

[54] **ABRASIVE-FILLED DENTAL
PROPHYLACTIC CUP**

3,599,333 8/1971 Muhler 32/59

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[57] **ABSTRACT**

[21] Appl. No.: **345,101**

An abrasive-filled, paste-free dental prophylactic cup is formed from a urethane elastomer. The elastomer consists essentially of tolylene diisocyanate endcapped polytetrahydrofuran cured with 4,4'-methylene bis(o-chloroaniline). The elastomer has 25 - 50 percent by weight of pumice added to the elastomer as a dental abrasive. Prophylactic cups formed from the abrasive filled elastomer will perform a suitable dental prophylaxis without the addition of prophylactic paste.

[52] U.S. Cl. 32/59

[51] Int. Cl. A61c 3/06

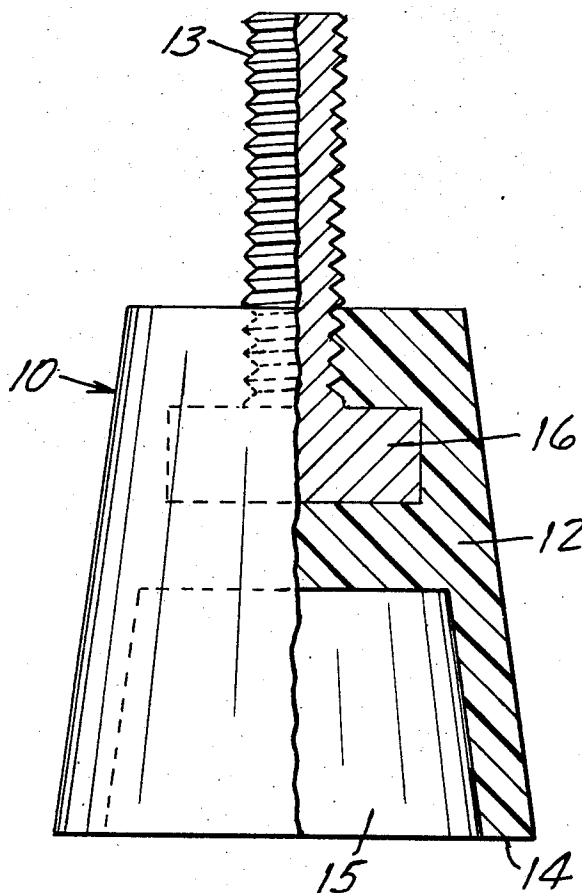
[58] Field of Search 32/58, 59

[56] **References Cited**

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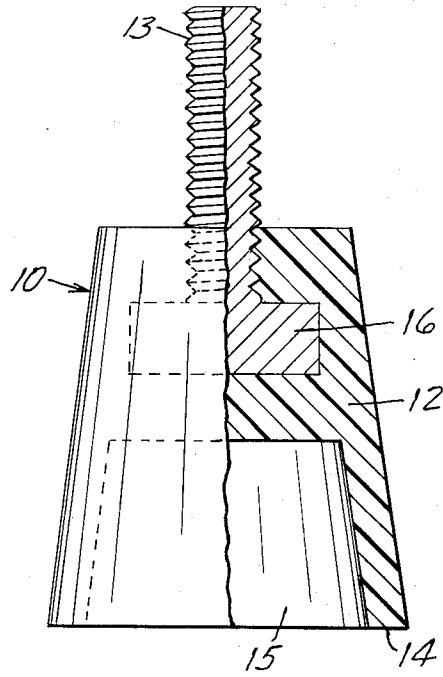
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3 Claims, 1 Drawing Figure



Patented Feb. 5, 1974

3,789,462



ABRASIVE-FILLED DENTAL PROPHYLACTIC CUP

BACKGROUND OF THE INVENTION

1. Field of the Invention

In one aspect this invention relates to abrasive-filled articles. In another aspect this invention relates to dental prophylactic implements such as rubber prophylactic cups.

2. Description of the Prior Art

There are or have been proposed abrasive-filled articles suitable for use in dentistry. Examples of such abrasive-filled implements are presently commercially available cups formed of a relatively rigid matrix material having dispersed throughout a harsh abrasive material forming an aggressive polishing implement suitable for polishing dental amalgams or restoratives. These cups have a relatively harsh abrasive action because the hard resins and amalgams used in dental restorations are difficult to polish. Therefore, these cups are not suitable for cleaning and polishing softer tooth enamel due to high rates of enamel removal and high heat buildup.

It has also been proposed to form a dental prophylactic cup from a flexible material such as butadiene-styrene block copolymers and to disperse therein an abrasive agent such as zirconium silicate or alumina to aid in the cleaning and polishing of teeth, e.g. see U. S. Pat. No. 3,599,333. Such cups are not designed to be used without the addition of prophylaxis paste. Traditionally, dental prophylaxis articles have been cup-shaped, as shown in U. S. Pat. No. 3,599,333, so that they can hold prophylaxis paste for polishing and in addition, the cup shape allows the formation of a lip for cleaning subgingival areas.

It is well known that some strains and pigmentations, which are left on the teeth's enamel after ordinary daily brushing, are resistant to the abrasive combinations found in conventional tooth paste and can not be effectively removed by daily brushing with a tooth brush and tooth paste. As a result, dentists commonly recommend dental prophylaxis at regular intervals, such as once or twice a year, to remove dental calculus and accumulated strains left by daily brushing. The teeth after dental prophylaxis should have high luster and smooth polish for good cosmetic qualities and also a smooth enamel surface which is more resistant to the accumulation of bacterial plaque.

The present state of the art consists of a process involving the application of a prophylactic paste containing an abrasive to a rubber cup, followed by polishing the teeth using the paste and the rubber cup. The art of applying the paste to the cup and then to the teeth is repeated frequently throughout the operation until the patient's teeth have all been cleaned. The present method is wasteful in terms of the dentist's and patient's time. Furthermore, considerable excess paste is spewed onto the dentist, patient, and into the dental equipment used for the cleaning. Because of the scattering of the excess paste, disposable prophylactic angles, a portion of the dental handpiece, are generally used to prevent clogging the damage to the expensive standard dental equipment.

In order to form an acceptable paste-free abrasive cup for dental prophylaxis, the finished cup should perform an acceptable prophylaxis with water alone and without the use of a separate prophylactic paste when

used on mouths having mild to moderate stains and plaque. In mouths with heavily stained teeth the use of a prophylactic paste with the abrasive cup may be necessary due to the severe cleaning requirements.

Another feature associated with a suitable abrasive-filled, paste-free prophylactic cup is the formation of a lip when a mild compressive force is applied to the cup. Lip formation is necessary for the cleaning of subgingival areas, and for adequate conformability of the cup to the irregular surfaces of the teeth.

A further desirable feature in a dental prophylactic cup is the ability to clean one mouth without mechanical failure requiring replacement. Also, the cup should not undergo a loss of cleaning effectiveness during the cleaning procedure.

The abrasive-filled dental cups presently available which would not require the addition of paste for average cleaning conditions are highly abrasive and useful only for polishing dental amalgams. Use of these cups to polish teeth would result in the abrasion of undesirably large amounts of tooth enamel and also the buildup of high temperatures in the tooth dentine due to the heat generated by the highly abrasive cups. Therefore, they are not used for prophylactic cleaning procedures.

SUMMARY OF THE INVENTION

I have discovered that an abrasive-loaded, paste-free dental prophylactic cup can be formed from a shaped body of resilient, elastomeric urethane material containing pumice uniformly dispersed therein. The shaped body has a mandrel and shaft or other means for removably mounting said body on a dental handpiece and is formed around said shaft from a urethane elastomer consisting essentially of 40 - 65 parts by weight of a tolylene diisocyanate endcapped polytetrahydrofuran having about 2.8 percent by weight isocyanate, cured by the use of 4,4'-methylene bis (o-chloroaniline). About 25 - 50 percent by weight of pumice is used as the abrasive. The abrasive-loaded cup formed from these ingredients is suitable for performing dental prophylaxis under average conditions without the use of additional dental prophylactic paste. The cup may also contain from about 0.05 to 2 parts by weight of a coloring pigment and preferably contains small amounts of a complex organic phosphoric acid plasticizer.

DESCRIPTION OF THE DRAWING

A further understanding may be had by referring to the accompanying drawing in which:

FIG. 1 is a view in elevation and partial section of the prophylactic cup of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the accompanying drawing a dental prophylactic cup 10 is formed from an abrasive-filled elastomeric urethane material 12. The elastomeric material 12 has sufficient flexibility so that when pressure is applied to cup 10 edge 14 will deform to form a lip, that is edge 14 does not roll under but spreads and rolls outwardly so the interior surface 15 of the cup contacts the tooth to be cleaned, and the edge is also available for cleaning subgingival areas. The cup has means 13, here a threaded stud, for attachment to a dental handpiece

(not shown). The threaded stud 13 is anchored in the elastomeric material by means of a head 16.

Numerous elastomeric materials have been used or proposed heretofore for use in dental prophylaxis cups, e.g. natural and synthetic rubbers, or plastics such as polyamides, flexible polystyrene, polyethylene, polypropylene, and the like. Also suggested have been butadiene-styrene block copolymers such as those available under the trademark "Thermolastic," see U. S. Pat. No. 3,599,333. These materials while suitable for dental prophylactic cups used with paste do not provide the necessary mechanical properties for a paste-free cup having a high percentage of abrasive material evenly dispersed throughout.

In my invention, I use a urethane-type elastomer, such elastomers having excellent abrasion resistance and being suitable for forming a prophylactic cup even when the cup contains as much as 50 percent by weight of a dental abrasive. The abrasive-loaded material forms a cup suitable for cleaning the irregular surfaces of teeth and the subgingival areas.

Several abrasives have been used in dental cleaning and polishing, such as zirconium silicate and alumina as well as the commonly known and widely used pumice. Zirconium silicate and alumina when used with the urethane elastomer disclosed hereinbefore do not form cups which have the required flexibility and abrasion resistance. In addition, high concentrations of zirconium silicate and alumina in the prophylactic cup result in severe scratching and abrasion to the tooth enamel. However, pumice when used in combination with the urethane elastomer disclosed hereinbefore, cooperates with the elastomer to form a prophylactic cup suitable for paste-free dental prophylaxis.

In producing the abrasive-filled elastomer, the pumice to be incorporated can be added directly to and mixed with the liquid isocyanate-terminated polytetrahydrofuran. Thereafter, the curing agent is added. The resulting mixture cures to form an abrasive-filled elastomeric material having the pumice evenly dispersed. The pumice will generally have an average particle size from about 10 to 200 microns, the larger particles providing faster cleaning and the smaller particles providing a smoother polished enamel surface. Pumice having an average particle size of from 25 to 50 microns provides a particularly desirable combination of rapid cleaning speed and smooth polish.

The cured abrasive-filled elastomeric material is formed into prophylactic cups of the desired shape by techniques well known in the art, e.g. compression or injection molding. Additives may also be added to the basic abrasive-elastomer mixture disclosed hereinbefore to develop desirable mechanical properties.

A particularly preferred additive, which brings about further improvement in the cups of this invention), is a plasticizer such as a complex organic phosphoric acid similar to the one sold under the tradename "Gafstat" AD-510. The complex organic phosphoric acid serves as a wetting agent, plasticizer, catalyst and coupling agent thereby improving the mechanical properties of the abrasive-filled urethane elastomer. Also, pigments such as titanium dioxide or copper phthalocyanine can be added to the starting materials to provide a cup having a pleasing and more esthetic color.

A further understanding may be had by reference to the following nonlimiting examples in which all parts are by weight. In the following examples, the pigments

and abrasive were milled into the premixed molten coreactants, the coreactants comprising a tolylene diisocyanate endcapped polytetrahydrofuran and 4,4'-methylene bis(o-chloroaniline). The resulting abrasive-filled elastomer was compression molded into prophylactic cups having a structure similar to FIG. 1. The abrasive particle size used is an average of the distribution as received.

In order to test the prophylactic cups it was felt that the development of a standard test suitable for laboratory use was desirable. The prophylactic cups were laboratory tested for their cleaning efficiency by spinning the formed cups against a lacquered metal surface, at 1,750 revolutions per minute with an impressed load of one pound while the metal and cup were immersed in water. The lacquer was 0.5 mils thick and had a 4H pencil hardness.

The removal rate of lacquer was equated with in vivo cleaning through clinical evaluations of cups having the same properties as the laboratory tested cups. Any cup requiring greater than 30 seconds for lacquer removal was found to be inadequate, for the clinical tests showed these cups required excessive cleaning time and lacked cleaning ability.

As a measure of present art acceptability a commonly used prophylactic paste, "Nupro." Dental Prophylaxis Paste (a trademarked product of Janar and Co.) in combination with a standard prophylactic rubber cup, BS Cups, Young Dental Manufacturing, was used under the same laboratory conditions as the abrasively loaded cups of this invention. The prophylaxis paste and cup removed the lacquer in approximately 10 seconds.

The cups were further subjected to a second laboratory test to determine their mechanical strength. In this test, the cups were rotated at 1,750 revolutions per minute on a 400 grit silicone carbide paper under a 2 pound load. The cups were visually checked at 30 second intervals up to 90 seconds for tearing, loss of lip formation, or general disintegration. Cups showing visual degeneration in less than 90 seconds were considered less desirable, inasmuch as clinical evaluation showed cups which did not withstand 90 seconds of this test generally would not clean one entire mouth. Cups which do not withstand 90 seconds of this test will provide a suitable prophylaxis for mildly stained teeth. Also in many cases more than one cup can be used.

EXAMPLE 1

A urethane elastomer was formed from 10 parts of tolylene diisocyanate endcapped polytetrahydrofuran, having 2.8 percent by weight isocyanate, (available as "Adiprene" L-42), and 0.88 part of 4,4'-methylene bis(o-chloroaniline), (available as "MOCA"). Also, 0.5 parts of a complex organic phosphoric acid, (available as "Gafstat" AD-510), was added as a wetting agent and plasticizer to the liquid coreactants. For color, 0.4 parts of titanium dioxide pigment, (available as RF-30 from the Cabot Corp.) and 0.02 part of copper phthalocyanine was added. Ten parts of a fine pumice powder having an average diameter of 55 microns was added to the liquid formation and the ingredients molded to form prophylactic cups like FIG. 1. The prophylactic cups formed from the formulations of this example removed lacquer in approximately 10 seconds and withstood more than 90 seconds of abrasion when tested by the laboratory tests. Clinical evaluation by dentists and dental hygienists confirmed the laboratory

test results that these cups were acceptable by cleaning one mouth without the addition of prophylactic paste.

In additional cups, the parts by weight of pumice was varied from 4 parts to 15 parts representing 25 to 56 percent by weight of abrasive. Below the 25 percent

coreactant, hereinafter referred to as Type B. Ten parts of abrasive were used in all runs and the other materials remained the same as in Example 1.

The formulations and test results, both laboratory and clinical, are given in Table I.

TABLE I

Run No.	Elastomer		Abrasive		Lacquer removal	Mechanical strength	Clinical evaluation
	Type	Parts	Type	Size, microns			
1.....	B	12.2	Pumice...	55	None.....	Good.....	Inadequate cleaning.
2.....	A	11.7	Al ₂ O ₃	5		<30 seconds...	Inadequate cleaning life.
3.....	A	11.7	Al ₂ O ₃	20		do.....	Do.
4.....	A	11.7	Al ₂ O ₃	50		do.....	Do.
5.....	B	12.2	Al ₂ O ₃	5	Not adequate...	Good.....	Inadequate cleaning.
6.....	B	12.2	Al ₂ O ₃	20	do.....	do.....	Do.
7.....	B	12.2	Al ₂ O ₃	50	do.....	do.....	Do.
8.....	A	11.7	ZrSiO ₄	13		<30 seconds...	Do.
9.....	B	12.2	ZrSiO ₄	13	Not adequate...	Good.....	Do.

weight level the cups failed the laboratory tests and clinical testing because they were too flexible and did not provide sufficient abrasion to properly clean the teeth. At the 56 weight percent loading the cups were mechanically too rigid for in vivo use and did not form a lip suitable for cleaning subgingival areas and the irregular surfaces of teeth; although, the cups did clean rapidly and were otherwise acceptable in terms of cleaning performance.

When the organic phosphoric acid was omitted from the elastomer of this example the resulting cups cleaned satisfactorily, but two cups would be required for the complete cleaning of one mouth in some cases.

EXAMPLE 2

Example 1 was repeated with the substitution of "flour of pumice," having a particle size of approximately 28 microns. The lacquer removal time was approximately 20 seconds, slightly lower than the cups of Example 1, but with no change in the mechanical performance or clinical acceptability of the cups.

EXAMPLE 3

Example 1 was repeated with the substitution of course pumice, having a particle size of approximately 225 microns. The lacquer removal time was approximately 10 seconds with mechanical performance approximately equivalent to the cups formed in Example 1.

EXAMPLE 4

Cups having a configuration like FIG. 1 were formed using two different elastomeric compositions and various types and sizes of abrasives. One elastomer was the composition of Example 1 hereinafter referred to as Type A. The second elastomer was a formulation comprising: 10 parts of a tolyene diisocyanate endcapped tetrahydrofuran having a 4.1 percent by weight isocyanate and 1.31 parts 4,4'-methylene bis(o-chloroaniline)

The cups made using elastomer type B were strong due to the high concentration of isocyanate in the starting material. However, elastomer B held the abrasive particles so tightly that no abrasive was released during cleaning; therefore, the cups made with elastomer B did not clean adequately.

Thus it is shown that the substitution of elastomers and abrasives, other than the preferred urethane elastomer and pumice to form an abrasive-filled prophylaxis cup results in a prophylaxis cup deficient in cleaning and/or mechanical strength.

What is claimed is:

1. In an abrasive-loaded, paste-free dental prophylactic cup suitable for being removably mounted on a dental handpiece, comprising a shaped body of resilient, abrasive, elastomeric material containing a dental cleaning and polishing agent uniformly dispersed therein, said shaped body being suitable for performing dental prophylaxis cleaning and having means for removably mounting said shaped body on a dental handpiece, the improvement which comprises:

using as said resilient material an elastomer consisting essentially of 40 to 65 parts by weight of tolylene diisocyanate endcapped polytetrahydrofuran having about 2.8 percent by weight isocyanate, said endcapped polytetrahydrofuran being cured with 4,4'-methylene bis(o-chloroaniline) and using as said cleaning and polishing agent, 25 to 50 percent by weight of finely divided pumice;

whereby said abrasive-loaded cup is suitable for performing dental prophylaxis without additional dental abrasive paste.

2. The abrasive-filled prophylactic cup of claim 1, containing a complex organic phosphoric acid as a plasticizer.

3. The abrasive-filled prophylactic cup of claim 1, containing from 0.05 to 2.0 parts of a coloring pigment.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,789,462

Dated February 5, 1974

Inventor(s) Charles Reich

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

Line 53, Col. 1 should read "act" instead of "art".

Line 63, Col. 1, 1st occurrence should read "and" instead of "-- the --".

Col. 4, Line 43 should read "mouth" instead of "Mouth".

Signed and sealed this 17th day of September 1974.

(SEAL)

Attest:

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