Jan. 16, 1962 R. O. PETERSON 3,016,554

BRUSH MATERIAL AND BRUSH

Filed May 12, 1958

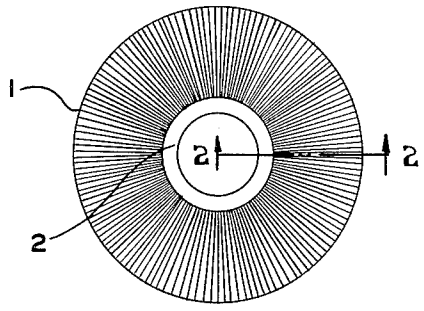

Fig. 1

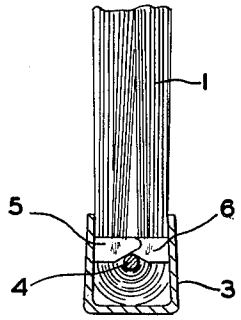

Fig. 2

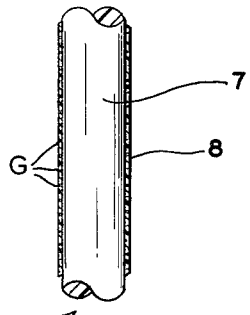

Fig. 3

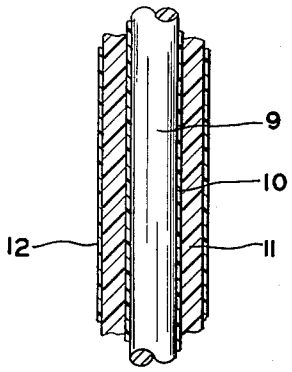

Fig. 4

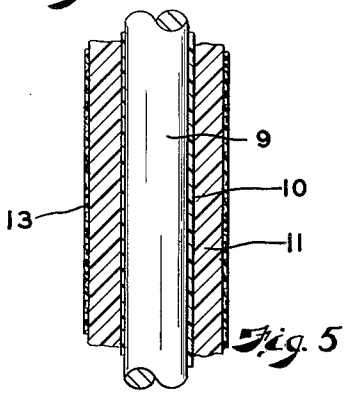

Fig. 5

Fig. 3a

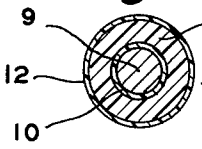

Fig. 4a

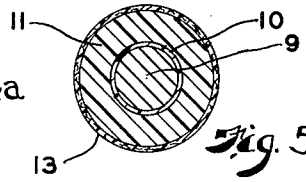

Fig. 5a

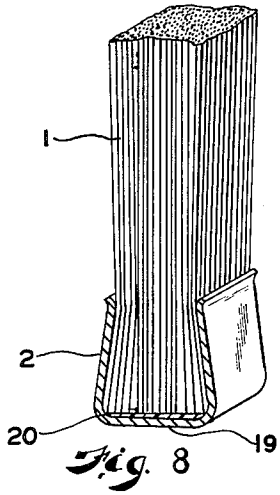

Fig. 8

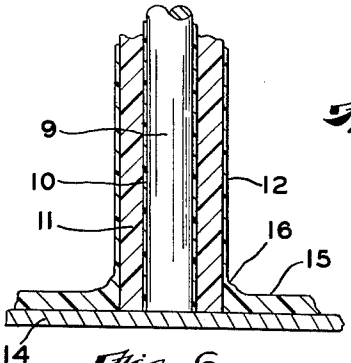

Fig. 6

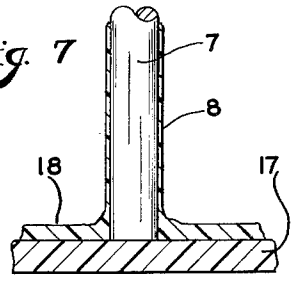

Fig. 7

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3,016,554

BRUSH MATERIAL AND BRUSH

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13 Claims. (Cl. 15—159)

This invention relates as indicated to novel brush material and a brush utilizing the same, and more particularly to brushes having filamentous brush bristles provided with individual protective coatings which may also be utilized to assist in securing such bristles to an appropriate base or support.

In my prior application Serial No. 416,989, filed March 18, 1954, for "Brush and Brush Material," now Patent No. 2,845,648, I disclose filamentous brush bristles which may, for example, comprise a wire core with an outer nylon coating thereon, such outer coating serving to protect such core and also to assist in bonding the inner ends of the bristles to a plastic layer on the brush back or equivalent support. Plastic coating materials such as nylon which are suitable for damping vibration and otherwise enhancing the life and effectiveness of the brush bristle material are, however, susceptible to certain types of chemical attack often encountered under operating conditions, and it is accordingly an important object of this invention to provide brush bristle material which may be of plastic such as nylon or the like, or of nylon coated wire or other filaments, which have been treated to resist such chemical attack.

Another object is to provide such novel brush material in which a thin outer protective coating thereon is bonded to a layer of like material on an appropriate base or support, thereby to form a brush element.

Still another object is to provide such brush material in which the thin outer protective coating is modified both to enhance its resistance to chemical attack and also its resistance to mechanical abrasion during operation of the brush.

Other objects of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 shows a rotary brush employing brush bristle material of this invention;

FIG. 2 is a transverse cross-section through brush strip of the general type shown and described in my prior Patent 2,303,386, likewise adapted to utilize brush bristle material of this invention;

FIG. 3 is a longitudinal sectional view on a much enlarged scale of a portion of a plastic monofilament such as nylon having a thin surface coating of an epoxy resin bonded thereto;

FIG. 3*a* is a transverse section of the FIG. 3 brush bristle;

FIG. 4 is a longitudinal sectional view of a metal wire monofilament provided with a protective layer of vibration damping plastic and a relatively thin outer coating of a resin composition of a type which will adhere to such plastic layer and form a substantially continuous film protecting such plastic against chemical attack;

FIG. 4*a* is a transverse section of the composite brush bristle of FIG. 4;

FIG. 5 is a longitudinal sectional view of a composite

brush bristle of the FIG. 4 type in which the thin outer protective coating includes additional material, preferably in the form of flakes of such material, effective to enhance the resistance of the latter both to chemical attack and mechanical abrasion;

FIG. 5*a* is a transverse section through the composite brush bristle of FIG. 5;

FIG. 6 is a sectional view illustrating the manner in which the composite brush bristle of FIG. 4 may be secured to an appropriate support or brush back;

FIG. 7 is a sectional view showing the brush bristle of FIG. 3 secured to an appropriate support; and

FIG. 8 is a transverse section through a length of strip having a channelform outer back and brush bristle material in accordance with this invention secured therein by an appropriate bonding agent.

Referring now more particularly to such drawing and especially FIGS. 1 and 2 thereof, the novel brush bristles of this invention may be utilized in any type of brush including hand brushes such as scrub brushes and also power driven rotary brushes having industrial applications. Thus, the brush bristle material **1** may be secured within an annular sheet metal hub **2** in the manner shown in Whittle Patent No. 2,288,337, for such brush material may be secured in a sheet metal channelform back **3** by being doubled around a retaining wire **4** held therewithin beneath pairs of teeth **5** and **6** punched in from the respective sides of the channel back as explained in detail in Peterson Patent 2,303,386. As will be explained below, however, my new brush bristle material is especially adapted for bonding to an appropriate base or support in a manner frequently eliminating the necessity for any auxiliary bristle retaining means.

Referring now to FIGS. 3 and 3*a*, the brush bristle of my invention there illustrated comprises an elongated monofilament **7** which may be of nylon (polyamide resins), for example, or of such other materials as the vinyl plastics (vinyl polymers and copolymers), trifluorochloroethylene polymer, neoprene (polychloroprene), Hycar (modified copolymers of butadiene and acrylonitrile), rubber, and melamine resins (melamine-formaldehyde reaction products), particularly when these latter materials have been compounded to exhibit properties similar to those of nylon. A relatively thin outer coating **8** of an epoxy resin composition is applied thereon which bonds very firmly to the underlying nylon or equivalent plastic filament and is much more resistant to chemical attack. Finely divided graphite particles G may also be incorporated in the thin outer epoxy resins composition coating both to enhance the chemical resistance of such coating and also to reduce friction between adjacent brush bristles.

As shown in FIGS. 4 and 4*a*, the brush bristle may comprise a central wire core **9** having a very thin coating of an adhesive material such as an epoxy resin composition **10** thereon serving to bond a thicker vibration damping plastic layer **11** thereto, such layer **11** ordinarily being one of the materials referred to above as constituting the monofilaments **7** of the FIG. 3 embodiment and generally preferably nylon. The epoxy resin composition bonds very firmly both to metal surfaces such as steel wire and also to nylon. A further thin epoxy resin composition coating **12** is applied to the outer surface of the nylon layer **11** to protect the latter against chemical attack. Such epoxy resin composition coating **12** will desirably be very thin but sufficient to ensure a continuous layer. The nyon layer **11** will generally be of a thickness about one half the diameter of the wire core **9** plus or minus 50%.

In the embodiment of the invention shown in FIGS. 5 and 5*a*, the wire core **9**, thin epoxy resin composition

coating 10, and nylon or similar plastic layer 11 may correspond to the above-described FIG. 4 embodiment, but the thin outer epoxy resin composition coating 13 has incorporated therein finely divided graphite preferably in relatively small thin flake form in an amount up to approximately 40% effective substantially to enhance the chemical resistance of such coating and also substantially to reduce friction between adjacent brush bristles when such brushes are operated at high speeds in use. Under many operating conditions, power driven rotary brushes such as the typical brush illustrated in FIG. 1 generate considerable heat due to the rubbing of the brush bristles against one another as they are flexed upon engagement with the work, this being in addition to heat generated internally of the bristles through flexing of the same and of the heat generated through frictional engagement with the work itself. When utilizing composite bristles of the types shown in FIGS. 3 and 4, for example, having thin outer coatings of epoxy resin compositions, the latter may be abraded and worn through in local regions due to such rubbing of the bristles against one another and thereupon become subject to localized chemical attack which may result in weakening and long fracture of the bristles. The life of the brush is consequently much shortened due to fracture and breaking off of long pieces of the brush material instead of merely wearing back gradually at the brushing face. The provision of graphite and/or other chemically resistant flaky material in the thin outer epoxy resin composition coating, however, much reduces the friction between the bristles so that the brushing action of the brush is enhanced, generation of heat is reduced and abrasion of the thin outer protective coating is likewise reduced, producing a longer lived brush. The graphite, of course, also enhances the resistance of the outer surface of the composite bristle to chemical attack.

Because epoxy resin compositions generally bond very readily and strongly to metal surfaces such as steel surfaces and also to plastic materials such as nylon, I am enabled to secure my new brush bristle material to appropriate supports or bases in a manner somewhat comparable to that disclosed in my prior application Serial No. 416,989 identified above, but superior thereto in that only a thin layer of the epoxy resin composition need be utilized to secure a strong bond. As shown in FIG. 6, the composite bristle of FIG. 4, for example, may be secured to a thin flat steel strip 14 by means of a surface coating 15 of epoxy resin composition applied to the latter. When the base 14 and epoxy resin composition layer 15 are heated, the latter becomes momentarily liquid, forming a slight meniscus 16 about the base of the composite bristle and merging integrally with the thin epoxy resin composition coating 12 of the bristle. Of course, it quickly solidifies or sets as the cure is completed and the bristle is thus very firmly attached to the sheet metal back 14. Inasmuch as the epoxy resin composition will not only thus merge with the outer epoxy resin composition coating 12 but will also bond strongly to any portion of the nylon layer 11 and inner wire core 9 which may be exposed thereto, it is apparent that the bristle is most strongly attached. Due to the resistance of epoxy resin compositions to chemical attack, there is also no tendency for liquids to work under the bristle ends gradually to loosen the latter.

The composite filaments or brush bristles of my invention may likewise be secured to other types of base matereials such as the nylon sheet base 17 of FIG. 7. Here, the epoxy resin composition layer 18 applied to the surface of such nylon sheet upon being heated and cured both merges with the thin outer coating 8 on the nylon bristle filament 7 (see FIG. 3) and also bonds firmly to the nylon sheet base 17 and the inner end of the nylon filament itself. It will, of course, be understood that large numbers of such composite brush bristles are thus affixed to an appropriate base, either in densely packed

or in predetermined spaced relationship. A typical example is illustrated in FIG. 8 where the inner ends of the brush bristles 1, which may be of any of the types described above, are bonded to the bottom 19 of the sheet metal channelform back 2 by means of a thin coating 20 of epoxy resin composition on the inner bottom of such brush strip channel back. With this construction, it is not ordinarily necessary or desirable to employ supplemental brush material retaining means such as those illustrated in FIG. 2 and the brush element may be circulated to form annular rotary brush sections such as that of FIG. 1, wound helically to produce cylindrical rotary brushes or mounted in a wide variety of other ways well known in the art.

A wide variety of different bristle core materials may be employed including nylon, steel wire, stainless steel wire, copper wire, glass fiber, Tampico fiber, and certain types of braided cord, but the invention is principally concerned with the protection of bristles which are of plastic material or coated with plastic material such as nylon from chemical attack under operating conditions as well as securing such bristles to appropriate bases or supports in a superior manner. The inner layers 10 of epoxy resin composition employed to bond the nylon to the wire core will be very thin but should desirably be substantially continuous. The outer epoxy resin composition coatings 8, 12 and 13 should be as thin as possible and yet provide substantially continuous protection to the underlying material. The epoxy resin composition wets both the composite brush bristles and the supporting base in a manner to afford a secure bond thereto as well as the aforesaid meniscus 16 which assists in supporting the inner ends of the bristles.

When utilizing wire as the core 9 of my new composite bristles, such wire may be of exceptional hardness, having a Knoop hardness of 700 or more, and yet be suitable for relatively hard usage without an excessive tendency toward long fracture in view of the vibration damping action of the nylon layer 11 and the chemical protection afforded by the epoxy resin composition layers. Examples of such hard wire core materials include hard wire (severe quench and a minimum draw-back), beryllium copper wire, stainless steel wire, and "Z" nickel wire (hard drawn, heat treated, relatively pure nickel). Such wire cores will ordinarily be in the form of monofilaments.

The epoxy resin composition coatings may be applied by dipping, and the plastic layers 11 such as nylon may desirably be applied by extrusion or any other suitable method. Epoxy resins (condensation polymers containing the epoxide group) are commercially available from Shell Chemical Company under the name "Epon resins." Compositions containing such resins can be made to bond to nylon in molten condition without frothing since no volatiles are involved. Nor does the epoxy resin composition layer adhered to the steel bristle core evolve gases when overlaid with molten nylon. For many purposes, it is preferred that the brush bristle material be crimped both to minimize local stress concentrations in use and also to enable the bristles better mutually to support one another, and to afford a somewhat less dense and solid working face to the brush element.

In addition to the finely divided flaky graphite which may desirably be incorporated in the outer protective coating or film 13, other protective materials such as ground mica, vermiculite, powderous aluminum oxide, titanium oxide, and clay may be utilized alone or in combination. It is preferred first to apply the thin outer protective film of epoxy resin composition or the like and then while it is still wet, dust on the material such as graphite. By this procedure the surfaces are more uniformly wet and coated with the epoxy resin composition or equivalent and the graphite or equivalent tends to adhere thereto as an outer film or layer which is both chemically resistant and also has desirable physical properties as explained above. The flaky graphite is consider-

ably preferred for most purposes. It is interesting to note that when a typical hard, bare, low damping capacity wire bristle is bent to hairpin shape as for mounting in a characteristic brush back, but not beyond its elastic limit, and subjected to the action of acids in concentrations, slightly greater than actually contact such bristles in use in a brush, the bristle will break in the region of high stress concentration after only a few minutes' exposure.

When such bristle has a protective layer of nylon bonded thereto, however, fracture under such conditions will be delayed about 24 hours. When such nylon coated bristle is further coated with a thin outer film of epoxy resin composition, fracture under such conditions will be delayed about 48 hours. And when such epoxy resin composition film has dusted thereon and bonded thereto an outer layer of flaky graphite, fracture will not take place until about 72 hours after exposure. Inasmuch as such tests involve certain conditions tending to accelerate fracture relative to the time required under normal working conditions, they reveal relative values rather than absolute values. Brushes treated in accordance with this invention are particularly suitable for performing brushing operations under wet conditions, including acid or alkaline conditions.

Epon resins may have suitable amines added thereto to make them more effective as adhesives, such as polyamids commercially available from General Mills as Versamid 100, Versamid 115, and Versamid 125. Aliphatic amines such as triethylamine and dicyandiamide may also be employed. Plasticizers such as polysulfides may desirably be included, for example Thiokol polysulfide available commercially from Thiokol Corporation.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A rotary brush having an annular sheet metal channelform back opening radially outwardly and brush bristle material secured therein and extending radially outwardly therefrom, said brush bristle material comprising filaments at least partially of plastic, with a thin outer epoxy resin composition coating on said plastic effective to protect the latter against chemical attack, graphite being included in said coating effective to reduce friction between adjacent bristles.

2. A rotary brush having an annular sheet metal channelform back opening radially outwardly and brush bristle material secured therein and extending radially outwardly therefrom, said brush bristle material comprising filaments at least partially of plastic, with a thin outer epoxy resin composition coating on said plastic effective to protect the latter against chemical attack, the inner ends of said brush bristles being bonded to the inner bottom surface of said channelform back by an epoxy resin composition layer bonded thereto and integrally merging with said thin outer epoxy resin composition coatings on said bristles.

3. Brush bristle material comprising a plastic monofilament and a thin outer coating of epoxy resin composition effective to protect said monofilament against chemical attack, said outer coating including graphite incorporated therein effective to reduce friction between adjacnt bristles when used in a brush.

4. Brush bristle material comprising a metal wire core, a vibration damping layer of plastic bonded thereon by a thin interposed layer of epoxy resin composition, and a thin but substantially continuous outer coating of a protective epoxy resin composition overlying said plastic layer, said outer coating including graphite incorporated therein effective to reduce friction between adjacent bristles when used in a brush.

5. Brush bristle material comprising a metal wire core, a vibration damping layer of plastic bonded thereon by a thin interposed layer of epoxy resin composition, and a thin but substantially continuous outer coating of a protective epoxy resin composition overlying said plastic layer, said core being crimped steel wire, said vibration damping layer of plastic being nylon, and said outer coating including graphite incorporated therein effective to reduce friction between adjacent bristles when used in a brush.

6. A brush element comprising a brush back and a plurality of brush bristles secured thereto comprising plastic filaments having a thin outer coating of epoxy resin composition, the inner ends of said bristles being bonded to said back by a layer of epoxy resin composition on the latter integrally merged with said outer epoxy resin composition coating.

7. The brush element of claim 6 wherein said back comprises a sheet metal channel with said brush material thus bonded to the inner bottom surface thereof.

8. A brush element comprising a brush back and a plurality of brush bristles secured thereto comprising plastid filaments having a thin outer coating of epoxy resin composition, said outer coating including graphite therein to reduce friction between adjacent bristles in use.

9. A brush element comprising a channelform sheet metal brush back and brush bristle material secured therein and extending therefrom; said brush bristles comprising a steel wire core, a vibration damping layer of nylon bonded thereon by a thin interposed layer of epoxy resin composition, and a thin but substantially continuous outer coating of protective epoxy resin composition overlying satid nylon layer; the inner ends of said bristles being bonded to the inner bottom surface of said channelform back by a thin layer of epoxy resin composition on the latter integrally merged with said outer epoxy resin composition coatings on said bristles.

10. A brush element comprising a channelform sheet metal brush back and brush bristle material secured therein and extending therefrom; said brush bristles comprising a glass fiber core, a vibration damping layer of nylon thereon, and a thin but substantially continuous outer coating of protective epoxy resin composition overlying said nylon layer; the inner ends of said bristles being bonded to the inner bottom surfaces of said channelform back by a thin layer of epoxy resin composition on the latter integrally merged with said outer epoxy resin composition coatings on said bristles.

11. Brush bristle material comprising a glass fiber core, a nylon coating thereon of substantial thickness, and a thin but substantially continuous outer coating of a protective epoxy resin composition overlying said nylon layer, said outer epoxy resin composition coating also including graphite effective to reduce friction between adjacent bristles when used in a brush.

12. A rotary brush having a rotatable hub and brush bristles extending outwardly therefrom, said bristles having a thin layer of substantially chemically inert smooth discrete particles bonded to their respective outer surfaces, said particles being small flakes of graphite and the bonding agent being an epoxy resin composition.

13. A rotary brush having a rotatable hub and brush bristles extending outwardly therefrom, said bristles having a thin layer of substantially chemically inert smooth discrete particles bonded to their respective outer surfaces, said particles being small flakes of graphite.

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