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V. K. CHARVAT

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SELF-REGULATING COMPOSITE BRUSHING TOOL

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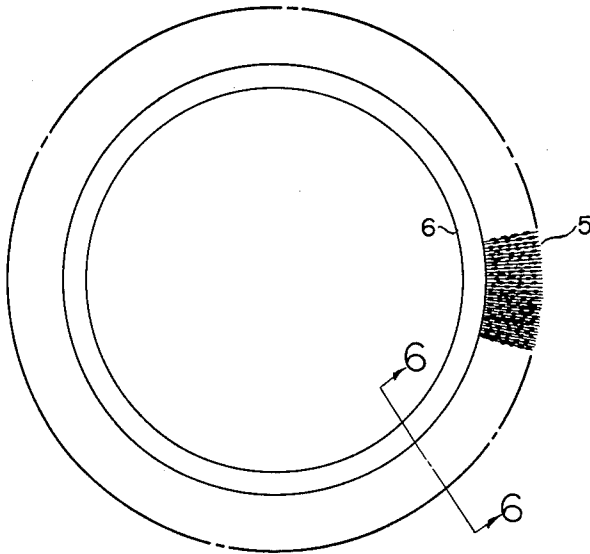


FIG 1

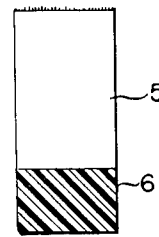


FIG 6

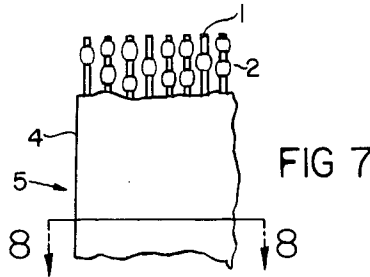


FIG 7

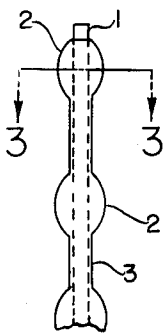


FIG 2



FIG 3

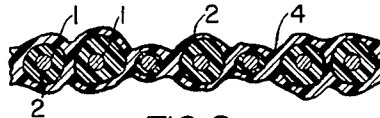


FIG 8

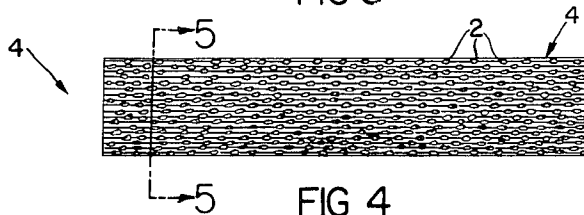


FIG 4



FIG 5

INVENTOR.  
VERNON K. CHARVAT  
BY

*Oberlin, Maky & Donnelly*  
ATTORNEYS

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## 3,233,271 SELF-REGULATING COMPOSITE BRUSHING TOOL

Vernon K. Charvat, Bay Village, Ohio, assignor to The Osborn Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

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8 Claims. (Cl. 15—179)

This application is a continuation-in-part of my co-pending application Serial No. 113,838, filed May 31, 1961, now Patent No. 3,134,122.

This invention relates as indicated to a self-regulating brushing tool, and more particularly to a power driven rotary brush, the bristles of which are assembled and treated in a novel manner to enhance the effectiveness of the tool.

By assembling a plurality of generally parallel brush bristles such as wire monofilaments in slightly spaced side-by-side relationship and interconnecting the same by means of a generally continuous layer of flexible plastic, brushing fingers may be produced which when assembled into an annular back, for example, provide a rotary brush having certain very desirable characteristics. In the first place, by thus embedding the bristles in the flexible plastic, it becomes feasible to employ quite hard bristle materials such as steel wire having a Knoop hardness of 700, without danger of excessive long fracture of the bristles and consequent rapid disintegration of the brush in use. Such hard bristle material, of course, is capable of much more rapid cutting action on the work than are bristle materials conventionally employed.

Furthermore, by thus incorporating the bristles in relatively thin, generally flat flexible plastic fingers, such bristles may still be permitted to flex substantially throughout their length in contrast to certain other brushing tools wherein the bristles may be substantially entirely embedded in a large body of elastomeric material.

It is preferred to employ straight bristle material rather than the commonly employed crimped wire for several reasons including the fact that very hard wire bristles are not capable of being satisfactorily crimped. It is also preferred that the bristles extend substantially radially outward from a central rotatable hub in the case of wheel brushes, for example, and when crimped wire bristles are employed, the working ends of certain of the bristles will be inclined in the direction of rotation of the tool and will therefore gouge the work, whereas the working ends of certain of the other bristles will be rearwardly inclined and will simply drag across the work surface.

When very hard brush bristles are embedded in relatively thin flexible plastic fingers, they may nevertheless occasionally break at points substantially spaced from their outer working ends but the plastic material may still suffice to retain the broken portions in the brush. When operating at high speeds of rotation and when a number of the hard bristles break, however, there may be danger of a substantial portion of a brushing finger breaking out of the brush, and it is an object of the present invention so to modify such fingers as to reinforce the same for retention in the brush in the event of long fracture of the hard bristles contained within such fingers.

Another object is to provide modified flexible brushing fingers having straight parallel brush filaments embedded therein, which fingers have modified surface contours assisting in securing such fingers together in a central assembly and also in affording an improved brushing action.

Still another object is to provide a brushing tool wherein the bristles and especially hard monofilaments are mount-

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ed in a manner facilitating their controlled flexing in the direction of rotation of the brushing tool while at the same time greatly limiting lateral movement of such filaments.

Another object is to provide a brushing tool of the type indicated, in which brush bristle material of a very high Knoop hardness but relatively low fatigue strength is associated with much more ductile brush filaments of much greater fatigue strength embedded in the same flexible plastic fingers in substantial parallelism longitudinally of the fingers, to achieve a combination of desirable characteristics.

A further object is to provide an annular rotary brush section having a support portion and brush material extending radially outwardly therefrom so formed and proportioned that when a plurality of such brush sections are assembled in closely packed axial alignment there will be no appreciable regions of reduced bristle density in the resultant cylindrical brush face corresponding to the regions of lateral interface contact of the annular supports.

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 herein-after 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 is an end view of a power driven rotary brush representing a preferred embodiment of the principles of this invention;

FIG. 2 is an enlarged fragmentary semi-diagrammatic view of a modified brush bristle adapted to be employed in forming the brushing fingers of this invention;

FIG. 3 is a transverse section taken on the line 3—3 on FIG. 2;

FIG. 4 is a plan view of an array of parallel filaments in accordance with FIG. 2 bonded together by a thin layer of additional plastic to form elongated generally flat flexible strips suitable for employment in the production of brushing fingers, such additional plastic being indicated as transparent better to disclose the beaded filaments bonded thereby;

FIG. 5 is a fragmentary transverse section taken on the line 5—5 of FIG. 4, on an enlarged scale;

FIG. 6 is a transverse section through the brushing tool of FIG. 1, on an enlarged scale;

FIG. 7 is a further enlarged fragmentary semi-diagrammatic view of a brushing element of this invention showing a portion of the work-engaging end thereof; and

FIG. 8 is a fragmentary cross-section on an enlarged scale taken on the line 8—8 on FIG. 7.

Referring now more particularly to said drawing and especially FIGS. 2—5 thereof, I prefer to utilize beaded wire bristle material of the type disclosed in my Patent No. 3,090,061, dated May 21, 1963, in preparing the brushing fingers of the present invention. Thus, the hard wire monofilament 1 may have plastic beads 2 adhered thereto at intervals therealong with the intervening portion of the filament coated with a much thinner layer 3 of the plastic, or, if desired, the surface of the monofilament may be exposed intermediate such beads. As explained more in detail in my aforesaid Patent 3,090,061, a wide variety of brush bristle material may be utilized including steel wire having a Knoop hardness in excess of 600 and preferably in excess of 700 or even 800, other metal wire such as stainless steel wire, glass monofilaments and the like. A wide variety of plastic materials

may be utilized to form the beads 2 and the intervening coatings 3 including nylon, polyurethane, neoprene (polychloroprene), and polyvinyl chloride. Foamed polyurethane and polyurethane rubber have been found especially satisfactory. Such plastic may be further bonded to the bristle 1 by means of various well-known bonding agents such as "Ty-Ply-S" for bonding rubber and rubber-like materials, and epoxy resins for bonding nylon.

Abrasive granules may, if desired, be incorporated in the plastic beads 2, to be released at the brush face as the bristles wear back in use. Such granular abrasive may, for example, include aluminum oxide ("Alundum" or "Aloxite"), silicon carbide ("Carborundum," "corundum"), chrome oxide, natural abrasives (e.g. pumice, emery), and mixtures of these.

Uniform spacing of the beads 2 along the filament is not necessary, and some irregularity of spacing is, in fact, preferred. In a typical preferred embodiment, the bristles 1 may be .0118" diameter carbon steel wire coated with polyvinyl chloride and provided with beads of the same material, such beads being about  $\frac{3}{32}$ " in length and occurring at a frequency of from about three to about six per linear inch of the bristle length.

A plurality of such beaded bristles may be arranged in parallel array but one bristle in thickness and then bonded together as shown in FIG. 4 by addition of a small amount of plastic which may be of the same type as that already previously employed to form such beads 2 although it will generally be preferred to employ plastic material for this purpose which will separate between the outer working ends of the bristles in use. A continuous elongated substantially flat plastic band or strip 4 may thus be produced in which the parallel brush filaments 1 are embedded and extend longitudinally, insufficient additional plastic being employed to submerge the beads 2 which persist as small protuberances or surface rugosities as shown in FIG. 5 in enlarged cross-section. This band or strip 4 may now be cut into desired lengths to form the flexible brushing fingers 5 of this invention.

In the preferred embodiment of the invention illustrated in FIGS. 1 and 6 of the drawing, a large number of brushing fingers are arranged to form an annulus with such fingers lying in radial planes parallel to the axis of such annulus and with the radially inner ends of such fingers closely packed together in order that a maximum number of fingers may thus be employed. The inner end portions of the fingers are then bonded together with a compatible plastic or cement to form a continuous inner annular support 6. Thus, for example, if the plastic fingers are formed of nylon, such inner annular support may be produced by bonding the closely packed inner end portions of the fingers together with an epoxy resin. As shown, the hard straight wires are thus supported and secured in the finished annular brush section without local bending which would tend to produce concentrations of stress and early fracture when repeatedly rapidly flexed in use.

Now referring more particularly to FIGS. 7 and 8, a generally flat flexible plastic finger 5 is shown comprised of a single row of straight bristle filaments 1 having plastic beads 2 securely adhered thereto, such beaded filaments being joined together by and embedded in plastic material 4 to form thin generally flat flexible fingers 5. Such plastic 4 is sufficiently thin where it interconnects adjacent filaments (FIG. 8) and/or has relatively low toughness and tensile strength so that it will tend to erode away and separate from between the outer end portions of the bristles in use to expose the latter with their beads 2 still bonded thereon. As best shown in FIG. 8, such thin plastic regions interconnecting adjacent parallel filaments result in the formation of grooves extending longitudinally of the fingers parallel to such filaments, with corresponding ridges where such filaments are embedded. The working ends of the fingers may be ini-

tially prepared in this manner, if desired, by subjecting the same to the action of an appropriate power driven rotary brush. Thus, the beads 2 may be of polyurethane firmly bonded to the bristles which may be hard straight wire bristles having a Knoop hardness of at least 700, and the plastic material 4 forming the flexible plastic finger in which the bristles are embedded may be of sponge neoprene (polychloroprene) which may further contain filling material enhancing the erodability of the sponge neoprene upon engagement with the work under operating conditions. It will be appreciated that the term "beads" as used herein and in the claims is not intended to be limited to apertured bodies threaded on the bristles but rather includes spaced globules and protuberances adhered to the bristles and which are not necessarily concentric therewith. With flexible brushing fingers of the type shown in FIG. 7, for example, it is possible to achieve very superior brushing characteristics; hard straight bristle wire is suitable for employment, since the disadvantage of long fracture may be largely avoided; the protruding bristle end portions are adapted to operate upon the work in the manner of a true brush in view of the fact that they are capable of individual flexure in directions circumferential of the tool (FIG. 1); and yet lateral movement of such protruding bristle end portions is very much limited by the beads 2 thereon so that when any bristle end encounters a surface rugosity on the work as the brushing tool rotates thereagainst, it will pass directly over such rugosity with consequent abrading action thereon rather than tending to deviate around such rugosity as has otherwise been the case in the past. This latter feature is of especial importance when brushing to produce a radius on the edge of a metal work-piece, for example. Prior brushing tools having a fast and efficient cutting action have tended to produce something of a saw-tooth effect under such circumstances. It might be said that the brushing tool of this invention as exemplified in FIG. 7 is one having a long trim effect circumferentially of the brush (inasmuch as the brushing fingers are capable of flexing in such direction for substantially their entire length) and a short trim effect laterally of the brush (inasmuch as such fingers are capable of very little flexing in their own plane and the protruding bristle end portions are likewise limited by beads 2 so far as lateral flexing is concerned). It will be appreciated that FIG. 7 of the drawing is semi-diagrammatic in character and that portions of the plastic material 4 may also adhere to the bristle end portions even though the plastic material 4 has separated between such end portions.

A desirable form of composite brushing finger in accordance with this invention may be produced wherein the flexible plastic finger has both a plurality of hard brush filaments of relatively low fatigue strength and a plurality of much more ductile brush filaments of much greater fatigue strength embedded therein in substantial parallelism longitudinally of the finger. Such fingers are preferably generally flat, as indicated, but may desirably have a multitude of small plastic protuberances on their surfaces to assist in spacing the fingers apart. The hard brush filaments may desirably have a Knoop hardness of at least 700 and preferably of at least 800 or higher, such filaments consequently tending to be brittle due to relatively low fatigue strength, whereas the more ductile and therefore tougher brush filaments of greater fatigue strength will ordinarily have a Knoop hardness of less than 600 and in any case substantially less than the aforesaid relatively hard brittle filaments. Both types of filaments will ordinarily be of steel wire and generally uniformly distributed across the width of the finger. The very hard filaments, of course, afford the sharper cutting or abrading action on the work while the more ductile filaments act more to blend such surface as well to reinforce the finger in the event of partial long fracture of such very hard filaments or bristles.

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As shown in FIG. 5 of the drawing, the bristles 1 embedded in the flexible plastic fingers may desirably be slightly offset one from another in a generally zigzag manner rather than forming a perfectly straight alignment. Such relative offsetting of the brush bristle filaments (in a direction circumferentially of the tool is shown in the FIG. 1 embodiment) may ordinarily be in an amount approximately equal to the diameter of such filaments and even a little more, up to about .01 inch in the case of the typical preferred embodiment in which the bristles are .0118 inch diameter carbon steel wire. Even a very small offset such as .005 inch is appreciably advantageous in effecting improved operating results, the faces of the finger having a corresponding zigzag conformation in cross-section as indicated in FIG. 5. More particularly, such arrangement of the bristles assists in snubbing flexure of the fingers in a circumferential direction when the FIG. 1 embodiment of the invention is rotated at high speed in engagement with the work, and the working ends of the individual bristles are prevented from skipping and bouncing upon impact against the work surface. Consequently, a controlled brushing action is obtained wherein each bristle tip is caused to travel in a substantially straight line across the work surface to produce a finish more nearly similar to that obtained with other types of abrading tools such as conventional belts, for example. This type of action is much preferred in certain commercial abrading operations such as the removal of solder from automobile bodies and the like. The brushing tool of this invention accordingly has a high degree of lateral stability and yet the brush material is enabled to flex in a circumferential direction with such latter flexibility, however, diminishing in increments toward the central support.

When employing brushing elements comprising flexible plastic fingers having embedded therein both a plurality of very hard brittle brush filaments having a Knoop hardness of at least 800 and even on the order of 900, and a plurality of much more ductile but substantially less brittle brush filaments having a Knoop hardness of less than 700 and even less than 600 in substantial parallelism longitudinally of the thin flat fingers, such filaments will desirably be disposed in a single zig-zag row with both types of filaments substantially uniformly distributed therein. Frequently there may be a substantially equal number of filaments of each type, although the proportion may be varied according to need and the effect desired. The less hard but more ductile filaments serve as structural members to reinforce the thin flat plastic fingers to prevent elongation and premature disintegration of the same even when the very hard filaments may suffer long fracture in use. Both types of filaments may be of steel wire but other materials such as glass fibers are also suitable.

In view of the foregoing, it is now possible to provide high speed rotary brushing tools utilizing hard and there-

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fore very effective bristle materials without decreased brush life due to long fracture thereof and without production of a non-uniform and inferior surface finish which would normally be anticipated when employing such materials.

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 brushing tool comprising a rotatable support and brushing elements secured thereto and extending therefrom, said brushing elements comprising flexible plastic fingers having both a plurality of hard brush filaments of relatively low fatigue strength and a plurality of much more ductile brush filaments of much greater fatigue strength embedded therein in substantial parallelism longitudinally of said fingers.

2. The tool of claim 1, wherein said fingers are generally flat.

3. The tool of claim 1, wherein said fingers are generally flat but have a multitude of small plastic protuberances spaced from each other both laterally and longitudinally on their surfaces.

4. A rotary brushing tool comprising a rotatable support and brushing elements secured thereto and extending radially outwardly therefrom, said brushing elements comprising flexible plastic fingers having embedded therein both a plurality of very hard brittle brush filaments having a Knoop hardness of at least 800 and a plurality of much more ductile but substantially less brittle brush filaments having a Knoop hardness of less than 700 in substantial parallelism longitudinally of said fingers.

5. The tool of claim 4, wherein said fingers are thin and generally flat.

6. The tool of claim 4, wherein said fingers are thin and generally flat and said filaments are disposed in a single row.

7. The tool of claim 4, wherein said fingers are thin and generally flat and said filaments are disposed in a single zig-zag row.

8. The tool of claim 4, wherein said fingers are thin and generally flat and both types of said filaments are substantially uniformly distributed therein in a single row.

#### References Cited by the Examiner

##### UNITED STATES PATENTS

|           |         |          |          |
|-----------|---------|----------|----------|
| 2,984,053 | 5/1961  | Peterson | 300—21 X |
| 3,090,061 | 5/1963  | Charvat  | 15—179 X |
| 3,114,925 | 12/1963 | Charvat  | 15—179   |
| 3,134,122 | 5/1964  | Charvat  | 15—179   |

CHARLES A. WILLMUTH, *Primary Examiner.*