Orthodontic Anchorage*

ROBERT H. W. STRANG, M.D., D.D.S.
Bridgeport, Connecticut

THE ABILITY to successfully manipulate any orthodontic mechanism depends upon three factors of equal importance. The first of these is a keen appreciation of tissue reactions and the limitations of tissue tolerance; the second is a thorough understanding of the mechanical principles involved in the application of the appliance that is to be used; and the third is a complete comprehension of the anchorage available in the structures that are to be modified.

Webster's International Dictionary defines anchorage as "a secure hold sufficient to resist a heavy pull." This implies a source of attachment that is absolutely stable and rigid. Therefore, we are confronted with the fact that intraorally there is no true anchor base available for orthodontic use. The teeth, which are the units of anchorage within the mouth, are held in position by tissues that are designed not to give rigid fixation but rather to furnish resistance to displacement and coincidentally to absorb and prevent shock and trauma. Each tooth swings in a hammock, as it were. The strands of these hammocks are built into a structure, which, though hard and quite unyielding, is more capable of undergoing changes of form than any other tissue in the body. The only reason that the dental units remain more or less stabilized is due to the fact that they are under the influence of balanced forces. *This is just as true of malposed teeth as of teeth located on the line of occlusion or in normal occlusion, as we term it.* Unbalance the force play upon any dental unit, and it will move and continue this change of position until it reaches a location wherein the forces brought to bear upon it are again in complete harmony with one another. It is this factor alone which makes possible the correction of malposed teeth.

The anchorage of a tooth has well been compared by Drs. Edward Gromme and Morse R. Newcomb to the anchorage of a ship. The ship, by virtue of the anchor and hauser attached thereto, remains in one position only as long as the forces of the wind and tide maintain a balanced action upon it. If the wind changes its direction or the tide increases in velocity of flow, the ship moves to a new location, where it will again be under the action of balanced forces. And so it is with a tooth, attached to the bone which is its anchor, by means of its hauser, the periodontal membrane.

Stationary anchorage in orthodontia, therefore, is a myth in the final analysis of the term and this factor must never be lost sight of. All tooth movements are accompanied by reciprocated changes of varying intensity within the anchorage base and successful results in treatment depend upon the ability of the operator to limit these structural modifications to a mini-

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mum amount in those locations where tooth movements are undesirable and to produce extensive changes in those areas where marked tooth shifting is indicated.

The problem of anchorage in orthodontia is tied up most intimately to the biologic reactions of bone cells in response to stresses and strains. The slightest pressure brought to bear upon these vital structures causes a response which is manifested, primarily, in purposeful changes in form whereby this new force can be antagonized and resisted. When duration of the force prohibits successful resistance, the bony tissue strategically yields in a method of organized retreat but continuously maintains an active and purposeful bulwark of resisting trabeculae and cortical layers during this period of retrogression.

Anchorage in the oral cavity, therefore, must be described simply as "resistance to movement." This resistance must be obtained from anatomical structures, some of which are tangible and constant while others are variable and invisible. The constant and tangible agents are the number and size of the tooth cusps and the number, form and size of the tooth roots. The periodontal membrane may also be reasonably added to this group.

And when mentioning the periodontal membrane it is well to call to mind that this structure is strongest on that side of the tooth roots that are normally subjected to tension and weakest on the side of normal pressure. The bone of the alveolar process is likewise adjusted to best withstand the forces of tension rather than those of pressure.

The variable anatomical structure available for resistance, and the most influential of all, is the supporting bone of the alveolar process. This may be well calcified and vitally active, or it may be lacking in its mineral content and hence be readily broken down under stress.

This means that every orthodontic case is individualistic, which naturally precludes definite results from the application of proven mechanical laws to this problem of anchorage. Biologic factors must be respected and utilized for they play a profound part in our problems of tooth resistance as well as tooth movement.

It would seem as if the importance of this fact had been overlooked in the analysis of the reaction of bone to the forces brought to play upon the teeth for the purpose of changing their positions. Oppenheim, in his classic studies, calls attention to the fact that the first modifications that occur in the osseous structures surrounding the roots, when force is applied, is a rearrangement of the trabeculae, on the side of tension and on the side of pressure, to harmonize with the lines of stress. This is a purposeful act and takes place in order that the tooth may be better braced against the displacing strain. Furthermore, before absorption occurs, so that the tooth can move, there is a primary deposition of new bone on the pressure side of the alveolar process so that the thickness of this bony structure may be kept inviolate. Therefore, there is the possibility of maintaining such a minimum degree of pressure on the teeth that are being used for anchorage as to limit the changes which occur in their supporting bony processes to a stage of active rearrangement and formation of bone for the purpose of resistance. This allows the operator to take advantage of a biologic aid in the stabilization of parts. On the other hand, if the resistance of the anchorage area is abused, as it were, further changes will take place in the bony structures which will permit the teeth to move in harmony with the lines of mechanical stress. From this evidence we may formulate an important biologic principle in anchorage which may be stated as follows:

The reaction from the force employed upon the teeth that are to be moved should be distributed in such manner upon the various units of anchorage that its intensity will be reduced to a degree that will dictate only such readjustments in the supporting bone as will build up the resistance of those anchor teeth against displacement and avoid changes that are responsible for tooth movement.

Owing to the fact that we are admittedly in the dark when depending upon the intensity of cellular response to mechanical stimulation for our sources of resistance in the movement of teeth, it is impossible to place complete reliance upon methods of appliance adjustment for perfection of stability. Clinical experience is the safeguard in this equation. However, mechanical principles do play an important role in this problem and their utilization with intelligence is quite essential. Practical tests have long given proof that a tooth crown can be shifted from one position to another much more readily by an adjustment of mechanism which favors a tooth tipping movement rather than by one which dictates a movement of the tooth bodily.

Research workers found just why this was true. When a tooth tips, it is only necessary for the bony tissues forming the alveolar process to modify themselves in that portion of the alveolus which is in the region of the occlusal third of the root. Little or no changes of tissue structure are evident in the gingival two thirds of the wall of the alveolus. On the other hand movement of the tooth bodily would demand an extensive and complete transformation of the bony wall of the alveolus.

The terms simple anchorage and stationary anchorage owe their origin to this clinical observation. Simple anchorage refers to the use of an attachment upon the tooth or teeth that are chosen for anchorage which will permit this anchorage base to tip if its resistance is overcome and it begins to move. The attachment is a hinged one. It goes without saying that it is the weakest form of anchorage, yet it can be used with safety and at times with advantage if the force application is tempered with intelligence.

Stationary anchorage, which has been previously stated to be a misnomer when used in orthodontia, refers to the application of such attachments upon the teeth selected for resistant agents in the treatment, that will prohibit all displacement of these teeth other than bodily shiftings. The teeth cannot *tip* in any direction, if they are moved, but must be displaced in the same axial relationship as they display at the beginning of the movement. It is, of course, the most desirable and advantageous form of anchorage.

But the form of anchorage that is most universely employed and which really is not anchorage from the viewpoint of fixation, but rather is equalized, controlled or balanced tooth movement, is obtained by a reciprocal action between various teeth or groups of teeth in which the movements desired are more or less in opposite directions so that the force and reaction law can be applied to advantage and universal displacement obtained. This has been termed reciprocal anchorage. It is, in reality, reciprocal movement.

Finally there are two forms of anchorage that have been made available through the use of auxiliaries in the form of elastic bands. The first of these is intermaxillary anchorage wherein dental units on one dental arch are pitted against dental units on the opposing arch through the agency of rubber bands. The second is extra oral, usually occipital, wherein a headcap is used for the attachment of elastic bands, which, in turn, are applied to the appliance within the mouth. Occipital anchorage is truly stationary anchorage and it is my belief that its advantages have been decidedly overlooked by most operators in our field.

Thus it is clear that every operator working in the specialty of orthodontia has exactly the same resources for anchorage as are available to everyone of his colleagues. But it is also undoubtedly true that the ability of operators to conserve the sources of anchorage and to obtain the best possible advantage from such dental units, varies to a marked degree. This places some men at a decided disadvantage, for the successful treatment of complicated cases of malocclusion depends, most emphatically, upon conservation of anchorage areas.

Intra-oral anchorage came into its own when a means was found for cementing bands upon the teeth in such manner that they resisted displacement over a reasonably long period of time. The evolution of appliances is but a tangible exhibit of efforts to produce perfection in anchorage. The jackscrew was not efficient until it was attached to bands cemented on the teeth from which and upon which it was to act. Fauchard's bandeau was a poor device until its ends were stabilized by being attached to anchor bands which were, in turn, made secure by cementation. Then it became such an efficient mechanism that its principle is in universal application today.

In the early days of our specialty and in the use of the more simple appliances today, the larger teeth in the denture were and are automatically accepted as the source of anchorage. Hence the first permanent molars came to be known as the anchor teeth. In the deciduous denture the second molars were chosen as the source from which to apply the power. As general expansion of the denture was the accepted method of obtaining room for rotated or blocked-out dental units, these anchor teeth were provided with bands carrying an auxiliary that permitted tipping movements buccally but prevented distal displacement other than a bodily movement. This was the primary form of stationary anchorage. The buccal tube with the round bore into which the round arch was received was efficient for such purposes.

Stabilization of the auxiliary by which the force of the spring lever was applied to the teeth that were to be moved was the next step of advancement in treatment and the application of bands on the anterior teeth with spurs for ligature attachment came into general use and force control was made more perfect.

With these improved methods for force control which made its application more positive and effective, the danger of displacement of the anchor teeth was increased. The reply to this difficulty was the employment of additional teeth to the anchorage section of the power plant. The second and first premolars were laced to the archwire to give the molar teeth the required support. These teeth, however, were almost universally attached to the archwire by ligatures so that the anchorage they afforded was only of simple form.

Cases were encountered in which buccal movement of one side of the denture had to be of greater degree than that of the other side. Hence stationary anchorage against buccal as well as against distal displacement was in demand. This led to placing an oval buccal tube on the molar band on the side that was to act as a source of increased anchorage, and using an oval arch end which accurately fitted this tube on this side of super-anchorage while the opposing molar still was under the influence of the round tube attachment. Sometimes a square or a vertical tube was used on the anchor side of the denture.

Bodily movement of both molars buccally was then seen of advantage in many cases and oval tubes were frequently used on both sides. Thus did we find simple, stationary and reciprocal anchorage in universal activity. The Baker and Angle principles of Class II and Class III treatment developed intermaxillary anchorage while occipital anchorage was also sometimes used in Class II and Class III malocclusion.

When the importance of the correct axial positioning of teeth was recognized, the movement of tooth roots during treatment was made possible through the agency of the pin and tube and the ribbon arch appliances. In these devices the molar teeth were still used as sources of anchorage. The stress and strain upon these teeth was relieved somewhat by the ability to supply reciprocal anchorage within the area of the six anterior teeth and by building up resistance to distal displacement by the judicial use of intermaxillary anchorage or by ligating the premolars to the archwire.

And with the introduction of the ribbon arch appliance a new force was available to orthodontists both for tooth movement and for anchorage stability. This was the torque force. By virtue of this positive agent the molar teeth could be placed in a condition of active resistance against buccal or lingual displacement, while the anterior teeth could be readily tipped either labially or lingually thus reducing the antero-posterior strain on the molar anchorage.

In both of these mechanisms stationary anchorage in the premolar area was lacking and this is a most useful adjunct to employ in certain cases. The only control that the operator had in this region was in the form of simple anchorage. These teeth could also be moved in all directions by proper auxiliaries but definite action upon their roots during treatment was impossible. Furthermore the need for distal movement of the buccal teeth became quite imperative and these two important necessities, namely, stationary anchorage and distal movement, led to the introduction of the edgewise arch appliance.

As soon as this mechanism was brought into use it was seen that the problem of anchorage had assumed a new status. No longer were the molar teeth in a position to be granted the honor of the title of anchor teeth. Quite to the contrary, each and every tooth was under perfect force control both as to its crown and to its root position. Hence each tooth now assumed the role of an anchorage auxiliary. So the problem of tooth movement was no longer thought of in terms of individual tooth shifting and individual tooth resistance but rather in group modification, group resistance and universal reciprocal movement. While this seemed to many a decided complication of orthodontic therapy yet the great advantage obtained from group stationary resistance far outweighed any disadvantage of complicated mechanism, and it became possible to perform certain tooth shiftings in a most satisfactory manner that heretofore were considered to be impracticable. Torque force was an even more useful adjunct in this device than in the ribbon arch appliance because it could be applied to all of the teeth.

And so in this ever-present equation of anchorage in orthodontics it seems to the writer that it has been more perfectly solved through the agency of the edgewise arch appliance than by any other device so far presented. Therefore, let us analyze the mechanics of this appliance from the viewpoint of tooth resistance.

The expansion archwire, per se, is a spring lever and acts by virtue of this mechanical principle. With the first molar employed only as the anchor tooth, the lever in action is a long-armed one, extending from the molar to the canine or perhaps to the incisor area. Hence the strain upon the anchor tooth is marked and the danger of displacement is eminent.

The effect of placing bracket bands upon the premolar teeth and engaging the archwire with the horizontal slots in these brackets, is to break up this long lever into a series of short spring levers each one of which has a working arm, a fulcrum and a power arm in association with each individual tooth. These power arms being short give added advantage in force control and hence increase the possibility of planned resistance. Power arms can be more perfectly balanced against one another to effect mass stability. Reciprocal action can be more universally and intelligently directed. Finally torque force can be dispensed on each tooth for increased resistance or for producing motion. Thus it has become possible to build up the resistance on certain teeth that require little change in their positions and augment the archwire activity upon those teeth that need extensive movement because every tooth is under accurate force control. Anchorage with this device has become a universal tooth proposition.

When the edgewise archwire appliance brought such a compounding of anchorage possibilities, mass distal movement became a reality. The initial attempts at this type of movement were directed against the maxillary denture in Class II treatment. Distal crown tipping bends were placed in the molar, premolar and canine areas of the archwire, which, when the archwire was locked in the brackets of all the maxillary teeth, set in action a series of double levers consisting of four anterior levers and three posterior levers, and these very effectively tipped the teeth in the buccal segments and depressed the incisors, a reciprocal action that was very desirable. However, these levers produced a minimum amount of distal action upon the crowns. Rather did they tend to tip the roots of the buccal teeth forward. In order to obtain a definite backward thrust upon these teeth it was necessary to bring into action a distinctly distally propelling force from an entirely new source of anchorage. This, of course, was intermaxillary elastic force acting from the mandibular base.

In the use of this intermaxillary force it was necessary to consider its reciprocal action and stabilize the anchorage units from which this force was applied or a reciprocal movement would result.

The simple appliances, depending almost entirely upon molar anchorage, gave a very inefficient anchorage base from which to apply intermaxillary force and try as hard and as ingeniously as one could, it was found impossible to prevent the mandibular molars from tipping forward and the incisors from doing likewise. This, of course, produced a faulty labial axial inclination of the mandibular incisors which was very tangible evidence of failure in mandibular anchorage and disastrous to successful treatment in Class II deformities.

The ribbon arch appliance greatly improved the possibilities of mandibular anchorage for use of intermaxillary force for it added the value of stationary anchorage to the incisors and canine area. But this was not sufficient in all cases and the molars, canines and incisors were still found susceptible to a reciprocal forward movement. Banding the premolars and ligating them to the archwire helped considerably, but anchorage troubles were not relieved, when using intermaxillary elastics, until the archwire could be inserted in brackets placed upon the premolar teeth, which prohibited all tooth movements in the mandibular denture other than bodily ones and these only occurred to a minimum degree. It is now quite common to add the second molar teeth to this universal anchorage base which still further improves its stability.

From such an anchorage, intermaxillary force is now applied to the maxillary denture upon which has been adjusted an edgewise archwire that has been so modified that it is acting to tip the buccal teeth and depress the incisors. Interpret this in terms of anchorage and it is seen that stationary anchorage is pitted against simple anchorage in resisting an antero-posterior elastic force. Hence the maxillary tooth crowns must move backward because the archwire will be pulled backward by the elastics. To further improve this simple anchorage problem in the incisor area it was suggested by Dr. Will M. Thompson that a round archwire be used in the maxillary denture rather than an edgewise. This was an additional element of safety for it allowed the maxillary incisor crowns to tip lingually and so automatically to correct their perverted labial axial inclinations and this coincidentally favored the distal pull of the elastics. At the same time the tipping force of the archwire upon the buccal teeth was maintained in a perfectly efficient degree of activity even though a round archwire was in use.

Unfortunately the orthodontist does not always find the teeth that he desires to use for anchorage purposes in such perfect alinement that he can obtain bracket engagement without first resorting to considerable tooth movement. In certain cases, when the alveolar process was not well developed, it seemed unwise to disturb this primary bone formation lest the changes associated with such tooth movements weaken the resistant powers of the supporting bone. In these specimens the suggestion was made, and I believe the idea originated with Dr. Allan G. Brodie, that the operator use the technic associated with the primary application of the ribbon archwire, and adjust the edgewise archwire to the malposition of the teeth that were required for anchorage, bending the wire until a passive adjustment of the brackets had been obtained. By such a procedure the osseous changes were minimized and the full value of this poorly calcified bony tissue for anchorage purposes was preserved as long as desired. This method was practised and taught by the writer until quite recently.

In mixed dentures which present themselves for treatment at a time when the deciduous roots are nearly absorbed and hence are useless for anchorage purposes, corrective treatment is wisely delayed until the permanent teeth erupt and can be utilized for resistance in reciprocal movements.

If we now pause and analyse this discussion up to the present moment, we will note that both the biologic and the mechanical phase of the problem have been presented and harmonized. The mechanical build-up, however, has been limited to a consideration of the efficacy of various appliances in effecting tooth stability.

Within the last few years an additional mechanical factor has been projected into the picture by Dr. Charles H. Tweed of Tucson, Arizona, which does not fit so snugly into the biologic teachings but does offer such positive clinical proof of its value that it seems destined to revolutionize anchorage preparation. Dr. Tweed lays great emphasis upon primarily reorienting every tooth in the anchorage section of the denture to an axial position wherein it is best able to mechanically resist the force that will eventually be used in producing the tooth movements required in treatment.

In order to achieve this objective in anchorage preparations he does not hesitate to produce extensive bony changes in the alveolar process in all of his cases, a procedure that is diametrically opposed by the operator who is guided by the teachings of the biologist.

Dr. Tweed first presented his suggestions for anchorage preparation in a paper that was published in the July, 1936, issue of THE ANGLE ORTHODONTIST. He was severely criticized for advancing radical and non-biologic technical procedures. Dr. Tweed's reply was the presentation, at a subsequent meeting in New York City, which some of you attended, I am sure, of casts and photographs of approximately one hundred *consecutively* treated cases that established him, in my opinion, as the finest clinical orthodontist in the world today and clearly showed that his anchorage preparation was the most stable of any heretofore evolved. Since that time, Tucson has been a Mecca for orthodontists and many men who have received instruction from Dr. Tweed, have been able to exhibit such outstanding results that their products have also justly won similar praise to that given to cases completed by their teacher.

Naturally the controversy between the men who lean toward the importance of primarily conserving the integrity of the osseous structure for anchorage stability and the followers of Tweed's technic, who pay no attention to this detail, still goes on and this is as it should be for the issue is of vital importance to every orthodontist. Further research will bring the desired knowledge as to which method is the proper one to follow.

As Dr. Tweed attributes the greatest part of his success to thorough anchorage preparation, it is quite proper that this paper should briefly discuss certain of his technical suggestions. In analyzing the Tweed treatment it appears to the writer to be based upon the following philosophy.

First: That practically all malocclusions are characterized by a forward drift of the teeth in relation to their basal bones. This is particularly in evidence in the mandibular incisor area where it will be noted that these teeth no longer overlie the basal ridge of bone from which the alveolar process takes its origin. This forward displacement produces a characteristic concave area labially to the incisor roots and a shelf-like formation of bone on the lingual side of these teeth.

Second: That teeth, like inanimate objects, best resist the force of displacement when directly overlying their basal ridge of support and when tipped to the angulation that offers the most advantageous mechanical resistance against the pull of dislodging forces.

Third: That teeth are most readily moved when their power of mechanical resistance has been primarily reduced.

Fourth: That the establishment and maintenance of a stable anchorage is a fundamental factor in successful orthodontic treatment and should be the initial concern of the operator.

Fifth: That all forces emanating from an orthodontic appliance must be synchronized if they are to be most effective in the mass movement of teeth.

Sixth: That nature, being an expert mechanic, offers biological compensations and adjustments when teeth are placed in positions of mechanical advantage for force resistance, which more than counterbalance the loss of bone stability that results from the initial tooth movements made for the purpose of establishing these adjustments.

In harmony with this philosophy, Dr. Tweed's initial application of force is directed toward moving the mandibular incisors lingually until they are relocated on their basal ridge and then rearranging the axial positions of all the teeth to offer the best possible mechanical resistance against forward displacement. To that end all of the buccal teeth are tipped distally and the incisors are given a lingual tip. Thus they assume the same relationship to the pull of intermaxillary elastics as do tent pegs to the guy ropes of the tent.

In this primary preparation of anchorage, Dr. Tweed does not hesitate to move all of the teeth into correct alinement and perform all rotations so that he will have nearly perfect tooth alinement, correct arch form and complete proximal contacting. He then ties back his archwire to the buccal tubes so as to have a stable unit, as it were, after which he is ready to apply his intermaxillary elastics.

While he is thus preparing his anchorage and obtaining positions of best mechanical advantage for all of the teeth of the mandibular denture, he is breaking down positions of mechanical advantage—in the teeth of the maxillary denture—that need to be moved by the force emanating from the anchorage he is establishing in the mandibular denture.

If it is necessary to use Class III elastics even in a Class II case, to replace the mandibular incisors on their basal ridge and to obtain this distal tipping of the mandibular teeth without a forward movement of their roots, he immediately applies such elastics. But when he is using the Class III elastics, he supports the maxillary tooth arch against forward displacement by the use of occipital anchorage. Dr. Tweed does not consider any case satisfactorily treated unless the mandibular incisors distinctly overlie their basal bone and he has eliminated all signs of the shelf of bone that is often so marked on the lingual aspect of the incisor roots and the groove that all too frequently is found beneath the incisors labially to their roots. All protrusiveness in the incisor area of both dentures is completely overcome by moving these teeth lingually. His finished cases are beautiful to behold! The profile photographs of his patients, taken after treatment, exhibit no evidence of protrusion of the lips as is the case when the teeth have been left too far forward on their basal bones.

From the clinical proof that he has furnished there is no question but that anchorage developed by placing the teeth in position of best mechanical advantage to resist the force of displacement gives more stability than anchorage obtained with the least disturbance of the bony tissues of tooth support.

It seems reasonable to state that the anchorage that is available within the mouth, although not of a stationary character, would have proved all sufficient had not the need for the distal movement of teeth been recognized and attempted. The writer has always been exceedingly interested in this complicated form of malocclusion. To the best of his knowledge he was the first to call attention to this particular variation from normal, in a paper entitled "Pitfalls in Class I cases," published in the *Dental Cosmos* for July, 1924. In this same paper is an illustration of occipital anchorage that, at the suggestion of Dr. Julius Minez, of Newark, N.J., was applied in a manner that simulates the present method of adjustment. At this time the essayist was using the ribbon arch mechanism.

When the edgewise arch appliance was presented to us, the possibilities for improved anchorage were so augmented that occipital anchorage was completely discarded. However, it was eventually appreciated that many cases of extensive forward drift of the buccal sections of both dentures, could not be successfully completed with intraoral anchorage, even with the increased amount available when using the edgewise arch mechanism. This led to a return to occipital anchorage and the evolvement of a much more satisfactory method of applying it.

Occipital anchorage has been used for many years in the correction of malocclusion. Angle describes a method of application in his sixth edition of Malocclusion of the Teeth; Case also advocates its use in his Dental Orthopedia; Dewey mentions it in his Practical Orthodontia as does McCoy in his Applied Orthodontics. In all of these texts, the method of adjustment to the appliances within the mouth is through a metal bar that fits on the expansion archwire in the region of the maxillary central incisors. This always seemed impractical to the writer because it prevented the child from turning his head during sleep and was readily displaced. Hence the suggestion of Dr. Minez to apply this resistance directly to the intermaxillary elastic hooks was adopted. At first the same form of headgear that Angle devised, i.e. the net cap surrounded by a steel hoop, was utilized. Although the net cap did not prove satisfactory, yet no modifications were made until 1937 when extensive experimentations were begun. In this work the writer was aided by his associates in the Eastern Component of the Angle Society. A brief report of the work of this group appears in THE ANGLE ORTHODONTIST for October 1940. As a result of the changes that were made in the form of the headcap and also in the method of applying the force to the expansion archwire, this form of anchorage is now found of great practical use and is being extensively resorted to, especially by the followers of the Tweed technic.

The headcap that the writer prefers consists of a band of non-elastic material that surrounds the head above the ears, in the same location as an ordinary hat. It is supported by an antero-posterior strap and a transverse strap. To the strap that surrounds the head is attached an extension that surrounds the back of the neck and extends forward below and just beyond the ears. This is held in position by a strap extending down from the head-cap in front of the ears. To this are sewed two hooks to which the elastics from the mouth hook are adjusted. The cap is made in various sizes. The elastics are ordinary stock size No. 10 rubbers, one inch in length.

These elastics, two for each side, are attached to hooks that connect the headcap to the intermaxillary hooks on the archwire. The form of these hooks has been a source of experimentation and modification for the last four years but the ones that are now being used are proving very satisfactory.

Fig. 1.—Front and side view of headcap for occipital anchorage.

The design is such that it relieves the pressure on the cheeks, prevents turning of the hooks, avoids irritation of the corners of the mouth and stabilizes the entire device most efficiently.

As these hooks are not to be found on the market, a description of their formation is necessary.

Technique of Forming Occipital Anchorage Hook

1. Take a piece of .045" Round Steel Wire and grind one end to an angle of 45 degrees. Place the beaks of pliers No. 139 as close to this beveled end of the wire as possible and form an eyelet in the end of the wire. Solder the free end to the main shaft to completely close the eyelet. Fig. 2-1.
2. Give the main shaft of the wire a bend at the point of soldering so that the eyelet will be in a direct line with the main shaft.
3. With pliers No. 139 make a series of six bends, the first of which is formed next to the eyelet and each succeeding one is separated 1/8 of an inch, thus producing a curved end and carrying the eyelet approximately at right angles to the main shaft. These bends are formed with the eyelet in a transverse relationship with the curved end. This curved

end should cover a section of the wire approximately 1 inch in length. Fig. 2-2.

4. Measure along the shaft from the deepest portion of the curved end a distance of $1\frac{3}{4}$ inch and place a mark at this point, best made with a moist finger-nail pencil. At this mark bend the wire at right angles using pliers No. 139 as the holding instrument, and having the beaks on the eyelet side of the mark. Fig. 2-3.
5. On the right angle portion measure a distance of $\frac{1}{4}$ inch and make a reverse bend paralleling this $\frac{1}{4}$ inch right angle section of the shaft but separated from it $\frac{1}{16}$ inch. This reverse section enters into the formation of the elastic control loop at the extreme end of the hook.

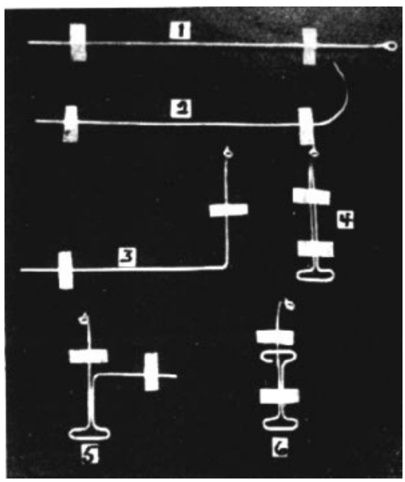

Fig. 2.—Technic of hook formation, occipital anchorage auxiliary.

6. Measure a distance of $\frac{1}{2}$ inch from the point of the reverse bend of the wire and make a second reverse turn to bring the free end of the wire back toward the main shaft and overlapping this at the first right angle bend. This completes the formation of the elastic control loop at the end of the hook.
7. Place pliers No. 139 at a point half way between the spot where the free end of the wire crosses the main shaft to complete the loop and the outer edge of the second reverse turn, and make a right angle bend causing the free end of the wire to parallel and lie against the main shaft of the hook. Fig. 2-4.
8. Measure a distance of 1 inch from the outer edge of the elastic control hook along the free portion of the wire and mark this point with the pencil. Place pliers No. 139 on the elastic control loop side of this mark (the plier beaks will force the paralleling wires apart in doing this), and bend the free end at right angles and away from the main shaft of the hook.
9. Solder the paralleling sections together over an area of $\frac{1}{4}$ inch extent

and located half way between the elastic control loop and the right angle bend just completed. Fig. 2-5.

10. On the free end of the wire now directed at right angles to the main shaft measure off 1/4 inch from the last point of bending and make a reverse turn that will cause the free end of the wire to cross the main shaft of the hook on the side toward which the eyelet lies. Fig. 2-6.
11. Measure a distance of 1/2 inch from the outer edge of the last reverse turn along the free end of the wire and make the final reverse turn toward the elastic control loop at the end of the hook to complete the second elastic holding loop. Fig. 2-6.
12. Cut off the end of the wire, leaving an opening of 1/16 inch for the insertion of the elastic. Sandpaper the rough free end of the wire.
13. Two small spurs are now soldered to both the elastic retaining and the elastic controlling loops. These are attached 1/16 of an inch from the

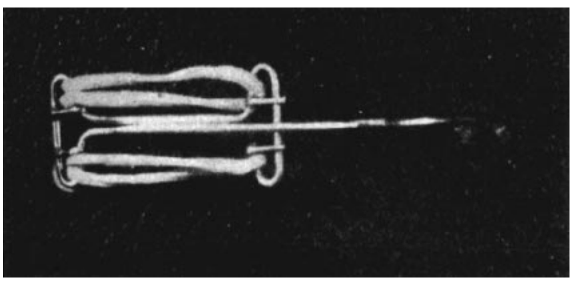

Fig. 3.—Completed hook with elastics properly adjusted for attachment to headcap. Also see Fig. 1.

main shaft. Those on the retaining loop are soldered at one end only so as to present a free end over which the elastic is caught. Those on the controlling loop are attached at both ends by solder so as to form two eyes through which the elastics are threaded before they are snapped onto the hooks on the cap. Fig. 3.

14. Finally give the elastic control loop at the end of the hook a slight bend away from the eyelet side and located on the double shaft 1/8 inch from the elastic control loop. This permits free slipping of the stretched elastic through these control loop eyelets. Fig. 3.

The elastic is anchored to the holding loop which is in the center of the hook. The eyelets in the loop at the end of the hook act simply as controls to prevent the hook from rotating in the mouth and impinging upon the cheek tissues. In threading the elastics through the control eyelets, they enter these from the side away from the cheek and emerge on the cheek side of the eyelets.

What Are the Indications for Occipital Anchorage?

Occipital anchorage is used by the writer purely as anchorage and not as an agent for active tooth movement. However, some of the members of our study group have shown cases in which quite extensive tooth movement has been performed by this auxiliary.

The cases in which I have used it with the greatest satisfaction are those in which the vertical spring loop auxiliary was active. In the Tweed technic, occipital anchorage is used on the maxillary denture while preparing the mandibular anchorage at which time Class III elastics are worn to carry the mandibular incisors lingually and the crowns of the buccal teeth distally. Its object is to prevent the forward movement of the maxillary teeth under Class III reciprocal force.

I have used this anchorage on both the maxillary and mandibular dentures with equal success although the hooks adjust themselves better to the maxillary archwire than the mandibular. The hooks that are soldered to the archwire must be slightly longer than the ordinary intermaxillary elastic hook and should be placed so that their free end lies just below the brackets on the lateral incisor bands. The brackets can then be used as checks against a forward displacement of the occipital hook.

The writer also uses occipital anchorage and a cloth chin strap for retention purposes in Class III cases. Special attachments connecting the chin strap to the cap must be devised by the operator for this purpose.

In analyzing Dr. Tweed's beautiful results one fact stands forth preeminently. A tremendously strong anchorage has always been prepared in the mandibular denture before any distal movement in the maxillary denture has been attempted and then this anchorage has been so carefully stabilized that it has held firmly against all displacement force. For this reason I am more than ever convinced that success in orthodontic treatment depends upon stabilized anchorage and that intraoral anchorage can be made most effective by rearranging the axial inclination of each tooth so that it will offer the greatest mechanical resistance against the displacing force. To do this, the operator must have command of an appliance that has complete control over every dental unit in each denture.

Intraoral anchorage can and should be further stabilized by the use of occipital anchorage in complicated cases.

886 Main Street