

[54] **ORTHODONTIC APPLIANCE HAVING COOPERATION DETECTION CAPABILITY**

3,478,742 11/1969 Bohlmann 32/14 C

[76] Inventor: **Earl O. Bergersen**, 950 Linden Ave., Winnetka, Ill. 60093

Primary Examiner—Robert Peshock
Attorney, Agent, or Firm—Larson, Taylor and Hinds

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[57] **ABSTRACT**

[51] Int. Cl. **A61c 7/00**

[58] Field of Search 32/14

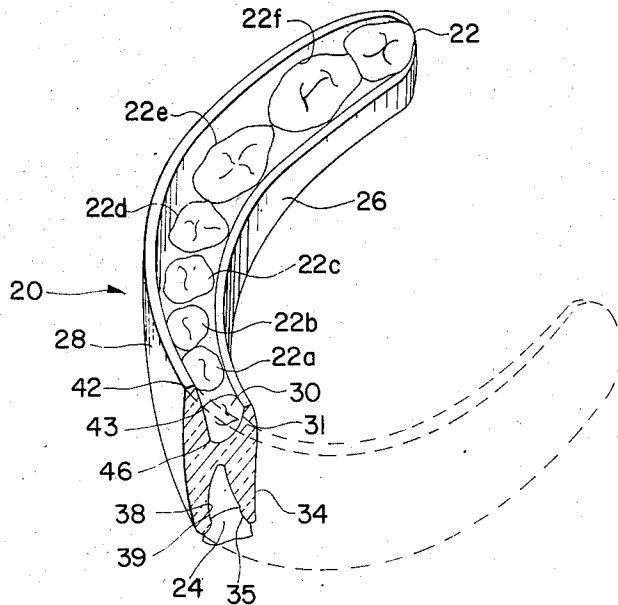
An orthodontic appliance having the property of changing its opacity during use to thereby give an indication of patient wear thereof.

[56] **References Cited**

UNITED STATES PATENTS

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15 Claims, 9 Drawing Figures



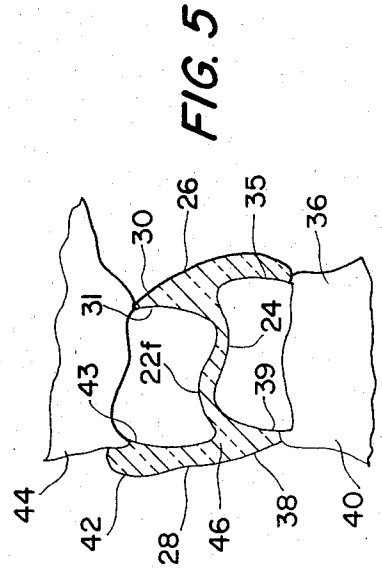
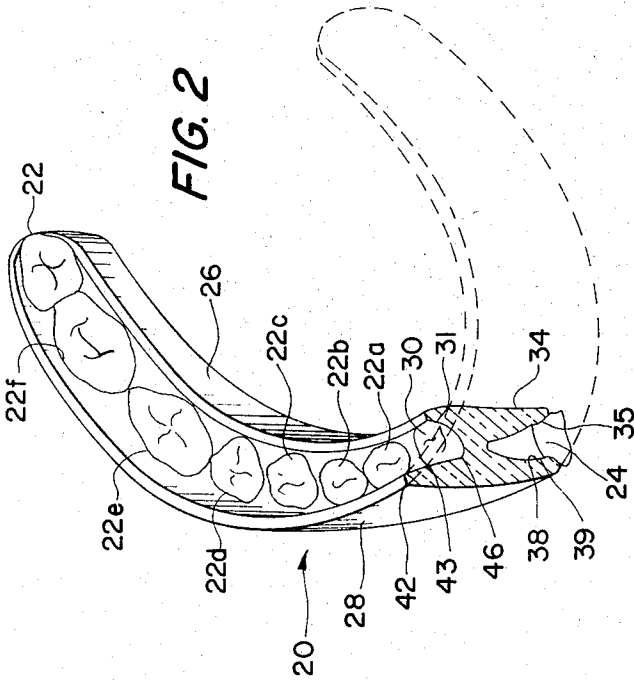


FIG. 1

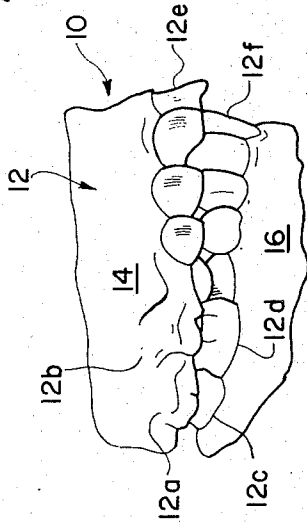


FIG. 4

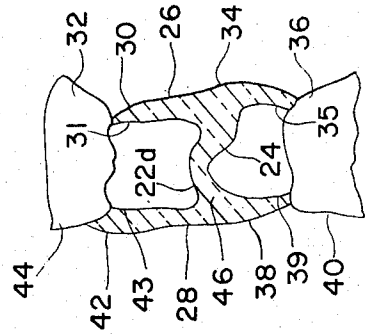


FIG. 3

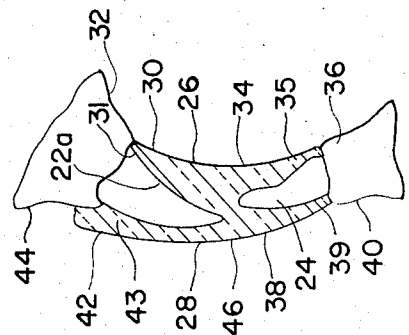




FIG. 7



FIG. 9



FIG. 6

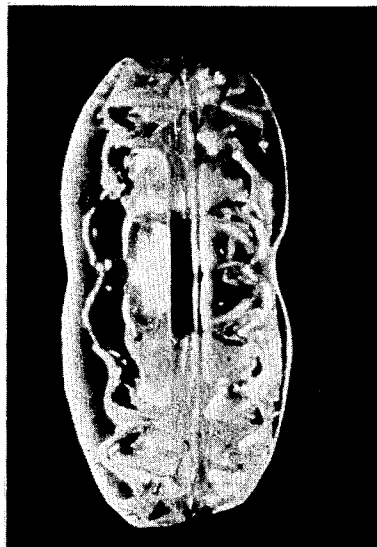


FIG. 8

ORTHODONTIC APPLIANCE HAVING COOPERATION DETECTION CAPABILITY

BACKGROUND OF THE INVENTION

This invention relates to tooth positioning appliances, and in particular it relates to determining the extent to which such an appliance has been used.

In the field of orthodontics, conventional orthodontic devices such as bands or the like are often used for straightening teeth to bring them to a predetermined position of proper or close to proper occlusion. To bring teeth into a final position of desired orientation in the mouth, the orthodontists will often use a tooth positioner, an example of which is shown in my earlier U.S. application Ser. No. 837,667, filed June 30, 1969. Other positioners of this general type have been known for many years, as illustrated for example in the Kesling U.S. Pat. No. 2,467,432.

A problem has always been present with orthodontic appliances of any kind, and in particular of the type of positioner described above. On occasion when a patient returns to the orthodontist an entirely insufficient level of progress will be observed. It is critical for the orthodontist to know whether this resulted from poor fitting of the positioner or from the simple fact that the patient did not wear the positioner as directed. Most patients in the field are children who might be embarrassed to give a negative answer when asked whether or not they used the positioner. But in any event, the fact remains that this problem is continuously presented to the orthodontist and he currently has no means for accurately determining whether or not the patient has in fact been wearing the positioner except of course for his own subjective opinion as to the veracity of the patient's statements.

Thus, there exists a need for a way to accurately ascertain whether or not a patient has in fact worn the positioner, or for that matter whether he has worn other orthodontic appliances, as instructed.

SUMMARY OF THE INVENTION

Thus, it is a purpose of the present invention to solve this problem in the art.

This purpose of the present invention is achieved by providing an orthodontic appliance which has the capability of changing its visual appearance, and in particular increasing its opacity, in proportion to the time during which it is used.

More specifically, this purpose is achieved by providing a positioner constructed of a material which in fact changes opacity during use. In a preferred embodiment, the positioner is made of polyvinyl chloride, a proportion of which is water-blush polyvinyl chloride. The proportion of water-blush and non-blush polyvinyl chloride will depend on many factors. Many different proportions will give good results but in one preferred embodiment a proportion of 50 percent water-blush to 50 percent non-blush polyvinyl chloride was used. This embodiment has the property of being transparent under normal room conditions and then at least to some extent transparent upon maximum use, still permitting the orthodontist to view the teeth within the orthodontic appliance when in use.

The invention further includes a method for detecting cooperation by a patient, this method including making or/and selecting an orthodontic appliance such

as a positioner of a material which changes its visual appearance such as by increasing its opacity in proportion to the time used and then observing the appearance of the positioner after alleged use to determine whether or not the positioner was in fact used as directed.

Thus, it is an object of this invention to provide a new and improved orthodontic appliance such as a positioner for overcoming the problem of accurately determining patient use.

It is another object of this invention to provide an orthodontic appliance such as a positioner formed of polyvinyl chloride, at least a portion of which is water-blush polyvinyl chloride which increases its opacity upon use.

Another object of this invention to provide a method for detecting patient cooperation.

Other objects and the advantages of the invention will become apparent from the detailed description to follow, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

There follows a detailed description of a preferred embodiment of the invention to be read together with the accompanying drawings in which:

FIG. 1 is a side elevational fragmentary view of a human mouth with maloccluded teeth.

FIG. 2 is a perspective view, partially in full outline, and partially in dotted outline, showing generally the superior surface of a prefabricated tooth positioner which could include the features of the present invention.

FIG. 3 is a fragmentary section view through a human mouth in the area of the central incisors showing the tooth retainer in place.

FIG. 4 is a fragmentary section view through the human mouth in the area of the bicuspid showing the tooth retainer in place.

FIG. 5 is a fragmentary section view of the human mouth in the molar area showing the tooth retainer in place.

FIG. 6 is a photograph showing in front perspective view the tooth positioner of FIGS. 1 through 5, this figure also illustrating the essentially transparent nature of the positioner. FIGS. 7 through 9 are photographs showing the positioner of FIGS. 1 through 6 in front elevational view at three different stages of opacity which represent different stages of use of the positioner of the present invention.

DETAIL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Like elements are designated by like numerals throughout the several views.

FIG. 1 is a view of a human mouth wherein the teeth 12 are obviously in need of correction by orthodontic devices or the like. Maxillary molars 12a and 12b are in an end-to-end relationship to their mandibular antagonists 12c and 12d and the upper incisors are generally protrusive and rotated in relation to the lower incisors. Conventional orthodontic devices, such as bands and the like, may be used for initially straightening the teeth of a mouth such as shown in FIG. 1 to bring the teeth to a predetermined position of proper or close to proper occlusion. To bring the teeth into a final position of desired orientation in the mouth, a tooth positioning retainer 20, such as shown in FIG. 2, may be used. Retainer 20 is generally U-shaped in plan

so as to conform to typical human mouth configuration and is generally H-shaped in cross section providing an upper or superior tooth receiving trough 22 and a lower or inferior tooth receiving trough 24. The sides of troughs 22 and 24 are bounded by a lingual flange 26 which covers the rear of the teeth of the upper and lower arch and a labial and buccal flange 28 which covers the front of the teeth of both arches.

Both the superior and inferior tooth receiving surfaces 22 and 24 are provided with a plurality of tooth receiving depressions or sockets, such as 22a, 22b, 22c, 22d, 22e, and 22f, of different configurations for receiving the different teeth of the mouth from the central incisors through the cuspids and bicuspid, into the first molar, and half of the second molar area. Alternatively, the positioner can of course be made having only an upper trough 22 or only a lower trough 24.

As best seen in FIGS. 3 through 5, the upper lingual flange 30, which secures the lingual cingulum areas of the upper anterior teeth and lingual surfaces of the lingual cusps of the upper posterior teeth, includes an inwardly directed rib 31 and covers a portion of the upper lingual gingival area 32, and the lower lingual flange 34 generally embraces the cingulum area of the lower anterior teeth and the lingual surface of the lingual cusps of the lower posterior teeth and includes an inwardly directed rib 35. This flange also extends over a portion of the lower lingual gingival tissue 36. The lower labial and buccal flange 38 which covers the labial and buccal surfaces of the lower anterior and posterior teeth includes an inwardly directed rib 39 and also extends over a portion of the lower labial and buccal gingival tissue 40 and the upper labial and buccal flange 42 has an inwardly directed rib 43 and covers the entire labial and buccal surfaces of the upper anterior and posterior teeth and also embraces a small portion of the upper gingival tissue 44.

The several ribs 31, 35, 39 and 43 generally follow the outline of the juncture of the teeth and the gingival tissue. Each retainer of the set would be formed by being molded about a model set of teeth wherein notches are cut closely adjacent the juncture of the teeth and the gingival tissue so that when the retainer is formed by molding the same about the teeth of the mold, the ribs would be so formed. However, it is not intended that notches would be formed in the teeth of a patient but rather these ribs would generally fit in the reduced area of the teeth adjacent the juncture of the teeth and the gingival tissue. These ribs provide a means for holding the retainer in place in a patient's mouth without the need for auxiliary fastening devices or the like. These ribs also aid in retention of tongue of the anterior teeth by placing pressure apically in the gingival third of the labial surface while maintaining the incisal edge in a stable position as the fulcrum.

The various pockets (such as 22a and 22b) in the retainer for the upper and lower teeth are made so that the teeth are snugly embraced by the retainer. The isthmus 46 which joins the lingual and buccal or labial halves of the positioner is generally thin, though it differs in dimension between the posterior region and anterior region so as to resemble the normal relaxed clearance between the teeth with the exception that the isthmus is slightly thinner in the posterior region. This enables all the occlusal and incisal surfaces of the teeth to be in contact with the positioner at the same time when occlusal pressure is applied. Any change which

might be made would be to increase the thickness of the isthmus in the anterior region to enable a corrected anterior vertical overbite to be effectively retained.

It has further been discovered that it is desirable to make the tooth positioner out of a semi-resilient plastic transparent material. The transparency enables the dental practitioner to actually see where the tooth movement will take place by observing blanching of tissue around the teeth and also enables him to detect potential soft tissue sore spots due to abnormal impingement of the flanges of the tooth positioner.

A perspective photograph of an essentially transparent positioner is shown in FIG. 6. It will be noted that the upper and lower flanges A are thinner in the horizontal or "lingual-labial" direction than is the thicker isthmus portion 46 which is denoted by the letter B in FIG. 3.

The present invention is concerned in particular with a specific problem facing the orthodontist, namely the problem of obtaining the full cooperation of the patient. On occasion a patient, having been instructed to wear a positioner for certain periods of time each day will return to the orthodontist's office at which time the orthodontist will observe that the progress in terms of movement of teeth has not been satisfactory. It is critically important that the orthodontist be aware of the reason for such insufficient progress. Specifically, was it because of an improperly fitting positioner or was it simply due to the fact that the patient did not wear the positioner as instructed. Many patients, especially children will be strongly inclined to state that they have in fact been wearing the positioner and the orthodontist is then left uninformed as to whether or not such is actually the case.

The present invention seeks to overcome this problem. In accordance with the present invention, the orthodontic appliance which may be any one of a large number of available appliances but for the present discussion is taken to be the above described positioner is formed of a material such that under normal conditions it is essentially transparent as described above and as noted in FIG. 4, but wherein the positioner has the characteristic of changing opacity in proportion to the time that the positioner is in the mouth.

As a result thereof, if a patient returns to the orthodontist office with insufficient progress, the orthodontist can then simply visually inspect the positioner to determine whether or not the patient has in fact been using the positioner.

For example, FIG. 7 shows a photograph illustrating the positioner of FIG. 6 in front elevation view, this positioner being essentially transparent just like that of FIG. 6. If a patient returned to the orthodontist's office with the positioner appearing as in FIG. 7, the orthodontist would be aware that it had not been worn regularly. The photograph of FIG. 8 differs from that of FIG. 7. It is more opaque, especially around the thicker isthmus. As will be described in more detail below, this would indicate that the positioner had probably been worn regularly at night although not during the day. Finally, the very opaque positioner shown in the photograph of FIG. 9 would indicate that the positioner has been worn every night plus approximately two to four hours each day.

Although there are perhaps many materials with which the present invention may be carried out, in a preferred embodiment, the present invention was de-

veloped by using polyvinyl chloride, commonly referred to (and hereinafter referred to) as PVC. Early PVC was known to have the disadvantage that it absorbed moisture and became cloudy. This is known as water-blush PVC. Over the years, however, many varieties of PVC have been developed including means for eliminating this water-blush characteristic such that they remain transparent even when subjected to high moisture conditions.

In the preferred embodiment, the positioner was made by mixing together a proportion of water-blush PVC and a portion of non-water-blush PVC. I have tried many different proportions from less than 5 percent water-blush PVC up to nearly 100 percent water-blush PVC (the remainder in each case being non-blush PVC). Almost all combinations of water-blush and non-blush would be operable in the sense that as long as they contained some water-blush PVC they would increase opacity to some extent. The actual percentage might depend in large part on the amount of opacity the orthodontist desired as an indication of full cooperation. Other factors would also be considered in determining the proportions of water-blush and non-blush. For example, if the positioner were formed of a substantially completely water-blush material, it might become almost completely opaque when worn for the desired periods of time, thereby eliminating the advantage that is gained by transparency as described above. Thus, the proportion should preferably be selected so as to retain at least some transparency as a diagnostic aid even during full cooperation.

In addition, the proportions should of course be selected with direct reference to the period of time that is contemplated the patient will be instructed to wear the positioner. That is, the proportions should be chosen such that after the correct time of wear, the positioner will have a high level of opacity consistent with the need for a certain degree of transparency.

As indicated above, tests have been conducted with numerous proportions of water-blush and non-blush material. Actually, about 25 percent water-blush PVC has been found to be the lowest practical level for obtaining what would appear to be a meaningful indication of wear, i.e., a discernible opacity. At the other end of the scale, however, some transparency is retained even with samples using up to 90 to 95 percent water-blush PVC although the transparency is apparently reduced below what I would consider to be an acceptable level after about 75 percent water-blush PVC.

In my preferred embodiment, I have selected a material which consists of approximately 50 percent water-blush PVC and 50 non-blush PVC. The results obtained with such a positioner are the subject of the photographs of FIGS. 7 through 9. With this embodiment, if the patient only wears the positioner at night, then the thicker central portion associated with the isthmus will become more opaque of "milky" to a greater extent than the upper and lower flanges. This is because the central portion is thicker and absorbs the moisture to a greater extent. If the patient also wears this positioner for two to four hours each day, the edges will also become rather whitish and the positioner will overall have a more milky or clouded appearance as in FIG. 9.

The characteristics of this positioner are such that when placed again into normal room conditions away

from the said high moisture conditions, for example when left out of the mouth, the moisture will evaporate and the positioner will return to its essentially transparent condition as in FIGS. 6 and 7. This can also be used as a diagnostic too. If the orthodontist is aware that the positioner has not been used for several days, if it appears as in FIG. 8 he will nonetheless know that the patient has worn the positioner for certain periods of time.

Another advantage of this particular embodiment, i.e., 50 percent-50 percent is that even with maximum use, i.e., full cooperation of the patient, there is still some degree of transparency remaining in the positioner. This is evident in FIG. 9 which represent maximum use and in which the outlines of the tooth receiving grooves can still be seen. This is an extremely important feature since a great deal of diagnostic significance lies in the fact that the orthodontist can always see through the positioner to determine what is happening to the teeth and supporting structure while the appliance is placing pressure against these tissues via the forceable occlusal forces that the patient is exerting while biting into the positioner. Actually, even the 50— embodiment is physically capable of higher opacity such as upon boiling in water for an hour or so, whereupon it would become completely opaque, but the fact remains that such conditions would not occur in a patient since it would require that the patient wear the positioner at all times for several days and even the most cooperative patient is asked to wear the positioner no more than approximately four hours per day plus the night time.

The invention has been described in considerable detail but it will be understood that the invention is capable of numerous modifications and variations apparent to those skilled in the art. For example, while the invention has been described with reference to a specific type of tooth positioner, it would of course be equally applicable to any type of orthodontic appliance or other items intended to be used in the mouth for certain periods of time. Also, while the results using one certain proportion have been described in detail, it will be understood that the other described proportions can also be used to indicate wear and hence achieve the advantages of the present invention. Other modifications and variations will be apparent to those skilled in the art.

I claim:

1. An orthodontic appliance for use in the positioning of teeth, said appliance formed of a material which is normally essentially transparent under normal room conditions and which increases in opacity by absorption of moisture when placed in a patients mouth for a predetermined period of time.
2. An orthodontic appliance according to claim 1, said material being polyvinyl chloride, at least a portion of which is water-blush polyvinyl chloride.
3. An orthodontic appliance according to claim 2, said appliance being formed of a material consisting of between 25 percent and 75 percent water-blush polyvinyl chloride, the remainder being non-water-blush polyvinyl chloride.
4. An orthodontic appliance according to claim 3, said appliance being formed of a material consisting of approximately 50 percent water-blush polyvinyl chloride and approximately 50 percent non-water-blush polyvinyl chloride.

5. An orthodontic appliance according to claim 1, said appliance being a tooth positioner which is generally U-shaped in plan and has a tooth receiving trough generally of a size and shape for reception of teeth of a patient, said trough being defined by lingual and labial-buccal flanges and having tooth receiving depressions, the flanges being thinner in the lingual to labial direction than the central portion of the positioner, whereby said flanges increase in opacity at a faster rate than the thicker central portion and wherein the flanges also return from a relatively opaque state back to the essentially transparent state at a faster rate than the central portion when the positioner is removed from the mouth.

6. A method of detecting cooperation of an orthodontic patient in the wearing of an orthodontic appliance, comprising the step of:

selecting an orthodontic appliance of a material which is normally essentially transparent under room conditions and which becomes at least partially opaque when subjected to a sufficient quantity of moisture at body temperature such as when placed in a patient's mouth, such that the degree of transparency of the appliance reduces upon wear in a patient's mouth,

instructing a patient to wear the orthodontic appliance for specific periods of time, and observing the degree of opacity of the appliance to determine whether the patient has worn the appliance the specified period of time.

7. The method of claim 6, wherein the material is polyvinyl chloride, at least a portion of which is water-blush polyvinyl chloride.

8. The method of claim 7, wherein the material is between 25 to 75 percent water-blush polyvinyl chloride.

9. The method of claim 8, wherein the material is approximately 50 percent water-blush polyvinyl chloride and 50 percent non-water-blush polyvinyl chloride.

10. The method of claim 6, including the step of forming the dental appliance of a mixture of water-blush polyvinyl chloride and non-water-blush polyvinyl chloride.

11. The method of claim 6, including the step of subjecting the appliance to use in position for positioning teeth within a patient's mouth for a specified period of time, wherein the opacity of the appliance will increase by an amount dependent on the period of time that the appliance is used in the mouth prior to the said step of observing opacity.

12. In the orthodontic art, wherein a transparent plastic positioner is placed in the patient's mouth for predetermined periods of time for repositioning teeth therein, a method of detecting whether the patient is cooperating in the wearing of the positioner for the said predetermined periods of time, comprising the steps of:

forming the positioner of a material which is normally transparent at room conditions but which increases in opacity when subjected to high moisture conditions such as when in a patient's mouth.

and observing the opacity of the positioner following a period when a patient was instructed to wear the positioner for certain periods of time to ascertain if the patient has in fact worn the positioner for said predetermined periods of time.

13. The method of claim 12, wherein the material is polyvinyl chloride, at least a portion of which is water-blush polyvinyl chloride.

14. The method of claim 13, wherein the material is between 25 to 75 percent water-blush polyvinyl chloride.

15. The method of claim 14, wherein the material is approximately 50 percent water-blush polyvinyl chloride and 50 percent non-water-blush polyvinyl chloride.

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