Is There One Best Orthodontic Appliance?*

By Cecil C. Steiner, D.D.S.,
Los Angeles, Calif.

In reviewing the really scientific progress in orthodontia one is impressed by the fact that, in the main, appliances have changed down the years in response to the growth in ideas and ideals of treatment. These mechanical devices are but the reflection of increasing knowledge of occlusion and of growing appreciation of the necessity of establishing normal occlusion in treatment. To arrive at a conclusion as to whether or not there has yet been, or can be developed one *best* appliance for the treatment of all cases, the important things to be considered are the true ideals of treatment and the requirements these impose on the appliance.

In making this study it will be helpful to review hastily the high points in the growth of present ideals as manifested in those appliances developed in an effort to attain them. But first, let us make a brief analysis of the basic requirements of orthodontic appliances and point out some of the possibilities and limitations of devices employed for the movement of teeth.

Basic Requirements of Orthodontic Appliances

An orthodontic appliance almost never generates power. It is generally a device whose function is to store and transmit power, the power being generated by means of the hands of the operator and stored in the appliance to be doled out or "fed back" to the teeth over a period of time. Ideally, this power would be doled out continuously and with an even intensity, under control, as desired by the operator.

All tooth movement is accomplished at the expense of anchorage, that is, of resistant force, regardless of where it comes from or how it is obtained. But inasmuch as it is usually secured within the mouth, the most universal orthodontic problem is that of transforming it into desired tooth movement. Unfortunately anchorage is not always obtainable in the areas wherein it would most easily be made use of with simple mechanical devices. Therefore two major requirements of an orthodontic mechanism present themselves for consideration: first, it must be capable of securing sufficient anchorage (resistant force) to adequately overcome the resistance to movement of all teeth that require to be moved; second, it must be capable of transmitting power from such resistant base to any area in the mouth in which power may be needed.

*Read before the Ninth Annual Meeting of the Edward H. Angle Society of Orthodontia, Chicago, October 16th, 1933.

As stated before, the demands made of appliances have changed with the evolution of thought regarding treatment. Also, these demands have become much greater and more exacting as ideas of treatment have come to involve more complex and precise tooth movements. At the present time these demands have extended to include force control in three dimensions or in any possible combination of these dimensions, and to rotate a tooth

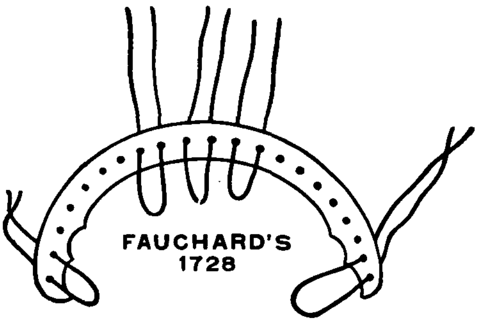


Figure 1

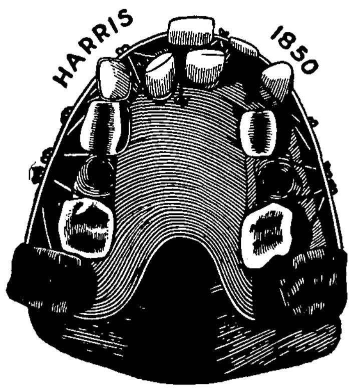


Figure 2

Fig. 1. Fauchard's expansion arch.

Fig. 2. The vulcanite plate as used by Harris.

through any of the three dimensions or possible combination of them. These demands have come in response to the knowledge that not single teeth alone, but combinations of teeth, must be reoriented not only with relation to each other, but with relation to the body as a whole, this reorientation to include not only their crowns but their roots as well.

Because of the manner of their attachment, teeth generally tip into the positions of malocclusion they occupy. This means that their restoration to normal positions can only be accomplished, in many instances, as the result of the most complex combinations of single or simple movements. Appliances which meet these demands then, must not only exert sufficient force in the directions necessary to produce these complex combinations of tooth movement, but the force must be under the complete control of the operator. In other words, an appliance, to meet modern demands of treatment, must feed out not force alone, *but metered force under control,* to accomplish the bodily movement of a tooth labially or lingually, mesially or distally, gingivally or occlusally, or to rotate it in any of these directions, and to perform these movements simultaneously in any or all possible combinations.

Evolution of Modern Appliances

Now let us hastily review some of the important points in the evolution of modern appliances noting the reasons for the creation of these appliances.

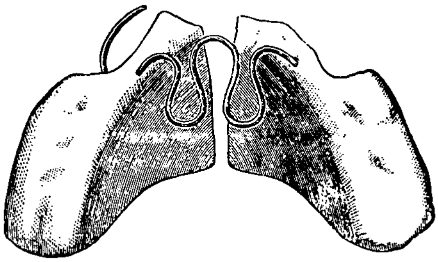


Figure 3

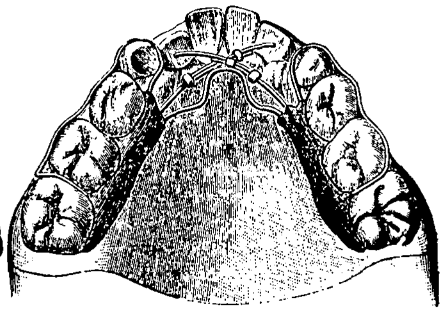


Figure 4

Fig. 3. The Coffin split plate.

Fig. 4. Skeleton plate with auxiliary springs.

Orthodontic movements were conceivably first accomplished by wedging teeth apart with wood or drawing them together by means of fiber, thong or wire ligatures, the movement attempted being limited to that portion of the tooth which was in view, namely, the crown. The movement accomplished was but the simple tipping of the crowns of individual teeth only, and the extent of the movement was judged by the positions of the tipped crowns in their relations to other teeth.

The first really scientific attempt at tooth movement occurred when, in 1728, the French physician, Fauchard, made use of a flat strip of metal, pierced with holes suitably placed, and formed into an arch to which the various "crooked" teeth were secured by means of threads passed around them and through the holes in the arch and tied. (Fig. 1.) This was probably the first true expansion arch to be employed in orthodontia and it embodied many beautiful and desirable principles. The anchorage which it provided was purely simple anchorage, for it did not permit root control. But it did reciprocate this simple anchorage nicely to meet the requirements that the dentist of the day asked of it, for the anchorage could be transmitted entirely around the dental arch to accomplish simple tooth-tipping movements.

It was a tremendous step forward in orthodontic procedure, and beyond question it came as a result of appreciation of the fact that more than the mere pulling together or pushing apart of certain anterior teeth was necessary. But the device lacked stability; there was no effective way of firmly fixing it in position on the teeth.

In an effort to gain greater stability, the use of the vulcanite plate became the next outstanding development. One of the earliest of these to be used for orthodontic purposes is shown in Fig. 2.

At first a series of plates was used, each succeeding one being intended to more nearly approximate the ultimate design of dental arch desired for the case in hand.

Then came the Coffin split plate (Fig. 3), the various segments of which were connected by means of springs so that the gross design of the plate could be altered at will.

Finally there were brought out the complex skeleton plates, of which the "Jackson Crib," with its many fingers and extensions, is a good example (Fig. 4). But none of the various forms of plates proved sufficiently stable, and they were so painful to the patient as to be worn with difficulty. Also, since they could be removed at will by the patient, the idea prevails that they were probably out of the mouth most of the time. In their use, force was not constant and was exerted only upon the crowns of the teeth, and in such manner as to obtain simple anchorage and consequent *tipping* of the teeth only.

With the introduction into orthodontia of screw force by Schangé, in 1841 (Fig. 5), and of the jack-screw by Dwinelle, in 1849 (Fig. 6), a very important means of delivering force in orthodontic mechanism came into use. It passed through various forms and phases and, indeed, is still being used, but now chiefly in connection with various types of expansion arches.

But because the jack-screw brought with it no more stable means for fixing the appliance upon the teeth than were already known, its value was almost negligible until, in about 1870, Magill introduced dental cement for immovably securing bands to teeth. This was a step in increasing the possibilities of orthodontic treatment the importance of which cannot be overestimated. Indeed, without it today there would be no scientific orthodontic treatment. One of the greatest benefits it conferred was that of increasing and stabilizing anchorage, and also it made possible the gaining and use of stationary anchorage. Instead of taking anchorage from the crest of the alveolar process alone, as formerly, it could now be secured throughout the entire length of tooth roots.

Stationary anchorage was introduced in its true form by Dr. Angle in 1887 in the use of the traction-screw, which he devised especially to assist in reducing protrusion of the upper anterior teeth in cases of Class II, Di-

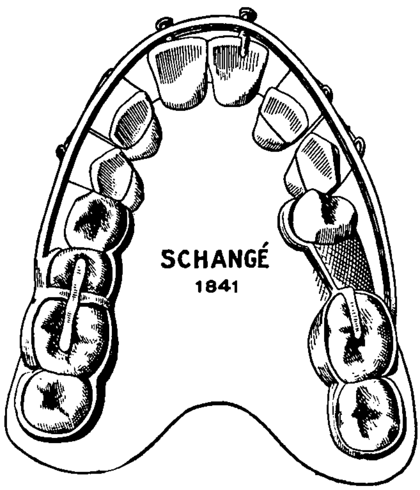


Figure 5

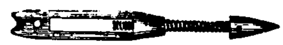


Figure 6

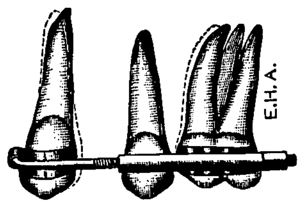


Figure 7

Fig. 5. An appliance used by Schange and introducing screw force for tooth movement.

Fig. 6. A jackscrew devised by Dwinelle in 1849.

Fig. 7. The Angle jackscrew which introduced stationary anchorage into orthodontia.

vision 1 (Fig. 7). This device was also used for other purposes, but was abandoned after the introduction, some years later, of the Baker (intermaxillary) anchorage. Even though the mechanics of the jack- and traction-screws were such as to make difficult the distribution of the force that could now be developed against this greater anchorage, the limitations of tooth movement were, with these appliances, pushed back an appreciable distance.

Let it be remembered that an orthodontic problem is like a game of chess. In chess a certain number of "men" on one side are pitted against a like number on the other, the problem being to outwit your opponent before he outwits you. In orthodontia a given amount of resistant tissue, the "opponent," is available against which to pit a certain amount of tooth movement, one's own "men," the problem being to transform or translate the resistance into the desired tooth movement with the greatest efficiency and the least amount of waste, or before the resistance gives way. Simple anchorage makes use merely of the resistance of the superficial structure,

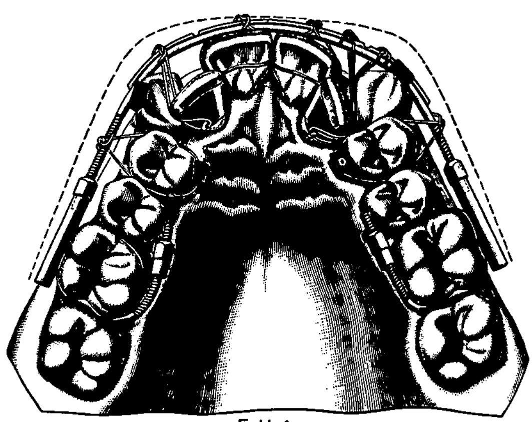


Fig. 8. Dr. Angle's expansion arch "E."

while stationary anchorage uses it to the very root ends, thus employing a solid wall of bone. Every false move is a waste, and the quality of the end-result and the promptness with which it is attained are dependent upon the efficiency and skill of the operator. In most orthodontic problems presented, only an amount of anchorage to barely meet the requirements is available. It is therefore imperative that the best principle of such anchorage be efficiently employed.

The Expansion Arch

In Dr. Angle's Expansion Arch E (Fig. 8), the simple expansion arch undoubtedly reached its highest development. It was fixed to anchor bands, could be shaped to ideal arch form and was relatively easy to manipulate. It came as a result of growing recognition of the fact that to obtain *normal occlusion of all of the teeth* was the end and aim of orthodontic treatment, and therefore that in most cases much more was necessary than merely to move one or more anterior teeth.

In its use stationary anchorage could be obtained from the posterior teeth in the direction from which the greatest resistance was necessary. Other than that, however, simple anchorage prevailed and crown movements only were attempted. In other words, stationary anchorage could be obtained from the process immediately mesially and distally to the anchor teeth, to the root ends. Other than this, the anchorage was "simple" and came from the gingival portion of the process only. It was transmitted and reciprocated

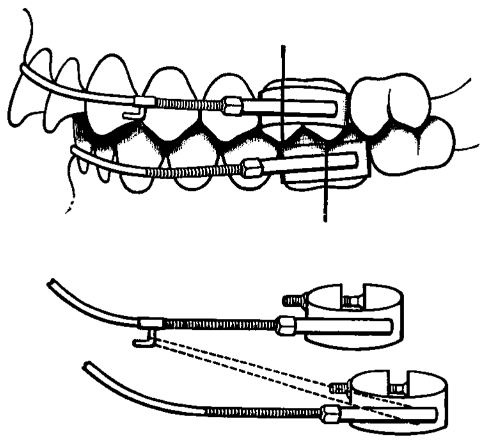


Fig. 9. Intermaxillary anchorage through the use of elastic force.

efficiently throughout the length of the arch. The fact that these arches could be shaped to ideal arch form and that the teeth could be lashed to them was an advantage that should not be under-estimated.

With the advent of the Baker or intermaxillary anchorage (Fig. 9), another very definite need in treatment was met and another invaluable step forward was made in orthodontic mechanics. With it anchorage in one jaw could be employed to accomplish tooth movement in the other. Thus anchorage from the maxillary teeth could be transmitted to those of the mandible, or *vice versa,* and at the same time and with the same mechanism there could be accomplished both maxillary and mandibular tooth movement. Baker anchorage used in combination with the Expansion Arches E and B thus permitted the correct orientation of the teeth of both arches with relation to each other, except that correction of the axial relations of the teeth could not thus be accomplished.

These later developments came at about the time of the appearance in the literature of the controversy over extraction in orthodontic treatment and the contention that extraction was not necessary, in fact was con-

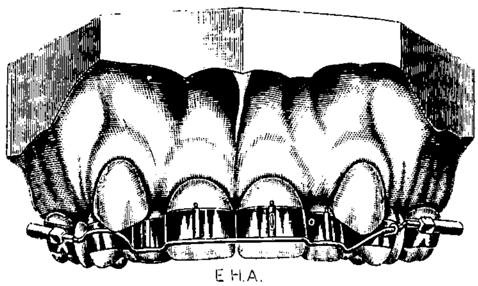


Fig. 10. The pin-and-tube appliance.

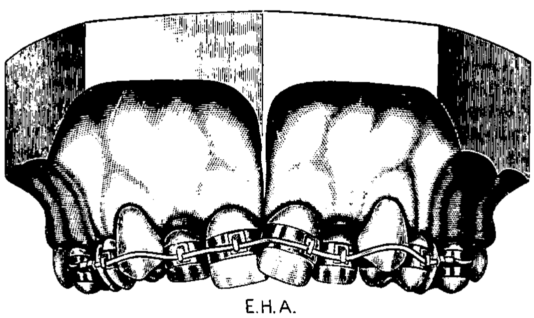


Fig. 11. The ribbon arch appliance.

traindicated, because of the necessity, or at least of what was even then known to be the greater desirability, of obtaining normal occlusion in treatment, and of course normal occlusion is not obtainable without the full complement of teeth. It can be safely stated that all these mechanical developments were the direct results of the broadening of ideas with regard to the object of treatment.

With the final establishment of the theory of normal occlusion as the basis of orthodontia and the goal of orthodontic treatment, came recognition of the necessity for moving or for stabilizing tooth roots, as well as crowns, in order that proper axial relationships of teeth might be gained and sufficient anchorage developed to accomplish the tooth movement recognized as being necessary.

The Pin-and-Tube Appliance

In response to this necessity came Dr. Angle's pin-and-tube appliance, Dr. Case's high labial arch and various other devises. The pin and tube (Fig. 10) served its purpose admirably. Certain principles of the E arch were compromised, however. It is true of most phases of progress that if something of value is gained something else must be given up. The question

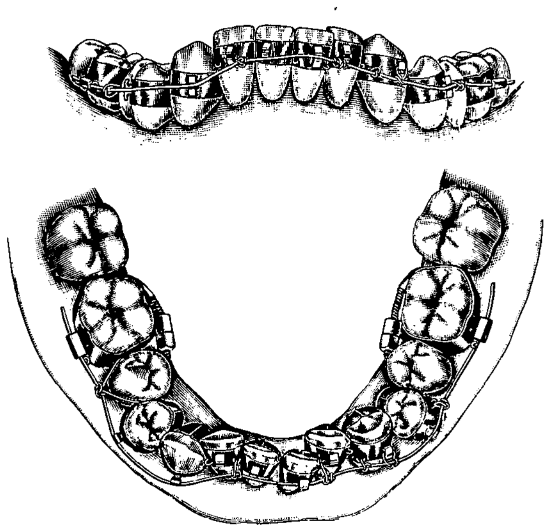


Fig. 12. The edgewise arch mechanism.

to be decided is whether or not the advance is worth the compromise. The possibilities of ideal dental arch form of the E arch had to be sacrificed in order to accomplish the required fixedness of attachment between pin and tube; for the arch-wire now had to be bent to the irregular shape of the malposed tooth arch in order that the pins might be engaged with the tubes. As the teeth moved toward their correct positions these irregular bends in the arch-wire were gradually removed, and the teeth were thus aligned. The distances on the arch-bar between pins had to be varied in length, however, as movement progressed, in order that teeth might be moved apart or drawn together. And, because of the construction of the appliance, to do this the pins had to be unsoldered, moved the required distance along the arch-bar and resoldered, and at the same time kept at the required axial inclinations. This was very difficult technique and apparently few mastered it so completely as to make the appliance easily handled. The fixation between pin and tube, however, was mechanically good, for the tubes and pins were of such length that error in diameter between them was disturbed over a relatively considerable distance and so became practically negligible. Furthermore, the cylindrical form of the tube made it strong and difficult to distort. With the pin and tube it became possible not only to orient teeth in their correct axial relations, but stationary anchorage on any or all teeth desired became available. Resistance of the bony processes to the very apices of all the tooth roots could be transmitted through the appliance to the various areas as needed to accomplish desired tooth movement.

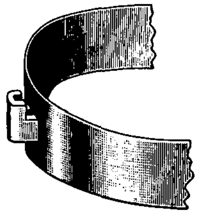


Fig. 13a

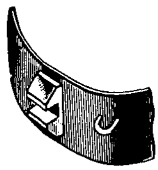


Fig. 13b

Fig. 13. a. The ribbon arch bracket.
b. The edgewise arch bracket.

The Ribbon Arch

Because of the difficulties of the technique of this appliance Dr. Angle soon set about devising another which would eliminate the difficulties and yet preserve the control of root movements. The ribbon arch (Fig. 11) was the result. With it, instead of having to move the pin attachments along the arch-bar and to resolder them, brackets are used which, in response to pressure, "slide along the arch-bar like beads on a string." This appliance is easily manipulated, gives good force control, a high degree of stationary anchorage and serves its purpose well.

Since the advent of the ribbon arch, in 1915, rapid strides have been made in the study of the structure and function of the denture and of the orientation of teeth, not alone with relation to one another of the same and opposite arches, but of the entire denture to the head as a whole. With knowledge gained from this study has come appreciation of the fact that ideals of orthodontic treatment of the past are not sufficient, and so still greater demands are being made of appliances. It has at last come to be realized that not only must each tooth be harmonized as to its position, inclination and relationship with all the other teeth, but, as a unit, the denture must be harmonized with all the other parts of the head. This has presented the necessity for *en masse* movement of teeth, particularly anteroposteriorly, in a great percentage of cases. For this movement of buccal teeth, the ribbon arch is dependent upon an accessory, the cleat, and this direction of movement is probably that of weakest force control in the use of this mechanism. For mesiodistal movements with the ribbon arch, stationary anchorage is generally derived from those teeth that carry the anchor bands and from four or six each of the upper and lower anterior teeth. In performing distal movement, the crown of the stronger, more securely supported cuspids and bicuspids are

Fig. 14

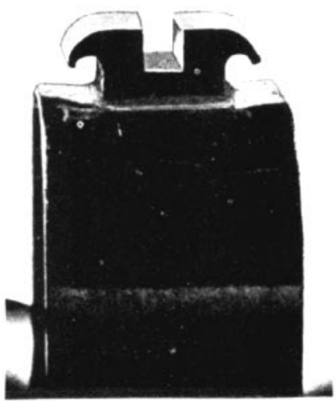


Fig. 15

Fig. 14. The edgewise arch bracket band as now manufactured.
Fig. 15. The edgewise arch bracket band as refined to better meet the requirements of tooth movement.

probably most often pulled back at the expense of the anchorage just mentioned. They thus become a liability rather than an asset in this operation.

The Edgewise Arch

With the knowledge born of this experience, Dr. Angle again set about devising an appliance that would not only overcome this difficulty but would better harmonize the possibilities of treatment with the theoretical ideal of treatment than did its predecessor. In 1928 he presented the Edgewise Arch appliance (Fig. 12), which he called, "the latest and best." The principles embodied in this appliance would seem to justify this name, for, in the writer's opinion, the appliance presents the best combination of possibilities for advantageous tooth movement, with less compromise, than any other so far devised.

Let us again quickly review some of the basic principles of efficient orthodontic appliances and see how this appliance meets present-day demands.

It must be remembered that in most orthodontic mechanisms the arch-bar is the energizing or power-storing factor. The bands and attachments are merely means of fixation between the teeth and this energizing factor. Various types of attachments are employed as means of fixing the arch-bar to the bands, and through these the power is delivered from arch-bar to band, and so to the tooth. They are merely transmitting devices. If the fixation between arch-bar and band is yielding or permits change or relationship between these parts, in other words if they do not fit properly, simple anchorage and simple movements of the teeth only, result. If the fixation is sufficiently rigid and unyielding, control of the force exerted, stationary anchorage and bodily movement of the teeth can all be accomplished. Some types of attachments accomplish rigid fixation in certain directions, while hinged connections result in other directions. It will be obvious that the most desirable type of attachment would be one in which stationary anchorage could be accomplished and the force controlled in the greatest possible number of desired directions or combination of directions.

The fixation of the arch-bar to band and tooth is often accomplished by some type of bracket whose function it is to grasp the arch-bar in such a way as to make the fixation rigid in the directions in which rigidity is desired. For reasons previously discussed, this would be rigidity in all directions except that parallel to the long axis of the anchorage. This then, would restrict the design of the mechanism to an arch-bar whose sides were parallel to its long axis and whose form, in cross-section, was other than cylindrical, encased in a correspondingly shaped slot in a bracket. This would permit the sliding of the bracket and its band and tooth along the arch-bar, but would not permit the tooth to tip in any direction.

There is another requirement to meet, however, since the arch-bar must sometimes be removed from the mouth and reseated in the brackets during the course of treatment. Obviously, it could not be pulled through a series of bracket slots in order to remove it. Therefore it must be removed through openings in their peripheries. This imposes another restriction on the shape of the arch-bar and bracket slot. If the bracket slot must have an opening in its periphery through which the arch-bar can be withdrawn, the arch-bar, while it is working, must be maintained in the bracket in such a way as continuously to maintain a definite relationship between the two. At the same time, the shapes of arch-bar and bracket slot must be such that the arch-bar can be readily withdrawn through the bracket opening. It will be apparent, then, that an arch-bar of the most efficient design should have parallel sides and would be encased in a bracket the slot of which has parallel walls. In other words, a square or rectangular wire would be engaged within a corresponding square or rectangular slot in a bracket.

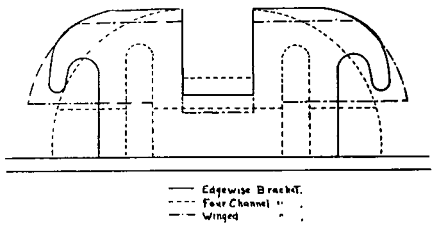


Fig. 16. Superimposed drawings of various edgewise arch brackets.

Of such design are both the ribbon arch and the edgewise arch, with their respective brackets. In each case brackets with box-shaped slots receive and house a rectangular wire. Each bracket slot has one open side through which the arch-bar can be seated and withdrawn, and the other three sides must each be sufficiently strong and accurate as to dimensions as to *continuously and with exactness* embrace the arch-bar under any and all strains which the arch-bar may put upon them.

The difference between the brackets of the two mechanisms is that the open face of the slot in the ribbon arch bracket (Fig. 13a) is on either the incisal or gingival aspect, and in the edgewise bracket (Fig. 13b), on the buccal or labial aspect. Naturally, the arch-bars of the respective appliances are removed in these directions. Granting that the replacement of the missing wall of the bracket, (*i.e.*, the open face of the bracket slot) in either appliance, whether by pin or by wire ligature, is insufficient to establish rigidity in the plane of the opening, the ribbon-arch appliance then gives force control, stationary anchorage and positive power delivery for bodily tooth movement in only two dimensions, rotations and labio- and bucco-lingual movements. For the third, that which is vertical and parallel to the long axis of the arch—in other words, that force which tips teeth in the direction of the long axis of the arch-bar—it is dependent upon an accessory, the cleat, which grasps the bracket and prevents it from sliding along the arch, which oft-times is a hindrance to the movement of the teeth anterior to the cleat.

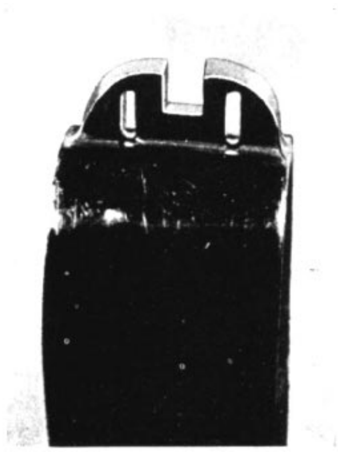
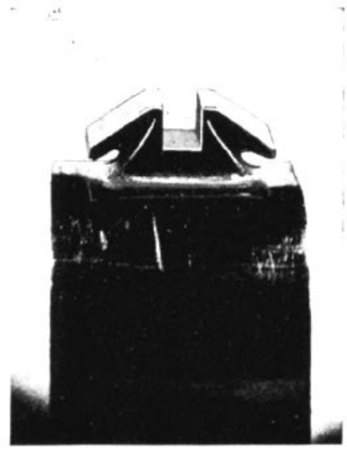


Fig. 17

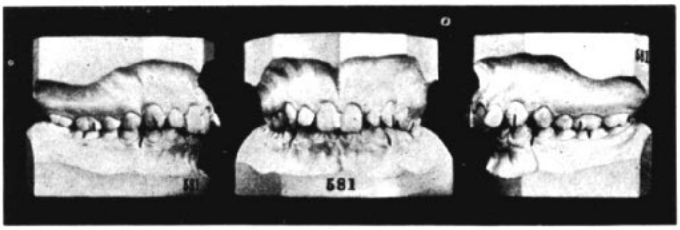


Fig, 18

Fig. 17. The four-channel bracket.
Fig. 18. A new design of edgewise arch bracket for the anterior teeth when the bite is overlapping.

The edgewise arch appliance also gives force control, stationary anchorage and positive power delivery for bodily tooth movement in two directions, those of tipping and torquing, but for the third, that which is horizontal and parallel to the long axis of the arch, or that force which rotates teeth on their long axes—it, too, is dependent upon an accessory, the wire ligature. This does not prevent the brackets from sliding along the arch-bar in the direction of its long axis, but, on the contrary, the wire ligature can be so manipulated as to cause or augment this. The wire ligature has long been recognized as a convenient and efficient device for storing power in the arch and transmitting it to the teeth for rotation; and it can be easily and quickly applied. A more important point in its use, however, is that through it power may be *digitally metered* and applied to each tooth separately and individually in known amounts, in contrast to the force derived from the long and short sections of the ribbon arch when the arch-bar is sprung into the brackets, which can only be roughly estimated. These long and short arch sections act as long and short levers, the nature of which makes the force they deliver most difficult to gage.

In almost every case of malocclusion, the teeth of one jaw or the other or even of both have drifted forward to some degree. It is the writer's opinion that failure to recognize this fact and to correct this phase of the malocclusion is responsible for a large number of the relapses which occur following treatment. It is in the mesial or distal *en masse* movement of teeth that the edgewise appliance it at its best. With it all of the teeth of either arch can be swung backward or forward upon their apical bases.



A B C

Fig. 19. A, B, C. Views of casts of case, before treatment.

Because of the direction of entry and withdrawal of the ribbon arch from its brackets, this arch must, at the beginning of treatment, be modified from the ideal typal arch form, at least for a certain period, and caused to conform more or less to the positions of the malaligned teeth. As treatment progresses the application of force is continued by gradually removing the bends in the arch-bar in such a way as eventually to regain its ideal arch form, and so bring the malposed teeth into their correct positions. As before mentioned, because of the long and short levers that are brought into play in its use, force upon individual teeth is very difficult to gage and to apply.

But because the edgewise arch brackets present open faces in the horizontal dimension, this arch-bar may be fashioned into ideal arch form in the beginning and thus maintained throughout treatment—a very important advantage. Power may be stored in it and transmitted to each tooth individually in such a way that the tooth, however distant from the arch-bar in the beginning because of its malposition, is caused by means of a ligature to move up to the arch-bar, its open-face bracket then engaging the arch-bar as soon as its position permits. Thus there is finally removed a serious compromise that it was formerly necessary to make in order to accomplish axial control of teeth.

The proportions of the arch-bar and the material of which it is made must always necessitate compromise between the qualities of stability, elasticity, ductility, flexibility and strength. The demands on these qualities in the arch-bar vary in the various locations in the mouth wherein it serves and in the various directions in which tooth movements are required. Due to the very great differences in leverage which come into play upon the metal in various parts of the arch-bar and to the varying areas on the arch-bar in which power must be stored for the movement of individual teeth, very great differences in distortion occur in its various parts.

In simple expansion of the dental arches, leverage is great upon the anterior section of the arch-bar to distort it in the horizontal dimension. For this reason, and because buccal teeth are well supported by their investing structures, probably the greatest demand for strength in any arch-bar occurs in the horizontal dimension. Here again the edgewise arch is superior, for the horizontal is its greatest diameter and therefore that of its greatest strength.

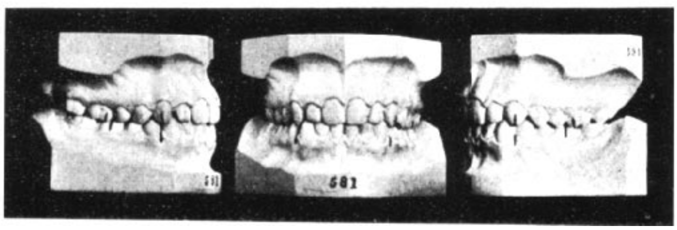
To tip buccal teeth mesially or distally is an important function of an orthodontic appliance, and because the power for the movement of each tooth in such case must be stored in a very short section of the arch-bar, flexibility and elasticity and a light, easy flow of power are desirable. Again the edgewise arch has the advantage, for in this, its vertical diameter, it is thinnest, and therefore permits of more distortion within the limits of elasticity to meet these demands.

As before stated, for a bracket to efficiently deliver force from the arch-bar to the tooth it must not only properly fit the arch-bar at the beginning of treatment, but *it must continue to do so throughout the entire period of treatment*. This means that it must be sufficiently strong to withstand any and all strains put upon it, without distortion.

The Brackets

The ribbon-arch bracket consists of a three-walled box of which the band forms one side wall. (Fig. 13a). It is mechanically possible to so strengthen the base and the opposite wall as to render these walls exceedingly strong. But, because of the design of the bracket, there is a limit to the amount of strength that can be developed in the wall created by the tooth band. In the edgewise appliance the three-walled box is affixed to the band by its base (Fig. 13b). Thus the leverage upon the walls of this bracket is reduced to the minimum; and, because of its mechanical design, all three walls can be increased in dimensions if required to secure the desired strength.

Because the principles embodied in the edgewise appliance are fundamental to the requirements and therefore best meet present-day demands in orthodontic treatment, it is the writer's opinion that the appliance is, as Dr. Angle stated, "the latest and best." Nevertheless, it is hardly conceivable to some of us who intimately knew Dr. Angle, his methods and his work, that in the approximately three years since he laid down his tools for the last time he would not, had he been here with his finger still on the pulse of orthodontic progress, have added something by this time even to "the latest and best." And it seems to the writer that this might have been something in the way of refinement for an easier or better application of its principles, in the way of greater precision of its working parts to provide for more ideal results in its use.



A B C

Fig. 20. A, B, C. Views of casts after ten months of treatment with the edgewise arch mechanism using the newly designed brackets and accurately fitting archwire.

With this thought in mind, after having used the appliance as Dr. Angle left it to us in the treatment of many cases, and with all the skill and conscience of which he is possessed, the writer now ventures to suggest some slight modifications which he hopes are true refinements of the mechanism and which he believes, if used with the necessary care and skill, will make more certain the application of the unchanged principles embodied in it and more satisfactory the clinical manifestations of its use.*

We have discussed the fact that, in the use of the edgewise appliance, control of the axial movement of teeth is accomplished by means of a rectangular arch-bar firmly engaged between parallel and closely fitting walls of brackets which are soldered to bands, the bands being cemented to the teeth. Let it be remembered that control of the axial movement can be maintained only so long as the bracket *snugly fits the arch,* and that if or when this close fit is lost, the error is increased many fold when projected to the root end. Let us say, for instance, that from the center of the bracket to the root

*These modifications are offered with the consent and approval of Mrs. Angle. The writer also wishes to acknowledge the co-operation of Dr. Charles E. Boyd in the evolution of these modifications.

end is one inch. (It is more than this in some cases.) The depth of the bracket is .028″. An error of .001″ in the fit of the bracket slot to the arch-bar, then, will be manifest at the root end in the ratio of one inch to .028″ or 035″. In other words, at the root end the error would be thirty-five times greater than at the crown of the tooth. If a .022″ x .022″ arch-bar is used the ratio would be one inch to .022″ or .045″; or, in other words, the error at the root end would be forty-five times as great as at the crown. Seldom indeed do root ends need to be moved any such distances.

Fig. 21a

Fig. 21b

Fig. 21. Photographs of patient before treatment.

It can be readily seen, then, that a continuous, absolute fit of bracket to arch-bar throughout treatment is imperative if the appliance is to manifest clinically the principles it embodies and the theoretical results of which it is capable. Theoretically, if all of the brackets were to be placed in correct relationships to the respective teeth and if there were to be used a 100 per cent elastic arch-bar, ideally formed not only as to gross horizontal form but to all of the curvatures, inclinations and fine typal, anatomical detail that presents for the case, then, *if the brackets were to continuously fit the* *arch-bar with absolute accuracy,* every tooth would receive such pressure as would tend to carry it to its correct location, not only as to position but to axial inclination as well. If, however, there were a .001″ error in a bracket-arch-bar fit or if a bracket were to be strained .001″, then a root end might be left .035″ behind. What then? Merely that the orthodontist

Fig. 22a

Fig. 22b

Fig. 22. Photographs of patient after treatment of ten months duration.

would have to remove the arch-bar and either correct the error in the bracket, which is most difficult if even possible, or substitute another bracket. Or he would do the usual thing, guess at the error and compensate for it by making a bend in the arch-bar which would, of necessity, be another guess.

In spite of the fact that the finest clinical results the writer has ever seen were accomplished with the edgewise appliance in the form in which it was first brought out, he sincerely feels that still finer results than have hitherto been obtained can and will be accomplished, since certain weaknesses in the construction of the original bracket have been overcome. He further believes that much of the discouragement in the use of the appliance that some have experienced has been due to these weaknesses, and that the modifications of the bracket herein suggested will so facilitate the manipulation of the appliance and improve its clinical manifestations that it will find a still more universal and enthusiastic reception by the profession than heretofore.

Fig. 14 shows the present band and bracket, and Fig. 15 shows the bracket designed to replace it. Power stored in the arch-bar is sustained by the "box" which forms the slot. The wings are for fixation of ligatures only. It is obvious that, because of the laws of leverage, the greatest strain on the box will come through its base and on its sides close to the base. It will be noted, then, in the original bracket (Fig. 14), that that portion of the box which receives the greatest strain is relatively weak and that the wings, which bear only the strain of the ligatures, are unnecessarily large. Also that because of the thickness of the wings, the clearance for passing ligatures underneath them is diminished. And because of the method of manufacture, the metal of which the original bracket (Fig. 14) is constructed is relatively soft as compared to that which is used in the construction of the new bracket (Fig. 15). Actual tests have shown that the original brackets do not withstand the average strain put upon them; therefore an excessive amount of compensating adjustments in the arch-bar has been necessary.

The new bracket is carefully and accurately milled from a solid piece of metal and the slot is held to very exact dimensions. The side walls and base have been sufficiently strengthened to withstand any and all strain that can be put upon them by the .022″ arch-bar. Also the wings have been so diminished in size as to allow full clearance for passing the ligatures underneath them, and so shaped as to prevent the ligature from slipping out while it is being adjusted. Minimum interference with the occlusion is occasioned in their use. The recess under the wing will be found of distinct advantage when the tooth is still some distance from the arch-bar, for a ligature can be hooked over one wing only, if desired, without danger of slippage.

Fig. 16 represents superimposed drawings of the original wing bracket (Fig 14), the original four-channel bracket (Fig 17) and the new edgewise bracket (Fig. 15). It will be noted that although great strength has been secured in the slot walls and base of the new edgewise bracket, the over-all dimensions of this bracket in no case exceed those of the original brackets designed by Dr. Angle.

Fig. 17 shows the four-channel bracket, which was intended for use on anterior teeth. Its design was intended by Dr. Angle to give it strength. Because of the fact that the wings were supported, it went far to accomplish this end. It is now found possible, however, to construct the box for the slot of a hard alloy by a milling process so that it is sufficiently strong to withstand all strains of the arch-bar, yet retaining the wing principle and avoiding the necessity of threading ligatures through the openings designed for them. Such a bracket is shown in Fig. 18. It is designed for anterior teeth, especially those of the lower arch, in close bites.

Fig. 23. The maxillary archwire used in treatment of case shown in Fig. 19, in the form that it presented at the end of treatment. Note the minor degree of the "tip-back" bends.

Since these brackets are made to precision measurements, the writer earnestly urges that the dimensions of all arch-wire to be used with them be carefully checked with a *very* accurate micrometer before being employed, and also that such tolerance between bracket slot and arch-wire as is necessary be recognized and observed, in order that a close working fit be accomplished without such binding as would defeat certain tooth movements. The writer has found by experience that .0005″ tolerance between bracket slot and arch-wire gives the most desirable working fit. Nothing will discourage the use of this appliance quicker than failure to recognize the absolute necessity of proper arch-wire size and the desirability of such tolerance in arch-wire-bracket fit as will permit the bracket to slide freely on the arch without loss of efficiency because of too loose a fit.

Rotations can only be accomplished either by the bracket slipping along the arch-bar so that the tooth can rotate with its long axis as a center or by the tooth, swinging around in an arc with the bracket as the center of the arc. Spaces for teeth that are crowded out of the arch are generally gained by moving apart the approximating teeth, permitted by the brackets slipping along the arch-bar. To attempt to bring about this movement without proper tolerance in bracket-slot-arch-bar fit is equivalent to trying to lift one's self by one's bootstraps. This tolerance is necessary, but it must be a measured and controlled tolerance, and should be determined only by the most accurate micrometer obtainable. A micrometer that is not calibrated in ten-thousandths of an inch is inadequate, because two or three ten-thousandths variation in fit of the working parts is sufficient to defeat the best application of some of the beautiful principles which the appliance embodies. If, on the other hand, exact technique is employed and fine measurements are adhered to, a new joy in treatment will be experienced in the ease with which the appliance may be manipulated and in the manner in which desired tooth movement can be accomplished.

As evidence of the efficiency of the edgewise appliance, constructed in conformity with these designs, the writer submits the following case.

Fig. 19a, b and c, shows front and side views of the teeth at the beginning of treatment, and Fig. 20a, b and c shows similar views of the teeth of the same case made after ten months of treatment, during which time the arch-bars were removed from the mouth, adjusted and replaced four times.

Figures 21a, and 21b show full front and profile views of the face of the patient before treatment, and Figs. 22a and 22b show similar views at the time the last models were made.

Fig. 23 shows the upper arch-bar, used in the treatment of the case, as it presented at the time the last models were made. It will be noted that it does not present the decided step-back bends that so often appear after such a period of treatment when the original brackets are employed, giving evidence of the fact that the brackets used have adequately withstood all the strains put upon them.

As stated before, an orthodontic appliance is a mechanism to store force which is to be gradually fed back to teeth over a period of time. Theoretically, given brackets that are 100 per cent efficient and arches that are 100 percent elastic, cases could be treated with one adjustment. While this desirable end may not yet have been attained, the writer sincerely feels that the redesigning of the edgewise bracket as herein set forth has gone a long way toward this end in making an efficient bracket of beautiful principles still more effective. Also, it is his opinion that stainless steel or its equivalent will make possible the constructing of highly elastic arches in even smaller dimensions than those already in use with these brackets, which would permit the force upon the teeth to be still less intermittent and therefore more physiological. By the use of such arches in conjunction with the redesigned brackets the number of necessary adjustments of the mechanism and the length of the period of treatment will in skilled hands most certainly be materially reduced.*

*For the technique of the application and operation of this mechanism, the reader is referred to the paper by Dr. Edward H. Angle, *The Latest and Best in Orthodontic Mechanism,* Dental Cosmos, December 1928, February, March and April, 1929.

1014 Roosevelt Bldg.