amount of carving necessary in order to ensure the proper inferior and posterior extensions in the lower labial region.

Similar carving of the flash is necessary on the maxillary model (Fig. 6). Some of the anatomic areas must be defined, particularly the area of the tuberosity, which lies posterior to the muscle attachment over the first premolar or first deciduous molar (Fig. 6). In addition, the area superior to the canine and anterior to the muscle attachment should be defined.

When the preparation of the work models is completed, the wax bite is inserted, and the posterior surfaces of the models are checked to make sure that the backs of the models are flush. This will allow the laboratory to check the wax bite when the work models are received, and it will also allow the clinician to check the bite registration when the appliance is returned to the office.

Prescription sheet

Prescription sheets vary from laboratory to laboratory, but there are specific parameters that must be indicated on any prescription sheet. The type of appliance (in this case FR-2) and the amount of wax relief needed, of course, should be indicated. Usually the standard amount of wax relief for the FR-2 is 3.0 mm. in the maxillary vestibular area and 0.5 mm. in the mandibular vestibular area. In certain instances other thicknesses of wax relief are indicated. For example, only minimal wax relief is needed in the upper arch in a case of telescopic bite.

The laboratory prescription sheet also indicates whether or not the teeth are to be notched. Notching is recommended because the notching permits a positive seating of the appliance in the maxillary dental arch if sufficient interdental spacing has not been created during the first phase of treatment. The notching of the teeth helps prevent unwanted lingual tipping of the maxillary incisors during treatment. If notching is requested, the laboratory will disk the distal surface of the upper canine, the mesial surface of the upper first deciduous molar, and the distal surface of the upper second deciduous molar. The upper first permanent molar is not notched. If there are permanent teeth present, the teeth should be notched on the model, though obviously not in the mouth. In cases with a permanent dentition, the appliance usually seats spontaneously during the first few months of appliance wear.

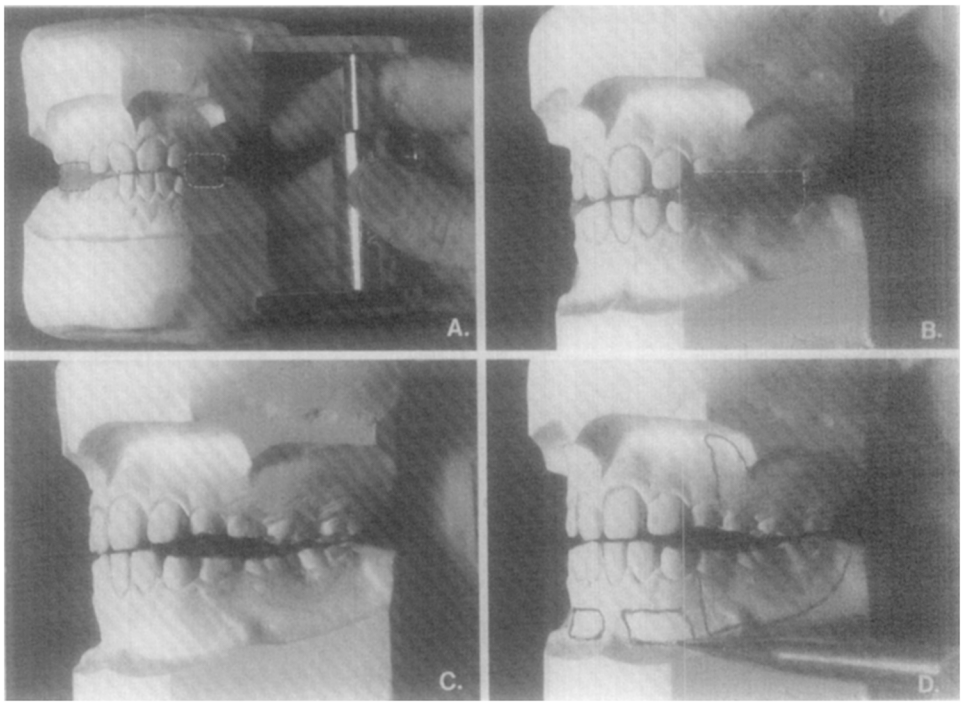

Fig. 7. A, Mounting the appliance in the fixator with a wax bite in place. **B,** Lateral view of working models with wax bite in place. **C,** Removal of wax bite. Note that at least 2.5 mm. of interocclusal space is present to allow for the wires to cross without impinging on the teeth. **D,** Pencil outline of future vestibular shields and lower labial pads.

Mounting the work models

After the work models have reached the laboratory they are checked for any obvious distortion. With the wax bite in place, the position of the midline is checked. Any deviation in midline alignment should have been previously noted on the prescription sheet by the clinician. The work models are then mounted with additional stone in a fixator model holder[12] with the wax bite still in place (Fig. 7, *A*). After the added stone has hardened, the wax bite is removed (Fig. 7, *B* and *C*). A minimum of 2.5 mm. of interocclusal space allows the wires to pass between the maxillary and mandibular teeth.

Wax relief for arch expansion

First, pencil outlines are drawn on the model to approximate the position of the ultimate vestibular shields and labial and lingual pads (Fig. 7, *D*). They are used as a guide in placing the wax. Layers of wax of specific dimensions are then applied to the construction models to provide for the desired relief between the acrylic portions of the appliance and the dentoalveolar region. Pink base plate wax of a thickness prescribed by the clinician is then applied (Fig. 8). Usually 3.0 mm. of wax relief in the maxillary alveolar region and 0.5 mm. in the mandibular alveolar region is requested. To facilitate the proper amount of waxing in the upper arch, 3 mm. thick red boxing wax can be used. Additional pink base plate wax is then applied to complete the contour of the wax.

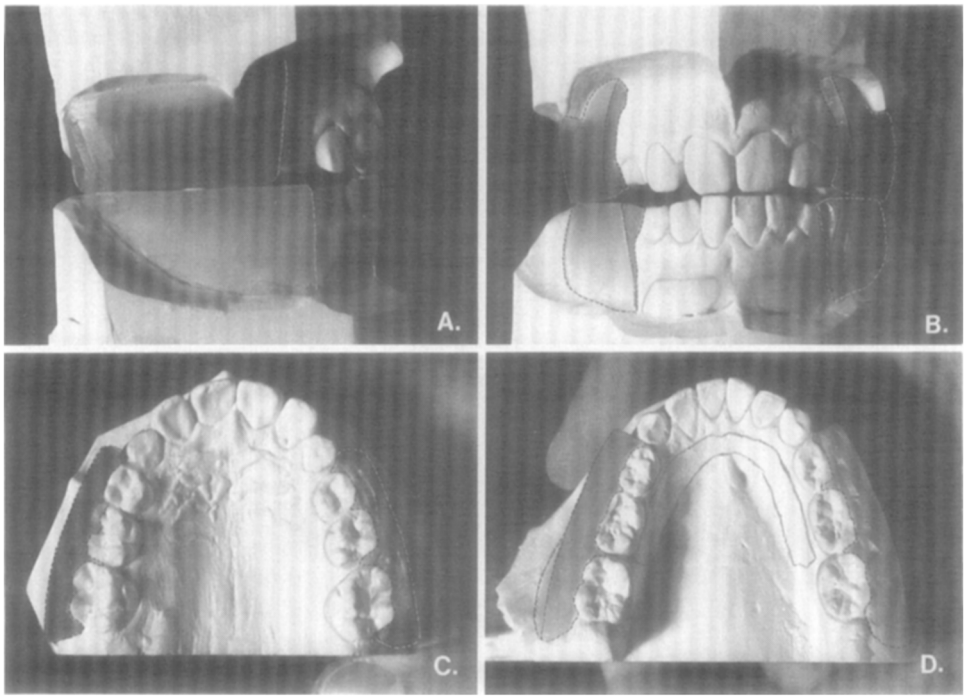

Fig. 8. Placement of wax relief for vestibular shields. **A,** Sagittal view. **B,** Frontal view. **C,** Maxillary view. **D,** Mandibular view. Note the thickness of the wax at the level of the dentition.

In some instances, the amount of wax relief in the most superior areas may be slightly more than 3 mm., depending upon the severity of the undercut above the canine region and upon the path of insertion of the appliance. Particular care should be taken in placing the wax relief on the mandibular cast. It should be noted that the wax relief tapers to a narrow edge inferiorly, as shown in Fig. 8, *B*. Although the thickness of the wax relief at the inferior border is only 0.5 mm., there may be 4 to 6 mm. of wax relief in the region of the dentition.

Wire fabrication

Lower lingual support wire. The lower lingual support wire can be formed either from a single piece of 0.51 stainless steel (Fig. 9) or, for ease of adjustment during treatment, from three separate pieces of wire (Fig. 2, *B*). The description given here is of the single-wire assembly. The wire is fabricated in the general arch configuration of the future lower lingual pad. It is then curved back on itself and directed upward and laterally to cross the occlusal surface of the teeth. It is important that the wire pass in the interocclusal area between the upper and lower arches and not interproximally between the teeth, or tooth eruption will be inhibited and possible mesial movement of the lower dentition may occur during treatment.

The lateral ends of the wire are parallel to the occlusal plane and parallel to each other because they will be used as guides when the lower anterior section of the appliance is advanced in future treatment adjustments. The portion of the wire embedded in the

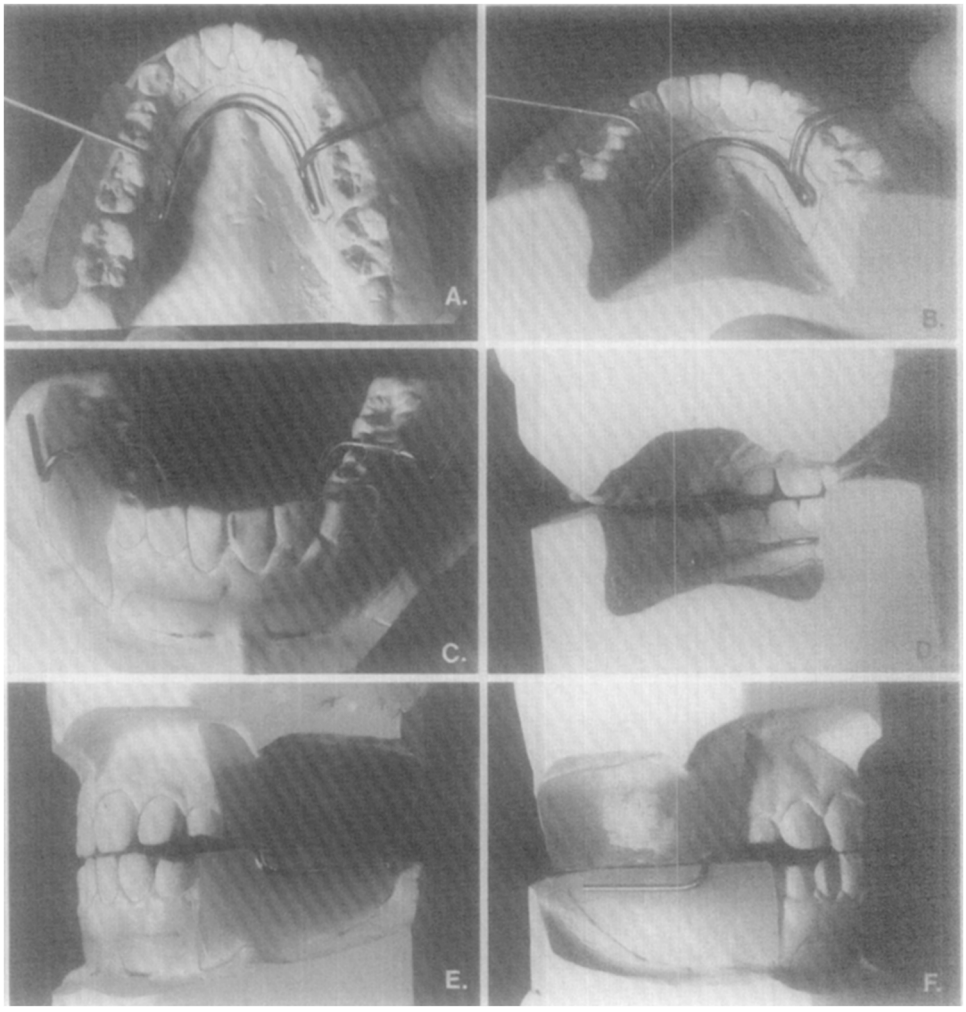

Fig. 9. Construction of the wires associated with the lower lingual pad. **A,** Occlusal view. **B,** Posterior view. **C,** Anterior view. **D,** Lingual view. **E** and **F,** Lateral views. Note that the extension arm of the cross-over wire is parallel to the occlusal surface. The cross-over wire must not contact any teeth.

vestibular shield must be perfectly straight so that it can slide through the buccal shield as the lower labial and lingual pads are advanced as a single unit.

The lingual contour of this wire is positioned approximately 1 to 2 mm. away from the underlying tissue. This distance is necessary so that the acrylic can be trimmed and polished without damage to the wire. The wire is positioned approximately 3 to 4 mm. below the gingival margin on the lingual surface of the mandible. If the acrylic is not kept well below the gingival margin, irritation and stripping of the lingual gingiva can occur. For all wires in the Fränkel appliance it is important to make sure that the angles are not bent too sharply. A 90 degree bend becomes a stress point in the appliance and results in frequent breakage due to wire fatigue.

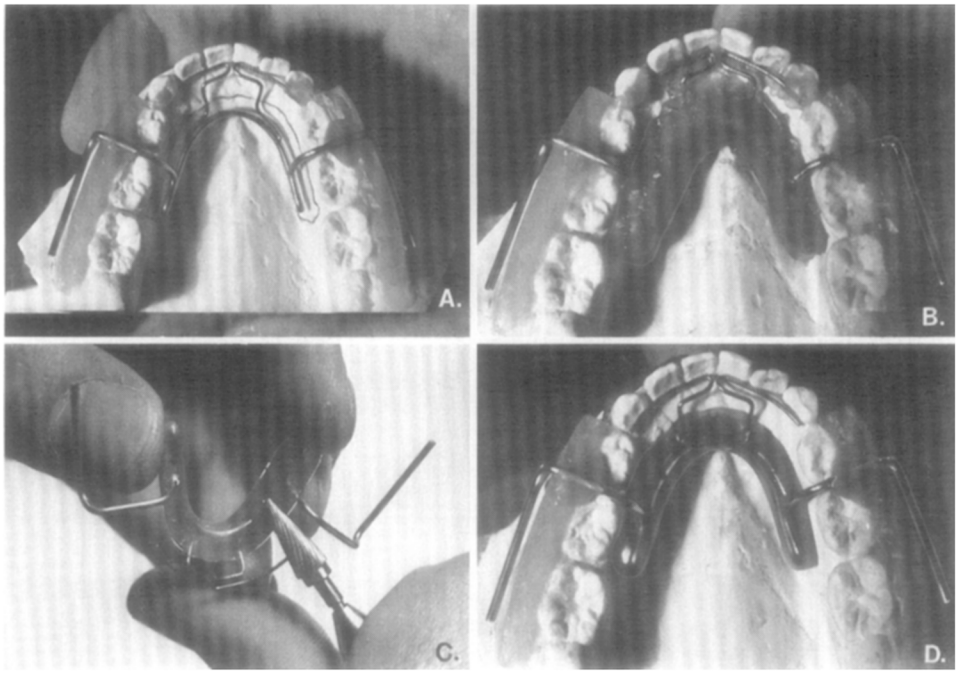

Fig. 10. Fabrication of the lower lingual shield. **A,** Placement of the lower lingual springs. **B,** Rough trim of the acrylic. **C,** Polishing the lower lingual pad. **D,** Final size and shape of the lower lingual pad.

Lower lingual springs. The lower lingual springs are constructed out of 0.028 inch wire and are contoured to the lingual curvature of the lower incisors at the level of the cingulum (Fig. 10, *A*). These wires are used to prevent extrusion of the lower incisors during treatment. Although these springs can also be used to move teeth horizontally, this type of tooth movement is more efficiently accomplished through a period of fixed appliance treatment before the initiation of Fränkel therapy. The lower lingual springs can also be used as a space maintainer by curving the wire around the distal surface of the lateral incisor. In some instances, particularly in open-bite cases, these wires are not necessary.

Lower labial wires. The next step in the construction of the appliance is fabrication of the support wires for the lower labial pads. This assembly can be constructed either of three individual wires as shown in Fig. 11, or of one continuous wire. The 0.036 inch wire should pass from the buccal shield in a slight anteroinferior direction. Like all wires in this appliance, the lower labial wires are positioned at least 0.5 to 0.75 mm. away from the wax relief in order to ensure that the wires will be embedded completely in acrylic. The ends of the wires which will be embedded in the future buccal shield are straight and positioned parallel to each other so that the lip pads can be advanced or retracted as necessary. The gable bend of the center wire must be high enough to avoid irritation of the labial frenum.

Fabrication of labial and lingual pads

After the lower labial and lingual wires have been fabricated, acrylic is applied directly to the mandibular model. As the acrylic polymerizes, it should be contoured and

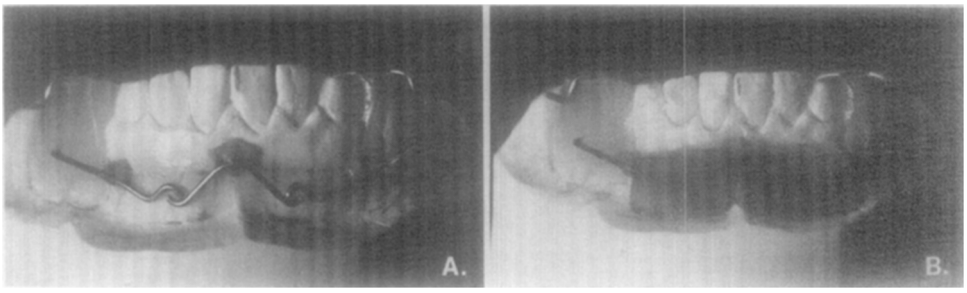

Fig. 11. Fabrication of the lower labial pads. **A,** Placement of the support wires. **B,** Rough trim of the acrylic.

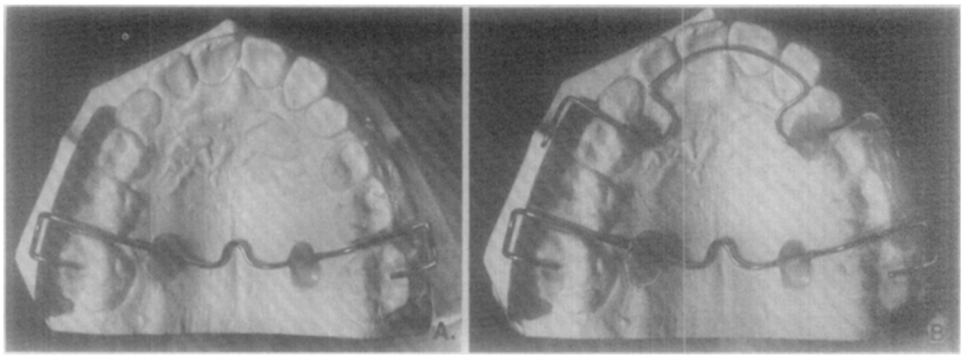

Fig. 12. Maxillary wires. **A,** Orientation of the occlusal rest–palatal wire. **B,** Additional placement of the upper lingual wire. Note that the upper lingual wire should lie on the cingulum of the incisors.

roughly trimmed into a shape which approximates the final outline of the lower labial and lingual pads (Figs. 10 and 11). The mandibular work model is then placed in a pressure pot at 25 to 30 pounds of pressure for 15 minutes to allow the acrylic to harden.

After the acrylic has cured, the lower lingual pad and its associated support wires can be removed as a unit from the model. The lingual pad can be polished with a tapered bur and pumice (Fig. 10). The lingual unit is then seated back into place and secured to the work model with sticky wax. At this point, the position of the lower cross-over wires is checked to make sure that they do not touch the upper dentition. If the cross-over wires touch any of the maxillary teeth, the future eruption of the teeth involved will be prevented. The extensions of the cross-over wire are also checked. These extensions, which lie in the vestibular shields, should be at least 0.5 mm. away from the wax relief, parallel to the occlusal plane and to each other.

Maxillary wires

Palatal wire. The palatal wire (Figs. 2, *A* and 12), which also forms an occlusal rest on the upper first permanent molars, is made from 0.040 inch stainless steel wire. It originates in the central groove of the upper first molar and recurves to cross in the interproximal area between the upper first molar and upper second deciduous molar (or second premolar). The wire then crosses the palate where it recurves in a similar manner (Fig. 12,*A*).

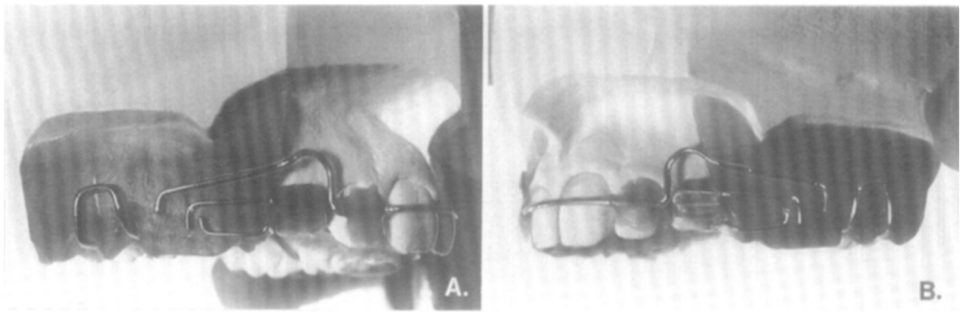

Fig. 13. Lateral views of the maxillary wires. **A,** Right side. **B,** Left side.

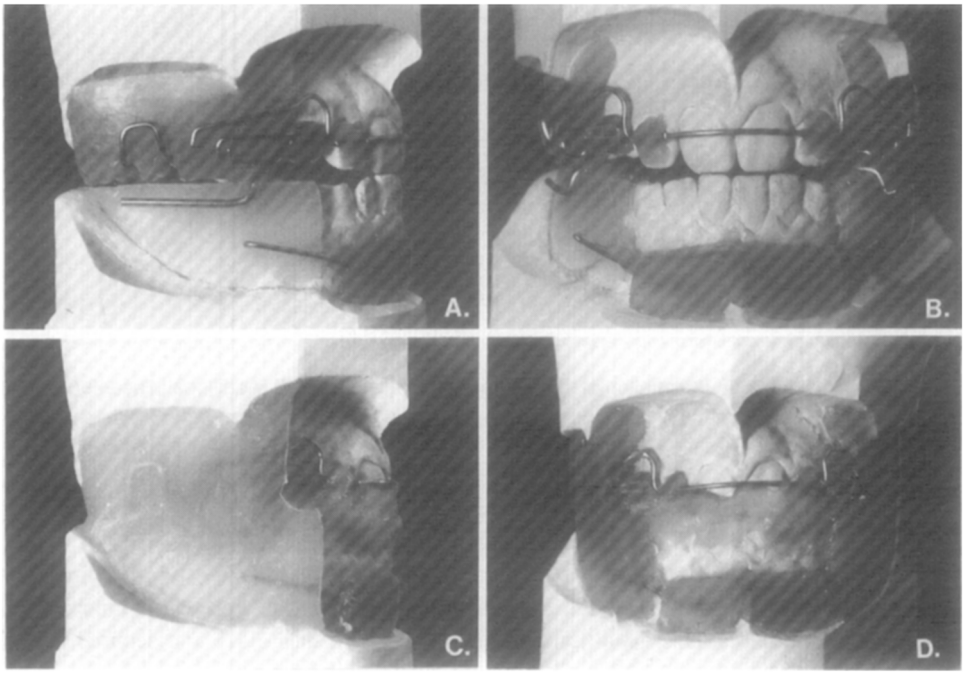

Fig. 14. Placement of the acrylic for the vestibular shields. **A,** Lateral view of completed wax relief and wire work. **B,** Frontal view of same. **C,** Lateral view of rough-trimmed acrylic. **D,** Frontal view of rough-trimmed acrylic. Note in **C** and **D** that wax has been placed in the interocclusal region.

The molar rests should lie parallel to the occlusal plane, so that the molars are free to expand laterally. The palatal wire then should make a 90 degree bend superiorly (Fig. 13) and then should curve inferiorly. The wire crosses in the interproximal region mesial to the first molar in the notched area of the second deciduous molar. As the wire crosses the palate, it should be kept slightly away from the palatal mucosa tissue to prevent irritation.

Upper lingual wire. We have stressed previously the need for fixed appliance treatment to align the incisors prior to Fränkel therapy, and thus a resilient lingual wire is not necessary. Therefore, we recommend that the upper lingual wire should be made of 0.036

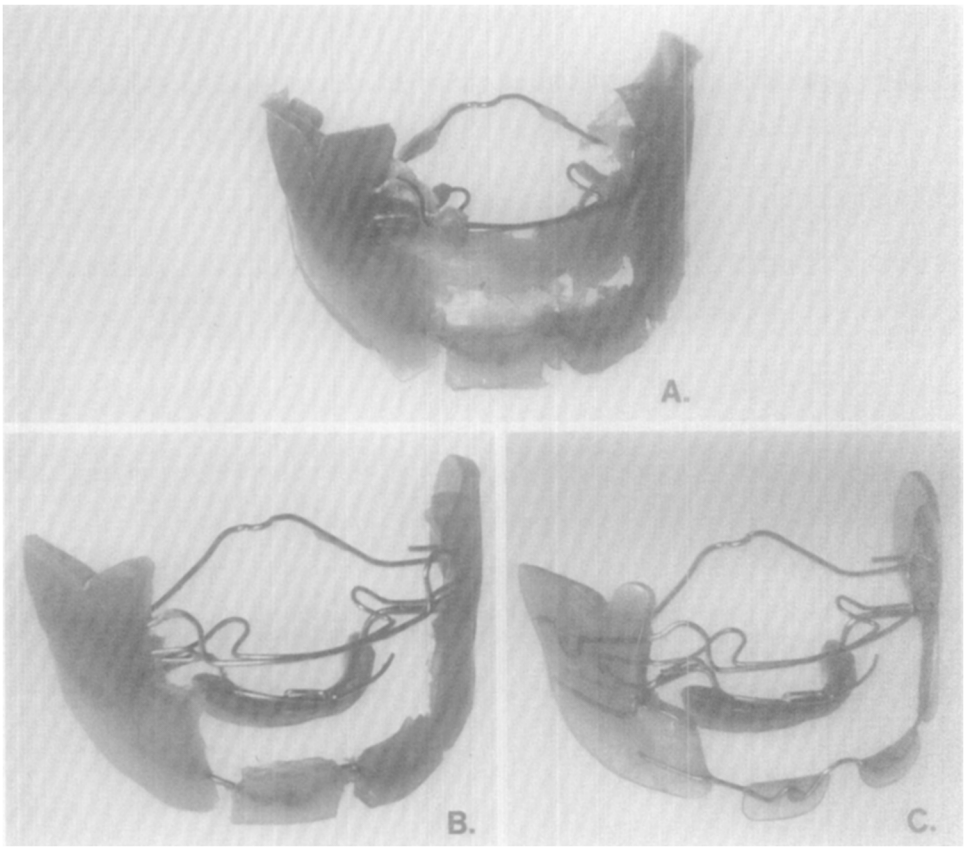

Fig. 15. Final trim of FR-2. **A,** Appliance immediately following removal of the cast. Note that some wax still remains. **B,** Appliance has been immersed in ice water to facilitate removal of wax and after rough contour has been completed. **C,** Finished appliance.

inch stainless steel. This wire originates in the area of the future vestibular shield (Fig. 13), curves slightly upward into the disked area between the upper canine and the upper first deciduous molar, and then recurves along the lingual surface of the upper incisors at the level of the cingulum. The upper lingual wire can be used to stabilize the incisors during treatment. The presence of the upper lingual wire, because it lies at the level of the cingulum, was designed to prevent lingual tipping of the incisors during treatment.

Breakage occurs most frequently at the entry point of the wire into the vestibular shield. This can be avoided by making sure that the bends are not made too sharply (Fig. 12, *B*).

Canine extensions. One reason that we like the design of the FR-2 better than that of the FR-1 is the configuration of the canine extension. The FR-1 has a canine clasp instead of extensions in the upper lingual wire. Fränkel has demonstrated that a buccally positioned canine can be coaxed into position by using the canine clasp of the FR-1. Ocassionally, however, we have noted that the canine clasp tends to interfere with eruption of the permanent canine, particularly during the transition period from the mixed to the

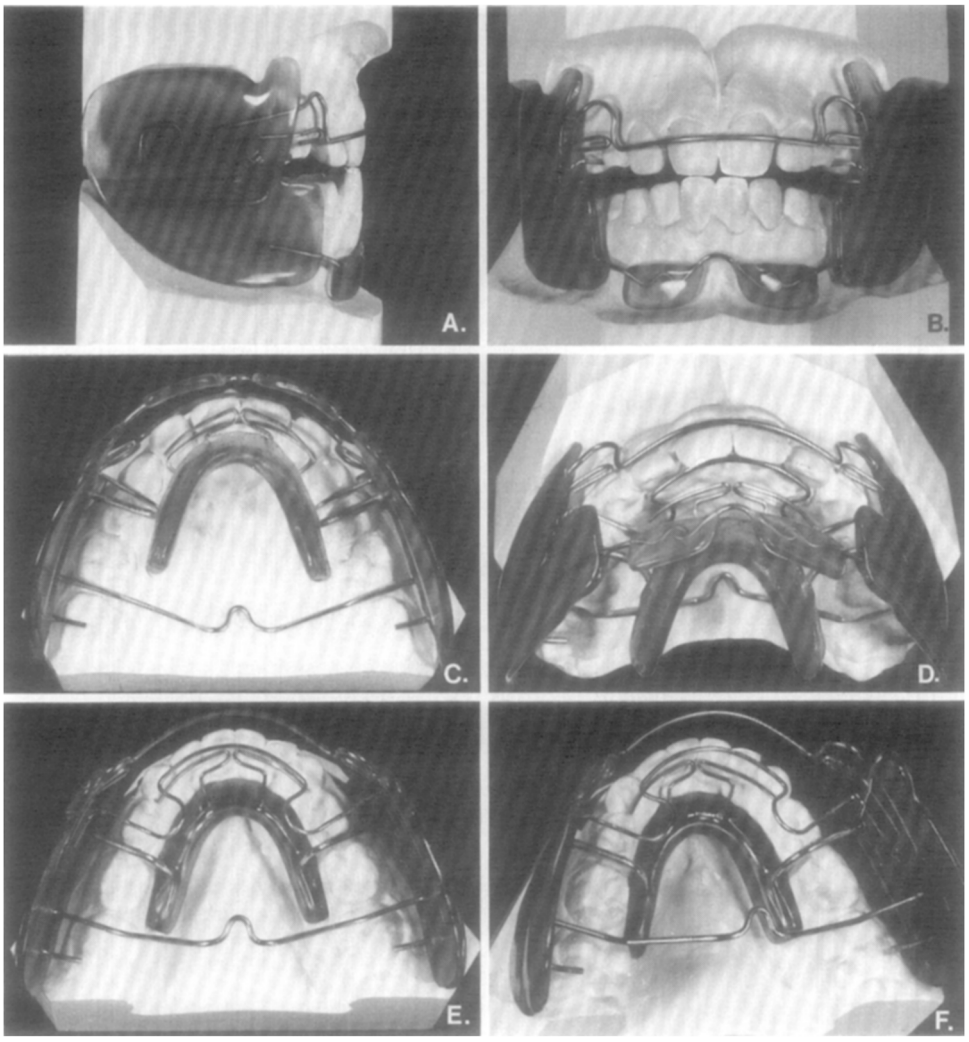

Fig. 16. Finished function regulator (FR-2). **A,** Lateral view. **B,** Frontal view. **C,** Maxillary occlusal view. **D,** Maxillary oblique view. **E,** Mandibular occlusal view. **F,** Mandibular oblique view.

permanent dentition. We have found no interference with eruption of the permanent canine with the FR-2.

The canine extensions, made of 0.032 inch wire, act as an extension of the vestibular shields in the canine region (Figs. 2, *A* and 13). The canine extensions are placed 2 to 3 mm. away from the deciduous canines. If permanent canines are present, the canine arms can be located in a slightly closer position.

The upper labial wire. The upper labial wire is made of 0.036 inch stainless steel (Figs. 1 and 13). It originates in the vestibular shields, makes a small half loop, and then crosses the incisors at their midpoints. The loop portion must lie approximately 2 mm. away from the tissue above the canines. This is particularly important when the permanent canines are erupting, as they may hit the wire if it is not bent correctly. However, if the

loops are positioned more than 2 mm. away from the alveolar mucosa, irritation of the inside of the lip may result.

The arch of the labial bow should be bent in an ideal contour, not to the contour of malpositioned teeth. As mentioned earlier, we recommend that any abnormalities in tooth position be corrected with fixed appliances before the onset of Fränkel therapy. During fabrication the upper labial wire rests gently on the teeth but is moved slightly away from these teeth when the appliance is placed in the mouth of the patient. This is done to prevent any lingual tipping of the upper incisors which might occur instead of the desired mandibular skeletal growth response. Lingual tipping is further prevented by the contact of the upper lingual wire against the incisors, as previously mentioned. If the upper incisors are tipped too far lingually during treatment, it is impossible to achieve an adequate forward repositioning of the lower jaw without bringing the incisors into cross-bite.

Fabrication of the vestibular shields

The next step in the fabrication of the Fränkel appliance is the application of the acrylic to form the vestibular shields. The upper and lower models are locked together with a fixator[12] (Fig. 14, *A* and *B*). The heels of the models should be checked with a straight edge to ensure the accuracy of the bite. Any opening between the teeth in the upper and lower models then is sealed with wax to prevent the acrylic from seeping through to the lower lingual pad which has already been finished and polished (Fig. 14, *C* and *D*).

The acrylic for the vestibular shield is applied with alternate applications of monomer and polymer. During this process, the name and phone number of the patient and the date of appliance placement are typed on a small piece of onionskin paper and placed in the acrylic. The acrlyic is trimmed to the approximate final size and shape of the vestibular shields before hardening and then cured under pressure for 15 minutes.

After the curing, the entire appliance is removed from the work models and placed in an ice bath to harden the wax and facilitate its removal. All wires should be gently pried free before the appliance is separated from the models. This is done to avoid distorting the wires.

Trimming the appliance

After the appliance has been removed from the work models (Fig. 15, *A*), it is roughly trimmed with a sandpaper arbor (Fig. 15, *B*). First the rough outlines of the vestibular shield and the lip pads can be formed and smoothed with a sandpaper arbor. The thickness of the vestibular shields also can be reduced to a uniform 2.0 to 2.5 mm. in the same manner.

The edges of the appliance around the wires are then trimmed with a handpiece and a small bur. Great care should be taken not to nick any of the wires where they enter the vestibular shield, because doing so could weaken them, causing them to break at a later stage. The appliance is finished by means of pumice and polish on a ragwheel (Fig. 15, *C*). All edges of the appliance must be smooth since they will be touching the soft tissue in the mouth.

Evaluation of the appliance

The finished appliance should be placed back on the work model (Fig. 16). All the wires should be checked for placement, as they can easily become distorted during the

finishing process. The acrylic borders should be checked on the models for accuracy. The anterior edge of the superior portion of the vestibular shield of the appliance, when viewed from the side (Fig. 16, *A*), should extend forward in front of the maxillary buccal muscle attachment to approximately the middle of the canine. This portion of the shield should be well rounded. The anterior edge of the inferior portion of the vestibular shield should extend anteriorly to the distal aspect of the maxillary canine. In the posterior region, the appliance should extend to and cover the last erupted tooth, usually the upper first molar. With the appliance seated on the model, the heels should be checked again with a straight edge. This will ensure the accuracy of the appliance.

The final adjustments on the contour of the acrylic parts of the appliance are, of course, made at the time of appliance delivery. Ideally, a continuous spectrum of acrylic to bone without a definite margin is the goal.

Summary and conclusions

The purpose of this article has been to provide a comprehensive description of the fabrication of the Fränkel FR-2 appliance. Many of the minor refinements that we have made in model preparation and appliance construction were a result of Professor Fränkel's visit to the United States in May, 1980. One of the most frequent criticisms that he made at that time was that the lower labial pads were not placed far enough inferiorly or posteriorly. Since that time, we have found that it is necessary to contour the lower labial region of the work model manually in order to ensure proper labial pad placement. Contouring of this region results in fewer chairside adjustments at the time of appliance placement and a decrease in mucosal irritation in the region. Furthermore, we have observed a significant improvement in perioral muscle function. The lower labial pads act to inhibit the function of the mentalis muscle and to flatten the mentolabial sulcus. If the pads are placed in too superior a position, the desired effect on the activity of the mentalis muscle is not possible. The pads may also act as a lip bumper, preventing the creation of a proper oral seal.

Another major change in our appliance construction is in the extension of the vestibular shields, particularly in the maxillary region, to facilitate expansion. This requires additional preparation of the work models in the upper tuberosity region, as well as in the area of the maxillary canine eminence.

It has been our experience that one of the major difficulties in achieving successful results with Fränkel therapy has been an inadequate design of the appliance. We hope that this article will serve to clarify the proper construction of one type of functional regulator.

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