

Sept. 17, 1963

G. S. CLEMENS

3,103,679

TOOTHBRUSH

Filed Nov. 1, 1961

Fig. 1

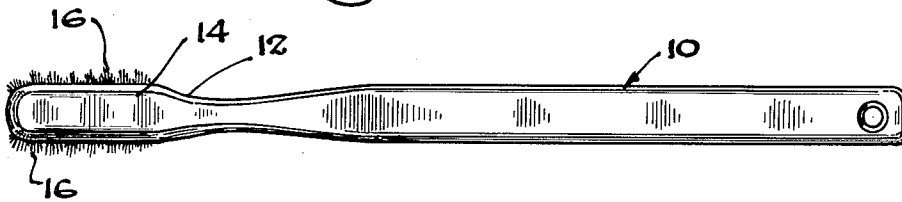


Fig.2

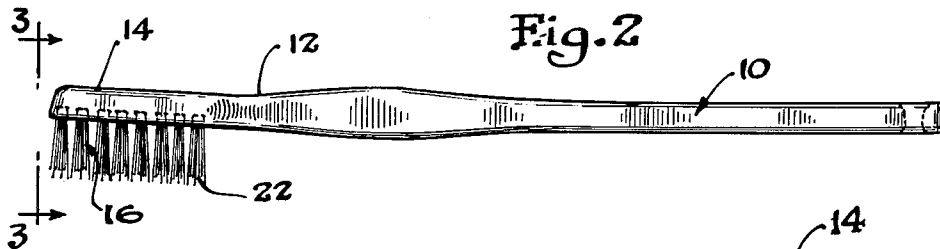


Fig.3

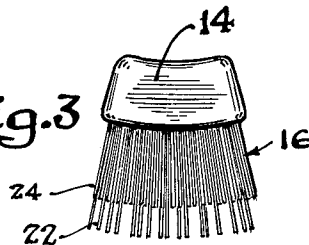


Fig.5

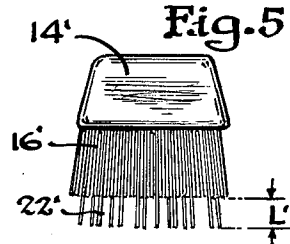
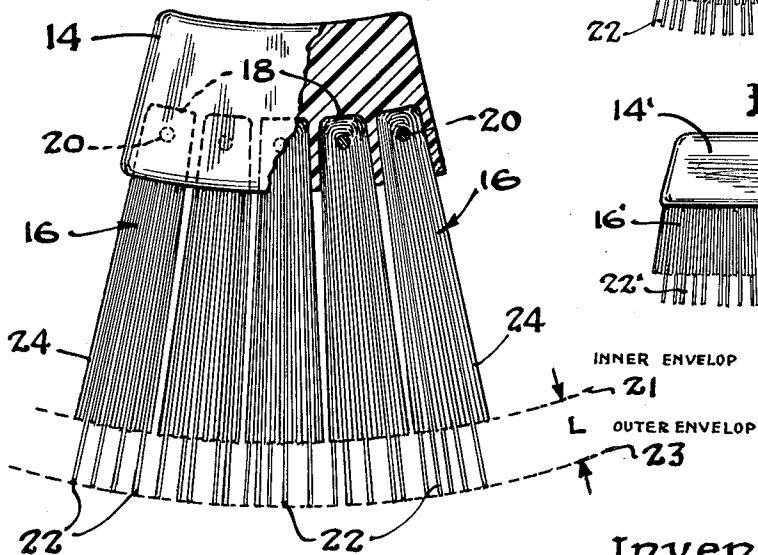


Fig.4



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3,103,679

TOOTHBRUSH

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Filed Nov. 1, 1961, Ser. No. 149,466

3 Claims. (Cl. 15-167)

The present invention relates to an improved tuft construction for toothbrushes.

One of the most difficult requirements to be met in the development of a toothbrush for cleaning human teeth lies in the provision of a brush that will satisfactorily clean the interproximal, or between teeth, areas as well as the general tooth surface. In order to assure a clean, healthy tooth structure it is essential that the tooth be thoroughly cleansed and that food particles be removed from the interproximal areas. Failure to remove such organic matter from the tooth surface will result in initiation of decaying action upon the tooth surface.

There have been a variety of toothbrushes and toothbrush tuft constructions developed over the years. Such constructions have been directed to continually improving the cleaning characteristics of the brush. Some of the development have been pointed toward the development of an improved construction especially adapted for cleaning of the teeth with the use of a particular cleaning method or stroke, such as the vibratory, roll stroke, or the like.

In one type of commonly used toothbrush the bristles of each tuft within the brush are trimmed in a uniform flat conformation wherein all of the tips of the bristles are disposed in a single, common, envelope. Another type of tuft construction currently employed is that wherein the bristles of each tuft are cut in progressively varying lengths to define a wedge shaped tuft having an included angle of approximately 60°. One of the limitations in optimum cleaning of the tooth surface with brushes of the types noted above is that in brushing a large number of bristles of substantially the same length are presented to the interproximal tooth areas at the same time. With such action the bristles have a tendency to wedge at the outer opening of the interproximal crevice and thus do not reach to the bottom of this area to brush particles therefrom. This is a serious limitation upon cleansing action since, as noted above, food particles have a tendency to collect in these interproximal areas. Such wedging action occurs even when the recommended roll stroke is employed in cleaning of the teeth, although it is not as pronounced as the action occurring with other unrecommended cleansing strokes.

It should be noted that the industry has made considerable investigation to the point of developing a brushing technique that would alleviate wedging action of the bristles and thus influence the efficiency of the bristles in cleansing the tooth surface. A number of different vibratory strokes were developed most of which were directed toward deforming the tufts or bristles of the toothbrushes by increased brushing pressure whereby some of the bristles of the tufts are severely bent and others are forced into the interproximal areas. The limitations on the use of such brushing strokes lies in the fact that they are tedious and time consuming and generally unacceptable for these reasons.

In accordance with the present invention, desirable cleansing of the entire tooth surface, including the interproximal areas, is realized regardless of which method or stroke is employed in brushing the teeth, although it should be recognized that the cleansing efficiency of the bristles or tufts will vary depending on the stroke used. The universally desirable cleansing action of a brush constructed in accord with the present invention is real-

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ized by providing tufts having randomly distributed long and short bristles therein. The long bristles define an outer envelope and are preferably relatively soft and thin. The shorter bristles define an inner envelope and are preferably relatively hard and thick. In the illustrative preferred form of the invention here shown, the long bristles are about $\frac{7}{16}$ " in length, are of about .007" diameter, and are cut from nylon stock, and the short bristles are approximately $\frac{3}{8}$ " in length, are of about .010" diameter, and are of nylon. Approximately 20% of the bristles of each tuft are long and the remaining are short. Preferably the tufts are distributed evenly throughout the brush.

It is, accordingly, a general object of the present invention to provide an improved toothbrush which is effective in cleaning the broad surfaces of the teeth and stimulating the gum tissues and, in addition, effective to clean the interproximal areas of the teeth.

Another object of the present invention is to provide an improved toothbrush wherein the bristle wedging action of prior brushes is avoided.

Another object of the present invention lies in the provision of an improved toothbrush tuft construction having combinations of relatively hard and relatively soft bristles therein, of varying length between an inner and an outer envelope.

An additional object of the present invention is to provide an improved tooth brush tuft having bristles therein of varying length between an inner and an outer envelope.

A further object of the present invention is to provide an improved tuft for toothbrushes having relatively long and short bristles therein the long bristles being softer than the short bristles, said construction permitting the user to conveniently vary the brushing pressure to give individually desired bristle contact.

Another object of the present invention is to provide an improved tuft construction for toothbrushes wherein the ends of some of the bristles therein may be ground or rounded prior to insertion in the brush with the completed brush still avoiding the irregular, untrimmed appearance of prior brushes constructed in this manner.

A further object lies in the provision of an improved tuft construction for toothbrushes each tuft having a number of bristles therein of smaller diameter and of slightly greater length than the remaining bristles.

The novel features which I believe to be characteristic of my invention are set forth with particularly in the appended claims. My invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a top plan view of a toothbrush constructed in accordance with the present invention;

FIGURE 2 is a side elevational view of the brush of FIGURE 1;

FIGURE 3 is an end view of the brush of FIGURE 1, showing only the brush head and bristles;

FIGURE 4 is a greatly enlarged view of FIGURE 3 illustrating the tuft and bristle arrangement of the present invention in greater detail; and

FIGURE 5 is an end view, like FIGURE 3, of a flat surface brush constructed in accord with the present invention.

Referring now more particularly to FIGURE 1 to 3 of the drawings, there is shown a handle, indicated generally at 10. The handle 10 is formed integrally with a neck portion 12, the neck 12 being integrally joined at its opposite end to the brush head 14. The handle 10 may be shaped to conveniently receive the hand or fingers gripping it for brushing action.

The tufts 16 may be mounted in the brush head 14 by any conventional method well-known to the art. One such method of affixing the tufts 16 within the tuft receiving openings 18 of the brush head 14 involves doubling a number of bristles over a pin 20 and inserting the

doubled bristles and pin assembly—pin first—into the tuft receiving openings 18 of the brush head 14. The pin length is slightly greater than the diameter of the tuft receiving opening 18 and is prevented from coming back out of said opening due to the fact that it forms an interference fit with said opening.

In the preferred embodiment of the present invention each of the tufts 16 is comprised of twenty to thirty bristles. The bristles within each tuft 16, as noted above, vary both in length and diameter. Each tuft is comprised of a small number of bristles 22 each a few thousandths of an inch smaller in diameter than the majority of the bristles 24 within the tuft 16. The smaller diameter bristles 22 are further distinguished from the majority of the bristles 24 in that they extend beyond the ends of the bristles 24 for a short distance, indicated generally at L, FIGURE 4. The short and long bristles, 24 and 22 respectively, define inner and outer envelopes, 21 and 23 respectively. It can readily be seen that the force required to flex or deflect the smaller diameter long bristles 22 will be somewhat less than the force required to deflect the shorter, larger diameter bristles 24. The force required to deflect a bristle a given amount is inversely related to the fourth power of the variance in the diameter of the bristle, as will be explained below. Thus, the long, smaller diameter bristles can be characterized as soft in comparison to the short, large diameter bristles within the tuft. The user, with such a construction, can vary the sensual bearing of the tips of the tufts upon the brushing surface by merely adjusting the pressure or force with which he urges the bristles against the brushing surface. It will be appreciated that with this construction the user has within one brush, so constructed, the entire range of the normally categorized soft, medium and hard toothbrushes. He may adjust the brushing pressure to realize whatever degree of softness or stiffness that is personally desired.

In one form of the present invention the bristles 22 are approximately $\frac{7}{16}$ " in length, as measured from the free tip of the bristle 22 to the bristle receiving base of the brush head 14. The remainder of the bristles within the tuft 16 are approximately $\frac{3}{8}$ " in length from the free end of said bristles 24 to the tuft receiving base of the brush head 14. Thus, the bristles 22 extend approximately $\frac{1}{16}$ " beyond the tips of the bristles 24 within the tufts 16.

The bristles 22 are further distinguished from the bristles 24 in that they are of slightly smaller diameter. In the preferred embodiment of the invention the bristles 22 are cut from .007" to .008" nylon stock, while the shorter bristles 24 are cut from approximately .010" diameter nylon stock.

The foregoing description relates to my specific preferred and illustrative embodiment of the present invention. Modifications and variations may be used while still overcoming the problem of wedging and while still permitting the user to control brushing pressure as desired. For example, the length of the longer bristles within each of the tufts 16 may be varied from about .235" to about .450" in length and said short bristles may be varied from about .210" to about .425" in length. Similarly the length differential between the inner and outer envelopes may be varied from .025" to about .150" while still exhibiting the desirable characteristics of the present invention. Additionally, the diameter of the bristles may be varied from about .007" to about .014". It should be observed that the very short bristle lengths noted above would very likely be employed in children's toothbrushes, for example, wherein all of the bristles are considerably reduced in length. The desirable charac-

teristics of applicant's tuft construction are realized with any combination of the above noted ranges.

The most desirable characteristics of the present invention are produced with the number of the longer bristles within each tuft being within the range of 10% to 30% of the total number of bristles within the tuft. However, satisfactory characteristics have been produced with tufts having from 10% to 75% long bristles therein.

The tuft construction of the present invention is shown applied to the flat type brush construction in FIGURE 5. Here it will be noted that the tips of the longer bristles 22' all lie in the same flat plane. In this construction, as in the construction of FIGURE 4, the tufts are constructed of a plurality of bristles of different length, the tips of the bristles defining inner and outer envelopes having a length differential therebetween as illustrated at L' in FIGURE 5.

A further advantage of the present invention lies in the fact that the ends of the shorter bristles within each tuft may be ground or polished prior to insertion of the bristles within the tuft without detracting materially from the appearance of the finished brush. It should be apparent that polishing of the bristle tips before insertion into the tuft is a much easier and less time consuming operation than if the polishing is done after insertion of the bristles into the tuft assembly. Polishing of the ends of the shorter bristles so that they do not present a cutting surface is feasible due to the fact that the shorter bristles define the inner envelope of the envelope of the brush, and therefore do not influence the appearance of the outer surface of the brush proper. In prior constructions the bristles are trimmed after insertion, in tuft form, into the brush head. This is done so that the flat surface generated will exhibit the desired degree of regularity. It could be observed that it is not feasible to insert the bristles into the tuft so that all of the ends lie within the same plane. Thus, if the ends of the bristles of prior brush constructions are to be polished, they must be polished after mounting in the brush. The alternative, of course, is to polish the bristle ends before insertion into the brush with the result that the finished brush has the irregular, unkempt appearance.

The present invention; in summary, is directed to the provision of a tuft construction for toothbrushes that can be employed with the recommended roll stroke, with the unrecommended scrub brush stroke, or with the acceptable Fones circular stroke and still obtain maximum penetration into the interproximal areas to thereby clean the same.

With the tuft construction of the present invention, it has been noted that the longer bristles remain in the interproximal areas and will bend when unable to penetrate further. In this sense, the bending action is the opposite of that of conventional tufts employed with the vibratory stroke where the outside bristles do the bending in order to permit entrance of a few bristles into the interproximal spaces.

The action of the bristles in avoiding wedging action by a small number of bristles and the control of the pressure is determined by their physical dimensions and by their flexural characteristics. The dimensions here given are for bristles of extruded nylon. Other materials that may be used include rayon, and various other nylon-like plastics. In each instance, a variation of material and flexural characteristics entails some change in dimensions for most effective operation. The limits expressed above, however, for application of the principle of this invention apply substantially to these other materials, as well as to similar materials not here mentioned, having similar flexural characteristics.

It should be noted that any member acts as a beam if bending is induced by external transverse forces. With this in mind I have observed that the characteristics of flexure of the bristles or tufts of the present invention are basically affected by the diameter of the bristle and the modulus of elasticity of the material. The bristles of

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a toothbrush act in cantilever beam action with, for analytical purposes, the load concentrated at the free end. The deflection, in inches, of such a beam may be determined by the formula:

$$y = K \frac{1}{Ed^4}$$

where E is the modulus of elasticity in lb. per sq. inch; d is the diameter of the beam; and where the constant K includes the substantially constant (for analytical purposes) load applied to the beam or bristle in the brushing action, and the length of the bristle. It can readily be seen that the deflection or flexure characteristics of the bristle will vary inversely as the fourth power of the diameter of the bristle varies and as the modulus of elasticity varies. Thus, if any given bristle is doubled in diameter the resultant force required to deflect the bristle the same given amount will increase 16 times. I am appreciative of the fact that a plurality of beams in a cluster, such as would occur with the bristles interposed in a tuft assembly, would not exhibit the identical characteristics of the single bristle or beam. However, I intend by the claims appended hereto to include the inherent variation in deflection of the bristles within the scope of the present invention as one of the characteristics that may be varied by a variation of any of the established components that serve to define the deflection characteristics of materials.

While I have shown and described a specific embodiment of the present invention it will, of course, be understood that other modifications and alternative constructions may be used without departing from the true spirit and scope of this invention. I therefore intend by the appended claims to cover all such modifications and alternative constructions as fall within their true spirit and scope.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An improved tuft construction for a toothbrush having a handle portion, a brush head attached to said handle portion, said brush head having a tuft receiving base, said improved tuft construction comprising:

a plurality of intermingled short and long bristles the terminal ends of which define two distance envelopes, the short bristles being approximately $\frac{3}{8}$ " in length from the tip of the bristle to the tuft receiving base of the brush head, the long bristles being approximately $\frac{7}{16}$ " in length from the tip of the bristle to the tuft receiving base of the brush head, said long bristles comprising 10% to 30% of the total number of bristles the remainder being short bristles, said long bristles being approximately .007" in diameter and said short bristles being approximately .010" in diameter, the end of each of the long and short bristles being embedded in the tuft receiving base with the other end of each being supported freely outwardly thereof, the free end of each of the short bristles being polished to provide a rounded surface, said short bristles defining a smooth non-abrasive outer surface along the free ends.

2. An improved tuft construction for a toothbrush comprising:

a plurality of intermingled short and long bristles de-

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fining distinct inner and outer envelopes, respectively, said long bristles being within the range of .235" to .450" in length and said short bristles being within the range of .210" to .425" in length, said bristles being within the range of .007" to .014" in diameter, said short bristles being larger in diameter than said long bristles, the long bristles comprising 10% to 75% of the total number of bristles within the tuft, each of said short and long bristles, respectively, within the tuft being substantially the same length.

3. An improved individual tuft construction for a toothbrush for cleansing teeth, said toothbrush having a handle portion and a brush head extending from said handle portion, said brush head defining a tuft receiving base, the tuft construction comprising:

a plurality of short bristles each having one end thereof affixed within the tuft receiving base and the other end thereof extending outwardly from the base to define a free terminal portion, each said short bristle being approximately $\frac{3}{8}$ inch in length from the free terminal portion to the tuft receiving base, the free terminal portions defining, in combination, an inner envelope, the terminal portions of each of the short bristles being polished to define rounded ends thereon, each short bristle being approximately .010 inch in diameter; and

a plurality of long bristles randomly interspersed among the short bristles, each long bristle having one end thereof affixed within the tuft receiving base and the other end thereof extending outwardly from the base to define a free terminal portion, each said long bristle being approximately $\frac{7}{16}$ inch in length from the free terminal portion thereof to the tuft receiving base, the terminal portions, in combination, defining an outer envelope, each long bristle being approximately .007 inch in diameter, the short bristles of the tuft adapted to engage the major tooth area to sweep said areas clean and to engage the gums, the polished ends of the short bristles presenting a non-irritating profile to the gums to avoid abrasive damage to the epidermal layers, the long bristles adapted, in use, to extend into the interproximal areas of the teeth to cleanse those areas, the long bristles comprising 10% to 30% of the total number of bristles in the tuft whereby interference between adjacent long bristles is avoided and efficient non-interfering long bristle access is provided to the interproximal tooth areas.

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