BRUSH WITH ABRASIVE-IMPREGNATED BRISTLES

Filed Nov. 12, 1970 2 Sheets-Sheet 1

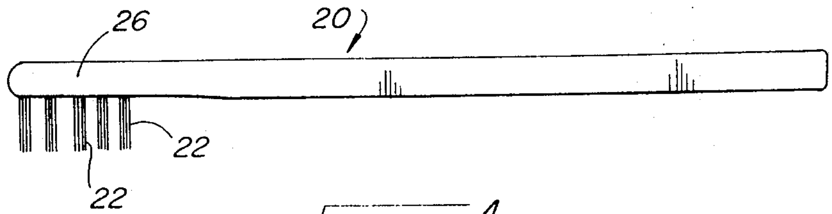

FIG. 1

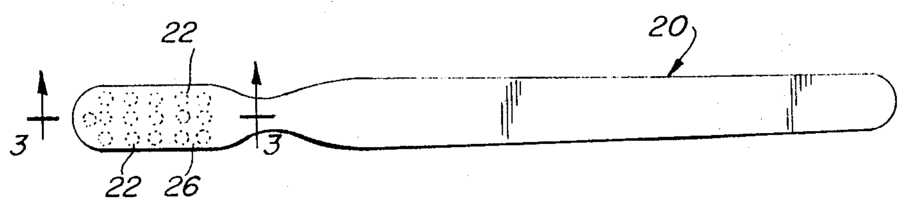

FIG. 2

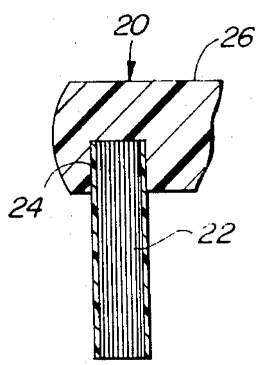

FIG. 3

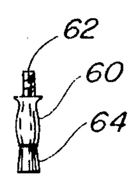

FIG. 8

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BRUSH WITH ABRASIVE-IMPREGNATED BRISTLES

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FIG. 5

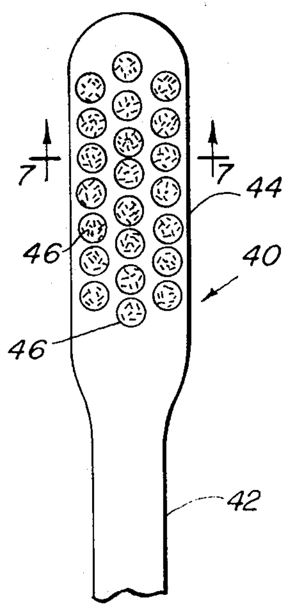


FIG. 4

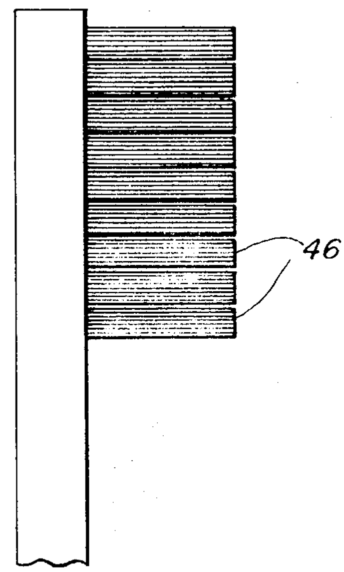


FIG. 6

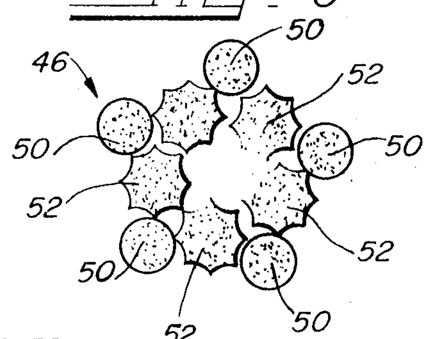
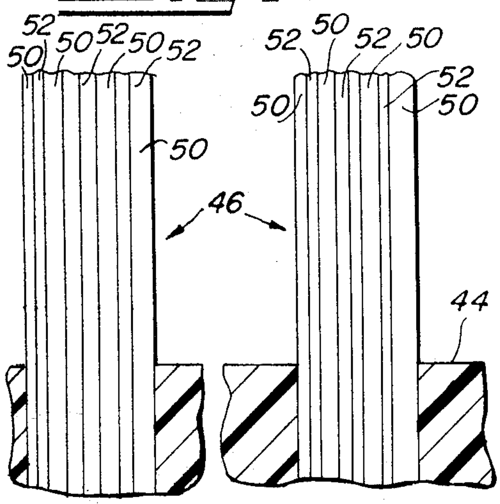


FIG. 7



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United States Patent Office

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BRUSH WITH ABRASIVE-IMPREGNATED BRISTLES

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U.S. Cl. 15—167 R 18 Claims

ABSTRACT OF THE DISCLOSURE

An abrasive material is incorporated in the plastic from which bristles are formed by extrusion or otherwise, and the abrasive-impregnated bristling material is employed in the manufacture of brushes, especially toothbrushes. One preferred brush is formed with bristle tufts, each tuft having in combination relatively small diameter bristles containing a relatively high level of abrasive and having a circular cross section and relatively large diameter bristles containing a relatively low level of abrasive and having a shaped or configured cross section.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to brushes and more particularly to toothbrushes in which the bristling material with which the brush is fabricated incorporates an abrasive material, especially a dental abrasive material.

Description of the prior art

In the dental health field today, toothbrushing is ordinarily accomplished with an inert brushing implement or device which is adapted for use with a dentifrice composition (either a toothpaste or a toothpowder) which contains an abrasive substance or material designed to celan the teeth (i.e., to remove stains, plaque, pellicile, and dental calculus (tartar)). While presently known dentifrice compositions have not been wholly satisfactory in this regard, it has been essential that the dentifrice contain such an abrasive material to obtain a satisfactory level of cleaning. Indeed, while so-called liquid dentifrices (i.e., dentifrice compositions not incorporating an abrasive component) have been known, they have been completely unsatisfactory by reason of their inability to clean the oral hard tissues.

However, as a result of the provision of mineral components (abrasives) in dentifrice compositions, the therapeutic advantages of water-soluble fluoride and stannous ion containing anticariogenic agents in such dentifrice compositions has been severely limited. The abrasives exert a deactivating effect on the stannous and fluoride ion components.

Dental research has developed substantial evidence that beyond the age of forty years loss of teeth is predominantly the result of periodontal involvement rather than dental caries. The most important single factor contributing to periodontal disease is the accumulation of dental calculus (e.g., salivary tartar) on the teeth. These deposits result in tissue inflammation of the surrounding gingiva, and, as the condition increases its severity, the supporting bone is also affected. These reactions lead to the destruction of the supporting structures and the subsequent mass loss of teeth.

Heretofore, available dentifrice systems have exhibited relatively unsatisfactory enamel polishing qualities and consequently have not been wholly effective in preventing the accumulations of materia alba, oral debris, plaque, pellicle, stains, and dental calculus. While such systems are capable, to varying degrees, of removing material

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alba, food particles, exogenous stains, and other tooth surface pigmentations when utilized in ordinary daily brushings, they have not exhibited the ability to remove the more resistant forms of enamel pigments and to produce a smooth tooth surface resistant to dental calculus reformation.

Thus, the present invention has for its primary objective the enhancement of tooth cleaning and polishing through the use of an implement rather than dentifrice systems.

Another object of the present invention is the provision of a toothbrush containing bristles incorporating an abrasive component capable of cleaning and polishing the teeth.

Yet another object is to provide a brush especially adapted for use with liquid dentifrice compositions containing soluble, anticariogenic agents, but no incompatible abrasive components.

A further object is the provision of bristling material adapted to be mounted in conventional toothbrush handles, which bristling material contains or has incorporated therein a dentifrice abrasive material suitable for use with a liquid dentifrice containing therapeutic anticariogenic adjuvant, but no incompatible mineral abrasive.

A further object is to provide bristling material for a toothbrush incorporating an effective amount of a dental abrasive material which is the same as an abrasive component of a dentifrice preparation such that hygienic and therapeutic cleaning and polishing effects of the dentifrice are complemented and enhanced by the common abrasive material provided in the bristling material.

A related object is providing a toothbrushing implement having improved cleaning and polishing performance (especially with respect to the prevention of re-accumulation of dental calculus, pellicle, materia alba, and the more resistant forms of oral hard tissue stains and pigmentations).

SUMMARY OF THE INVENTION

The foregoing and other objects, advantages, and features are achieved with the present invention through the use in a brush of bristling material comprising filaments of plastic material having incorporated therein up to about 30% by weight of an abrasive material, especially zirconium silicate parties. More particularly, where the bristling material is employed in a toothbrush, the abrasive material is a dental abrasive material, preferably one selected from the group consisting of zirconium silicate ($ZrSiO_4$), calcium pyrophosphate ($Ca_2P_2O_7$), anhydrous calcium hydrogen phosphate ($CaHPO_4$), calcium hydrogen phosphate dihydrate ($CaHPO_4 \cdot 2H_2O$), insoluble sodium metaphosphate [$(NaPO_3)_x$], calcium carbonate ($CaCO_3$), alumina (Al_2O_3), tin dioxide (SnO_2), talc [$Mg_3Si_4O_{10}(OH)_2$], and mixtures thereof.

An especially preferred brush is formed with tufts of bristles, each tuft comprising at least one first type of bristle having a relatively smooth surface and a generally circular cross section and incorporating abrasive at a level of at least about 7.5% by weight and at least one second type of bristle having a non-circular cross section and incorporating abrasive at a level of no more than about 5% by weight, the diameter of the first bristles being larger than that of the second bristles.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a brush produced in accordance with the present invention;

FIG. 2 is a plan view thereof;

FIG. 3 is a fragmentary sectional view taken substantially along line 3—3 in FIG. 2;

FIG. 4 is a fragmentary side elevational view of another brush produced in accordance with this invention;

FIG. 5 is a fragmentary plan view thereof;

FIG. 6 is an enlarged plan view of one bristle tuft thereof;

FIG. 7 is an enlarged fragmentary sectional view taken substantially along line 7—7 in FIG. 5; and

FIG. 8 is an elevational view of a dental prophylaxis brush produced in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1–3 illustrate a brush **20**, such as toothbrush **20**, which may be manufactured using conventional handle molding and bristle tufting technology. However, up to about 30% by weight of an appropriate dental abrasive material has been incorporated in the molten plastic material from which the bristles are extruded or otherwise formed, and the extruded bristle thus contains an abrasive component. This bristling material is processed through conventional machinery (not shown) and is provided in the form of a plurality of tufts **22** which may be provided in an opening **24** provided in a handle or brush head **26** of brush **20**.

The plastic from which the bristling material may be extruded in accordance with this invention includes polyamides, such as nylon and flexible polystyrene; polyolefins, such as polyethylene and polypropylene; acetals; urethanes; and the like. Mixtures of plastics may be advantageously employed. Especially preferred as a plastic for producing the abrasive-impregnated bristling material illustrated in FIGS. 1–3 is 6–10 nylon.

As previously noted, a special feature of the brush of the present invention is that up to about 30% by weight of a dental abrasive material is incorporated in the bristling material from which the brush is fabricated. The abrasive material may be incorporated into the plastic from which the bristles are extruded or otherwise formed in any convenient fashion. For example, the abrasive material may be physically mixed with the plastic material before it is pelletized or, alternatively, plastic pellets and abrasive in suitable quantities may be admixed in a suitable grinder prior to introduction of the plastic into the extruder molding apparatus. Substantially any such method may be employed so long as the molten plastic reaching the mold contains up to about 30% by weight of the cleaning and polishing agent.

While up to about 30% by weight of the abrasive material may be used with satisfactory results, best results are achieved with about 2–10% by weight abrasive.

Suitable dental abrasive materials include zirconium silicate, $ZrSiO_4$, talc, $Mg_3Si_4O_{10}\cdot(OH)_2$, calcium pyrophosphate, $Ca_2P_2O_7$, calcium hydrogen phosphate dihydrate/anhydrous calcium hydrogen phosphate,

$$CaHPO_4\cdot 2H_2O/CaHPO_4$$

insoluble sodium metaphosphate $(NaPO_3)_x$, calcium carbonate, $CaCO_3$, alumina, Al_2O_3, tin dioxide, SnO_2, and others. Mixtures of these agents may be employed.

The size of particles of dental abrasives can be expressed in a number of different ways, one of the most common of which is "mean diameter," i.e., the arithmetical average of the diameters of particles in a representative sample. As hereinafter utilized, the term "particle size" refers to a mean diameter value.

Zirconium silicate is a well-known industrial abrasive which is used for the grinding and polishing of glass and ceramics, however, prior to the subject invention, this material had not been proposed for use as a cleaning and polishing material incorporated directly in the bristles of an otherwise conventional toothbrush for frequent and direct application to the teeth. The extreme hardness and the abrasion characteristics exhibited by zirconium silicate (e.g., a hardness number of 7.5 on the Mohs scale for commercially available zirconium silicate, such as types used for grinding of glass) would suggest to one skilled in the art that zirconium silicate would seriously damage (i.e., abrade and scratch) tooth structure and would thus be unsuitable for use on the teeth. However, it has been ascertained that it may safely be employed under the conditions of the present invention.

The preparation of suitable particle size zirconium silicate can be accomplished by conventional techniques well known to the art. Basically, these techniques involve milling zirconium silicate ore (zircon), followed by standard screen sieving (or air separation) to segregate the desired particle size. Various milling techniques may be utilized in order to obtain the desired surface configurations for the zirconium silicate particles. For example, particles may be prepared by a ball and hammer milling technique. Preferably, the cleaning and polishing agent of the present invention comprises a mixture of ball milled and hammer milled particles.

As is well known to the art, hammer mills utilize a high speed rotary shaft having a plurality of hammers or beaters mounted thereon. The hammers may be T-shaped elements, bars, or rings fixed or pivoted to the shaft or to discs pivoted to the shaft. The shaft runs in a housing containing grinding plates or liners. The grinding action results from the impact between the material being milled and the moving hammers. When zircon ore is milled by an attrition technique such as hammer milling, relatively rough, jagged particles are produced. Particles having such jagged surface configurations function from a tooth cleaning standpoint in a relatively superior manner as compared to more smoothly configured particles.

Similarly, a ball mill comprises a cylindrical or conical shell rotating on a horizontal axis which is charged with a grinding medium such as balls of steel, flint, or porcelain. The grinding is accomplished by the tumbling action of the balls on the material to be ground. Particles of zirconium silicate treated in a ball mill of the character described have relatively smooth surface configurations and function better from the polishing standpoint than more jaggedly configured particles. Similar techniques can be employed with the other abrasives employed in accordance with this invention. One or more of the foregoing other dental cleaning and polishing agents are preferred abrasives for use in practicing the present invention. Such mixtures should comprise in excess of about 1% zirconium silicate and preferably about 10% zirconium silicate or more, by weight of the abrasive mixture.

Especially preferred abrasives are described in the following examples:

EXAMPLE I

One preferred abrasive system is the zirconium silicate-tin dioxide mixture described in U.S. Pat. No. 3,378,445.

EXAMPLE II

Particle size $ZrSiO_4$:	Wt. percent
$<5\mu$	70
$>5\mu$ $<10\mu$	15
$>10\mu$ $<20\mu$	15

EXAMPLE III

Another preferred abrasive system comprises a 1:1 weight mixture of alumina, Al_2O_3 (240 mesh) and zirconium silicate particles lying in the range of up to about 8 microns particle size.

Brush **20** could be adapted for use on an automatic toothbrush power handle by altering the handle in a known manner and by reducing the size of the brush head **26** and the number of bristle tufts **22** as is also known in the art. Similarly, the bristling material of this invention could be employed on a denture brush. Denture brushes may be used for all forms of dental prostheses (i.e., complete dentures, removable bridges, and partial dentures), and, compared with conventional denture brushes, are significantly less abrasive to the acrylic resin of which dentures are formed. The bristles of this invention could also be utilized on a dental prophylaxis brush. Such a prophylaxis brush, which is shown in FIG. 8, comprises a brush head or base **60** which is provided with a screw **62** suitable for attachment to a dental prophylaxis angle. Projecting from the brush head **60** are a plurality of bristles **64**, which are arranged in the form of a tuft. Such a prophylaxis brush is used professionally to perform a dental prophylaxis, and may advantageously be used with a dental prophylaxis paste.

Especially good results may be achieved with toothbrushes in accordance with the present invention where the abrasive incorporated in the bristling material is also used in the dentifrice system employed with the brush.

A preferred embodiment of this invention is illustrated in FIGS. 4–7. A brush **40** comprises a handle **42** and a brush head or base **44**, with a plurality of bristle tufts **46** being mounted in brush head **44** in a conventional manner. A brush in accordance with this invention should, however, comprise at least one tuft **46**.

Each bristle tuft **46** comprises two different types of bristles **50** and **52** (see especially FIG. 6). Tufts **46** should comprise at least one bristle of each type **50** and **52**, and, as shown, the number of each type should be substantially equal. While the exact number of bristles will depend on the size of the tuft, tuft **46** has five bristles of each type randomly distributed throughout the tuft.

Bristles **50** are generally circular in cross-section and thus have generally smooth sides, except for the natural roughness caused by the abrasive particles distributed therein. Bristles **52** have a configured cross section (see FIG. 6) and thus have a generally rough outer surface. While the cross section of bristles **52** can be configured in any desired manner, the longitudinal groove arrangement shown in the drawing is preferred since it may easily be formed during the filament extrusion process. Bristles **50** preferably incorporate abrasive material at a higher level than do bristles **52**. More particularly, bristles **50** comprise in excess of about 7.5% abrasive by weight, preferably about 10%, whereas bristles **52** comprise no more than about 5% abrasive by weight, preferably about 2%. In addition, bristles **52** are substantially larger in diameter than are bristles **50** (by a factor of 25–75%, preferably about 50%). For example, bristles **50** may advantageously be about 8 mils in diameter, and the diameter of bristles **52** may be about 12 mils. Bristles **50** are particularly useful in imparting a high degree of polish to the teeth, but are not unduly abrasive. Bristles **52** serve to clean the teeth well and have good wear characteristics.

In addition to utility on manual toothbrushes, the unique combination of bristles **50**, **52** may also be employed on brush heads for automatic toothbrushes, denture brushes, prophy brushes, and on brushes of other types.

By combining bristles **50** and **52** in the foregoing manner, these benefits may be maximized, and substantial and material dental health benefits may be obtained. A clean and very highly polished tooth surface may be achieved (thus reducing the accumulation and re-accumulation of dental plaque, pellicle, and dental calculus), thereby not only contributing to the minimization of periodontal disease, but also serving in reducing the incidence of dental caries. Furthermore, a superior implement for gingival stimulation is provided, and the oral health benefits resulting therefrom may be obtained.

The substantially hygienic and therapeutic oral health benefits of this invention have been experimentally verified in the following manner.

EXPERIMENTAL EVALUATIONS

The superiority of the abrasive-containing brushes of the present invention has been substantiated by the following experimental evaluations. A definitive laboratory cleaning test procedure has been used to evaluate a number of toothbrushes, among which were brushes produced in accordance with the present invention. This procedure (as set forth and described in Cooley et al. U.S. Pat. No.

3,151,027) involved the use of polyester plastic blocks specifically designed for use in an electric toothbrushing machine. The blocks are ground smooth, washed, dried, and a thin coating of black lacquer is carefully applied to the surface of the block. The blocks are then inserted in a toothbrushing machine and brushed with the brushes for 3,000 double strokes with a pressure on the lacquer surface of 150 grams. Reflectance measurements of the blocks are then obtained through the use of a reflectometer. The cleaning values for the materials tested are given in Table I, on a scale ranging from 0 to 6.5, a higher value indicating a greater cleaning ability (i.e., higher reflectance produced by greater removal of the lacquer is indicative of better cleaning ability).

Enamel polishing values have also been obtained in accordance with a so-called "toothbrush polishing procedure." The lingual surfaces of freshly extracted maxillary anterior teeth are reduced with the aid of a diamond disc, and the teeth are mounted by means of a low melting alloy, such as Wood's metal or an acrylic, such as methacrylate, on hexagonal jigs constructed so as to fit the movable stage of a reflectometer. The exposed labial surface of each tooth is mounted in such a manner that the height of the contour is a suitable distance above the base of the jig. Throughout the procedure, care is taken to ensure that the teeth do not become dry in order to prevent damage of the tooth tissues. The exposed enamel surface is then dulled by exposing it to 0.10% hydrochloric acid (pH 2.2) for 30 seconds. Any acid remaining on the tooth surface is neutralized by immediately transferring the tooth to a saturated sodium carbonate solution for 30 seconds. The tooth is then rinsed with water and blotted dry.

The maximum reflectance of the dulled tooth surface is determined by means of a reflectometer especially adapted to detect the changes in the degree of polish of the enamel surface. The reflectometer is constructed so that the enamel is exposed to a beam of polarized light, and the amount of light reflected from the enamel surface is determined by a photoelectric cell which in turn activates a galvanometer. The smoother the enamel surface, the smaller the amount of diffused and absorbed light and, hence, the higher the galvanometer reading.

After the maximum reflectance of the dulled tooth is determined, the tooth is polished with a toothbrush mounted on an automatic toothbrushing machine for a specified number of strokes. After the tooth has been polished, the enamel surface is rinsed with water so as to remove any residual particles of the cleaning and polishing agent, and the reflectance of the enamel surface is again measured with the tooth located in exactly the same position as that used to obtain the "dull" reading. The absolute change in the amount of reflectance between the dulled and polished enamel surfaces is taken as a measure of the degree of polishing imparted by the treatment.

Cleaning and polishing values have been obtained in the foregoing similar manner for toothbrushes of the type shown in FIGS. 1–3, and these data, as well as comparative data obtained for a conventional non-abrasive containing manual toothbrush, are reported in Table I.

TABLE I

Type of brush	Bristles	Polishing agent	Conc. polishing agent	Cleaning ratio	Polishing ratio
Manual	Nylon			2.30	1.56
Do	do	$ZrSiO_4/Al_2O_3$[a]	2	1.83	0.50
Do	do	$ZrSiO_4/Al_2O_3$[a]	5	1.99	0.60
Do	do	$ZrSiO_4/Al_2O_3$[a]	10	2.57	2.36
Do	do	$ZrSiO_4/SnO_2$[b]	2	1.93	1.06
Do	do	$ZrSiO_4/SnO_2$[b]	5	3.08	3.38
Do	do	$ZrSiO_4/SnO_2$[b]	10	3.17	3.66
Do	do	$ZrSiO_4$[c]	2	1.01	1.16
Do	do	$ZrSiO_4$[c]	5	1.24	2.00
Do	do	$ZrSiO_4$[c]	10	1.59	3.60

[a] 1=1 mixture of Al_2O_3 (240 mesh) and $ZrSiO_4$ ($<8\mu$).
[b] $ZrSiO_4$ abrasive of U.S. Pat. No. 3,378,445.
[c] $ZrSiO_4$ 70% $<5\mu$; 15% $>5<10\mu$; 15% $>10<20\mu$.

In order more closely to approximate practical usage conditions, a procedure was employed in which an automatic toothbrush power unit was held by a technician with a tension of about 75±25 grams. In order to eliminate the possibility of bias, two different technicians were employed and all brushes were coded with the identity unknown to the technician. Lacquer-coated polyester blocks were selected to have an initial reflectance ≥ 8.5 using a reflectometer with an onyx standard value of 10.0. The blocks were then brushed 15 seconds with the respective system in the presence of a 1:2 slurry of the abrasive system (20 grams abrasive or dentrifrice: 40 ml. aqueous 1% carboxymethyl cellulose solution). The amount of lacquer removed was determined by the decrement in reflectance.

Polishing and abrasion evaluations were obtained by a procedure in which the device was held in the hand of a technician. For enamel polishing, selected enamel specimens were dulled by etching (30 second immersion in 0.1% HCl followed by 30 second immersion in saturated aqueous Na_2CO_3) and the reflectance determined using a reflectometer standardized with an onyx stone at 8.5. Since enamel polish is a cumulative phenomena, the teeth were polished with the respective device-brush system and the dentifrice/abrasive slurry described above for 15 minutes. The reflectance of the enamel was subsequently determined and the increment utilized as a measure of the polishing ability of the system. The identical set of teeth were employed in each instance. The results are expressed as a ratio based upon a value of 2.00 obtained with the regular nylon brush and a $Ca_2P_2O_7$ dentifrice. Enamel and dentin abrasion values were obtained by the well-known basic procedure involving radioactive teeth, with individual exposure times of two and one minute, respectively.

Cleaning, polishing, and abrasion data were obtained in the foregoing manner using bristles containing the abrasive system of Example I, and for comparative purposes non-impregnated bristles were also employed. The brush identified by code A had tufts containing 5 strands each of 8 mil circular nylon filaments containing 10% abrasive and of 12 mil configured nylon filaments containing 2% abrasive. Brush B had tufts containing 4 strands each of 8 mil circular nylon filaments containing 10% abrasive and 12 mil configured nylon filaments without abrasive. Brush C had tufts containing 6 strands of 8 mil circular nylon filaments containing 10% abrasive and 7 strands of 8 mil circular nylon containing no abrasive. The data which are reported in Table II verify that the best results are achieved with brush A, the blend of two different abrasive impregnated filaments which forms the preferred embodiment of this invention.

TABLE II

Brushing system brush	Cleaning data			Polishing data			Abrasion data		
	Dentifrice	Cleaning ratio	Percent change	Dentifrice abrasive	Polishing ratio	Percent change	Dentifrice abrasive	REA (Enamel)	RDA (Dentin)
Regular nylon	$Ca_2P_2O_7$	[a]4.00±0.15	----------	$Ca_2P_2O_7$	2.00±0.36	----------	$Ca_2P_2O_7$	8.00±0.50	650±50
A	$Ca_2P_2O_7$	4.56±0.15	[b]±14.0	$Ca_2P_2O_7$	3.59±0.43	[b]±79.4	$Ca_2P_2O_7$	7.68±0.99	[b]347±36
B	$Ca_2P_2O_7$	4.24±0.25	+6.0	$Ca_2P_2O_7$	2.84±0.58	+41.9	$Ca_2P_2O_7$	[b]5.01±0.67	572±69
C	$Ca_2P_2O_7$	3.25±0.16	−18.7	$Ca_2P_2O_7$	3.64±0.53	[b]+8.9	$Ca_2P_2P_7$	([c])	593±50

[a] Standard error of the mean.
[b] Significantly different from regular nylon brush ($P < 0.05$).
[c] Not available.

Polishing data were also obtained using the usual reflectometer procedure with onyx standard set at 8.5 on a scale of 1 to 10 for a series of brushes formed with tufts of a series of filaments of circular and configured cross sections using different abrasive systems. The enamel sections were dulled, brushed for 4500 strokes with a tension of 150 grams while immersed in an aqueous 1% carboxymethyl cellulose solution, and the polish increment determined.

The usual cleaning procedure was also employed using lacquer-coated polyester blocks. With the onyx standard set at 10.0, the blocks were selected using only blocks with a pre-reading ≥ 8.5. The blocks were then brushed with the respective brushes for 3,000 strokes with a tension of 150 grams while immersed in an aqueous 1% carboxymethyl cellulose solution. The amount of lacquer removed is expressed as a decrement as measured by the reflectometer. Table III gives cleaning and polishing data for these brushes.

TABLE III

Toothbrush identity			Enamel polishing score	Cleaning score
Type of filament	Cleaning and polishing agent — Name	Cleaning and polishing agent — Conc., percent		
Regular nylon			[2]1.40±0.08	1.11±0.27
Circular	Example III	2	2.59±0.43	5.41±0.90
Do	do	5	2.55±0.21	6.52±0.23
Do	do	10	3.66±0.35	7.16±0.32
Do	Example II	2	2.23±0.18	4.62±0.62
Do	do	5	3.13±0.21	4.18±0.57
Do	do	10	5.58±0.53	6.40±0.65
Do	Example I	2	1.79±0.10	5.02±0.54
Do	do	5	3.19±0.27	6.28±0.48
Do	do	10	5.31±0.48	7.70±0.23
Configured nylon	Example III	2	2.13±0.33	4.46±0.45
Do	Example II	2	3.38±0.40	5.97±0.46
Do	Example I	2	2.04±0.11	5.51±0.83
Do	$CaSiO^3$	2	0.53±0.15	1.97±0.36

[2] Standard error of the mean.

The data of Table III verify that, in general, the inclusion of selected abrasives resulted in a significant ($p<0.05$) increase in tooth cleaning and polishing when compared with a comparable non-impregnated bristle toothbrush. Further, cleaning and polishing efficacy appear to be related to the concentration of abrasive in the bristles, but other factors (wear and consumer acceptance) may pose practical limitations on the actual limits on the level of abrasive employed.

Using the foregoing procedures, cleaning and polishing data were obtained for a conventional nylon manual toothbrush (control brush); a nylon bristle brush formed with 8 mil filaments of circular cross section and containing 10% of the Example I abrasive (brush A); a nylon bristle brush formed with bristles configured in the same manner as bristles **52** shown in FIG. 6 and containing the Example I abrasive (brush B); and a brush utilizing equivalent numbers of the bristles from brushes A and B (brush C). The data, which are reported in Table IV, demonstrate that brush C represents a substantial improvement relative to the control brush. Moreover, the wear and consumer acceptance properties of brush C make it preferable to brushes A and B.

TABLE IV

Toothbrush identity	Enamel polishing score	Cleaning score
Regular nylon	[2]1.40±0.08	1.11±0.27
Brush:		
A	4.32±0.51	6.52±0.58
B	2.04±0.11	5.27±0.30
C	2.59±0.44	5.88±0.12

[2] Standard error of the mean.

The cleaning and polishing effectiveness of the brushes of this invention when used on dentures has been demonstrated as follows. Specimens of methyl methacrylate, as commonly used for complete and partial dentures, were prepared using a metal mold. The specimens were rectangular in shape with dimensions of ½ x ½ x ⅜ inches (length x width x height). The specimens were dulled by rubbing on an extra fine emery cloth over a flat surface and the reflectance of the dull surface determined using a reflectometer standardized at 10.0 with an onyx block. The specimens were then brushed with the respective toothbrush in a mechanical brushing machine for 6000 strokes with a tension of 300 grams in the presence of a 2:1 slurry of the denture cleanser. The post treatment reflectance was determined and the increment considered as evidence of the acrylic polishing ability of the system.

Lacquer coated polyester blocks were dried to a constant weight and then brushed with the respective brush in the presence of the denture cleanser using the mechanical brushing machine for 10,000 strokes with a tension of 300 grams. The blocks were subsequently dried and weighed in order to determine the amount of lacquer removed in order to determine cleaning effectiveness. The results are given in Table V.

TABLE V

Toothbrush identity	Denture cleanser abrasive	Acrylic polishing score	Cleaning score, mg. removed
Commercial denture brush (12 mil nylon bristles).	$ZrSiO_4$	[a] 3.18±0.22	2.41±0.08
Soft nylon (8 mil bristles)	$ZrSiO_4$	3.96±0.23	3.26±0.37
10% Example I abrasive in 12 mil nylon.	$ZrSiO_4$	4.38±0.27	3.89±0.17
10% Example I abrasive in 8 mil nylon.	$ZrSiO_4$	5.34±0.09	4.49±0.15

[a] Standard error of the mean.

A comparison based upon equivalent bristle diameters indicates that the impregnated bristle brushes are significantly ($p < 0.01$) superior to conventional nylon with regard to both cleaning and polishing of dentures.

From the foregoing, it can be seen that the brushes containing abrasive containing bristles of the present invention, especially brushes containing a mixture of the two types of bristles as described above, represent a substantial advance in the dental health arts. The use of this implement permits one more efficiently to clean and polish the tooth surfaces so as to remove and inhibit the reformation of plaque, pellicle, and calculus.

Moreover, while the impregnated bristling material of this invention is especially useful when employed in toothbrushes, such bristling material is also of great benefit when used in other types of brushes, such as cleaning brushes, hairbrushes, industrial brushes, and the like. One especially useful non-dental application of this invention is in the fabrication of brushes useful in washing automobiles.

What is claimed is:

1. Bristling material for use in a brush adapted for application to the teeth comprising filaments of plastic material having incorporated therein a dental abrasive selected from the group consisting of zirconium silicate ($ZrSiO_4$); calcium pyrophosphate ($Ca_2P_2O_7$); anhydrous calcium hydrogen phosphate ($CaHPO_4$); calcium hydrogen phosphate dihydrate ($CaHPO_4 \cdot 2H_2O$); insoluble sodium metaphosphate [$(NaPO_3)_x$]; calcium carbonate ($CaCO_3$); alumina (Al_2O_3); talc [$Mg_3Si_4O_{10}(OH)_2$]; tin dioxide (SnO_2); and mixtures thereof, the dental abrasive being present in the filaments at a level of up to about 30% by weight.

2. Bristling material, as claimed in claim **1**, wherein the member is zirconium silicate.

3. Bristling material, as claimed in claim **1**, wherein the member is a mixture of zirconium silicate and tin dioxide.

4. Bristling material, as claimed in claim **1**, wherein the member is a mixture of zirconium silicate and alumina.

5. Bristling material, as claimed in claim **1**, wherein the dental abrasive is present in the filaments at a level of about 2–10% by weight.

6. A brush comprising a brush base and at least one bristle tuft on the brush base, with each bristle tuft including:

at least one first bristle having a generally circular cross section; and

at least one second bristle having a non-circular cross section;

the diameter of each second bristle being substantially greater than the diameter of each first bristle,

the first and second bristles having incorporated therein an abrasive material, with the abrasive material being incorporated in the first bristles at a level of at least about 7.5% by weight and in the second bristles at a level of no more than about 5% by weight.

7. A brush, as claimed in claim **6**, wherein the abrasive material is a dental abrasive selected from the group consisting of zirconium silicate ($ZrSiO_4$); calcium pyrophosphate ($Ca_2P_2O_7$); anhydrous calcium hydrogen phosphate ($CaHPO_4$); calcium hydrogen phosphate dihydrate ($CaHPO_4 \cdot 2H_2O$); insoluble sodium metaphosphate [$(NaPO_3)_x$]; calcium carbonate ($CaCO_3$); alumina (Al_2O_3); talc [$Mg_3Si_4O_{10}(OH)_2$]; tin dioxide (Sno_2); and mixtures thereof.

8. A brush, as claimed in claim **7**, wherein the dental abrasive is zirconium silicate.

9. A brush, as claimed in claim **7**, wherein the dental abrasive is a mixture of zirconium silicate and alumina.

10. A brush, as claimed in claim **7**, where the dental abrasive is a mixture of zirconium silicate and tin dioxide.

11. A brush, as claimed in claim **6**, wherein the abrasive is incorporated in the first bristles at a level of about 10% by weight and in the second bristles at a level of about 2% by weight.

12. A brush, as claimed in claim **6**, wherein the same abrasive is incorporated in the first and second bristles.

13. A brush, as claimed in claim **6**, wherein the first and second bristles are formed of nylon.

14. A brush, as claimed in claim **6**, wherein a plurality of bristle tufts are provided on the brush head and wherein each bristle tuft comprises a plurality of first and a plurality of second bristles.

15. A brush, as claimed in claim **14**, wherein substantially the same number of first and second bristles are provided in each bristle tuft.

16. A brush, as claimed in claim **15**, wherein the first and second bristles are randomly distributed throughout each bristle tuft.

17. A brush, as claimed in claim **6**, wherein the diameter of the first and second bristles differ by about 25–75%.

18. A brush, as claimed in claim **6**, wherein a plurality of longitudinal grooves are provided in the exterior surface of the second bristles.

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15—159 A, 51—295, 395; 424—49

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,613,143 Dated Oct. 19, 1971

Inventor(s) J. C. MUHLER ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 72, "material" should be --materia--;

Column 2, line 46, "parties" should be --particles--;

Column 6, after Table 1, footnote a, "1=1" should be --1:1--;

Column 7, Table II, under heading "Percent change", "±14.0" should be --+14.0--;

Column 8, Table II, under heading "Percent change", "±79.4" should be --+79.4--;

Column 8, Table II, under heading "Percent change", "+8.9" should be --+81.9--; and

Column 10, line 33, "where" should be --wherein--.

Signed and sealed this 11th day of April 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents