

March 31, 1959

A. S. SWANSON ET AL

2,879,534

ROTARY BRUSH

Filed April 19, 1956

3 Sheets-Sheet 1

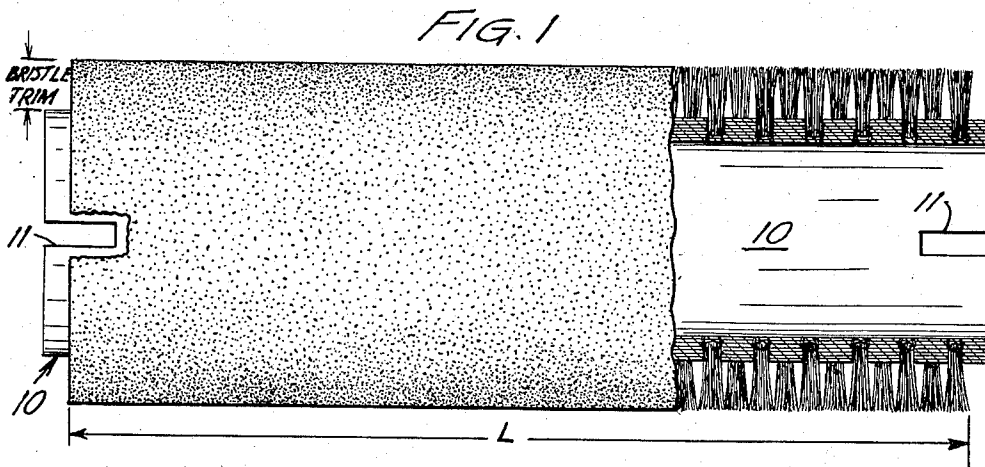


FIG. 2

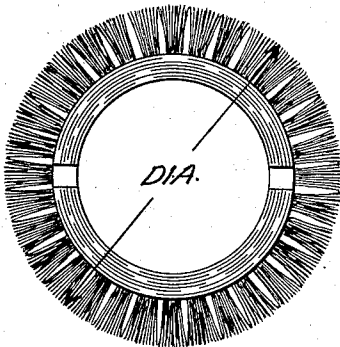


FIG. 3

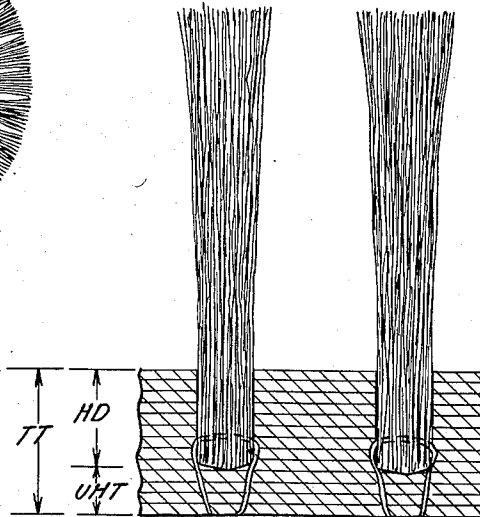
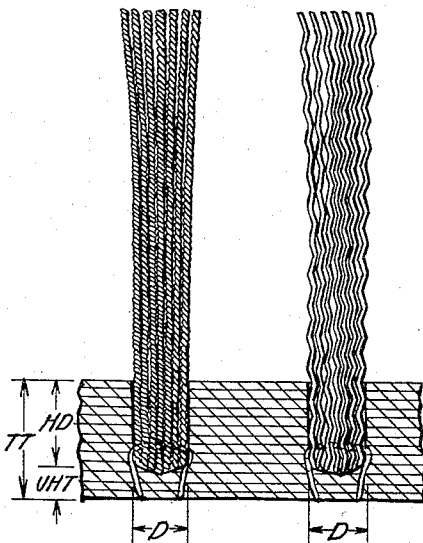


FIG. 4



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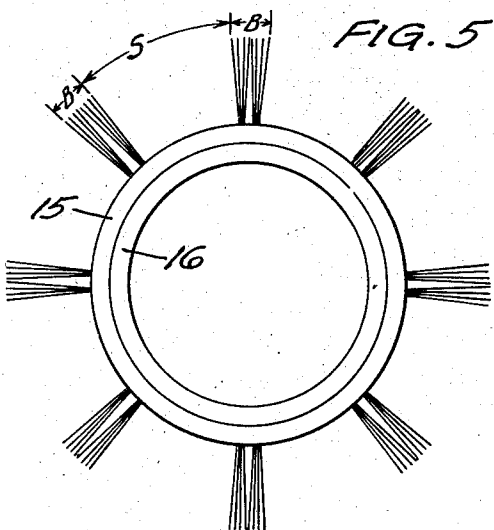
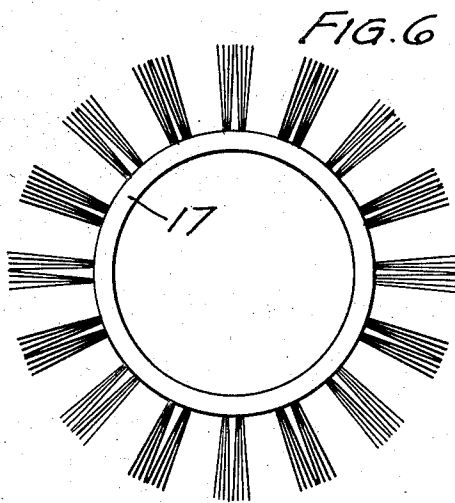
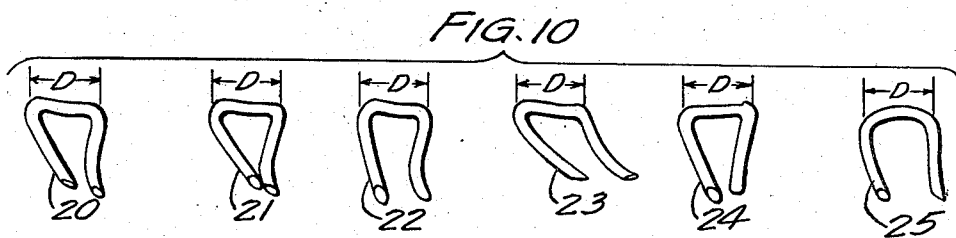
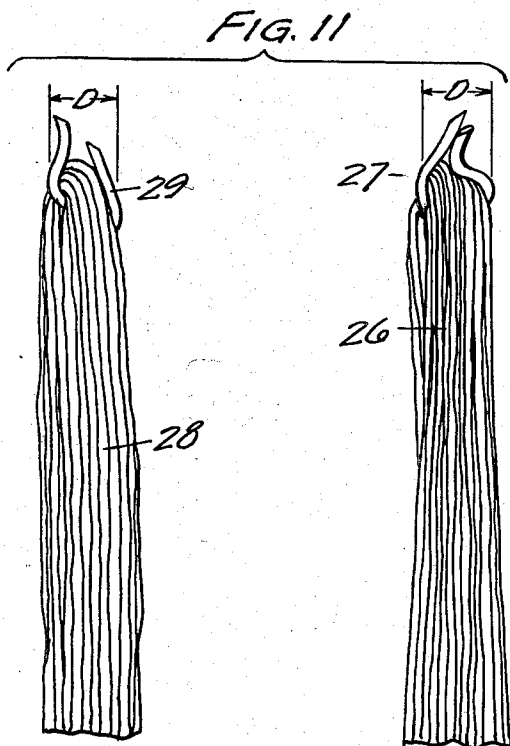
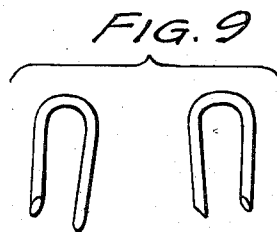
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3 Sheets-Sheet 2



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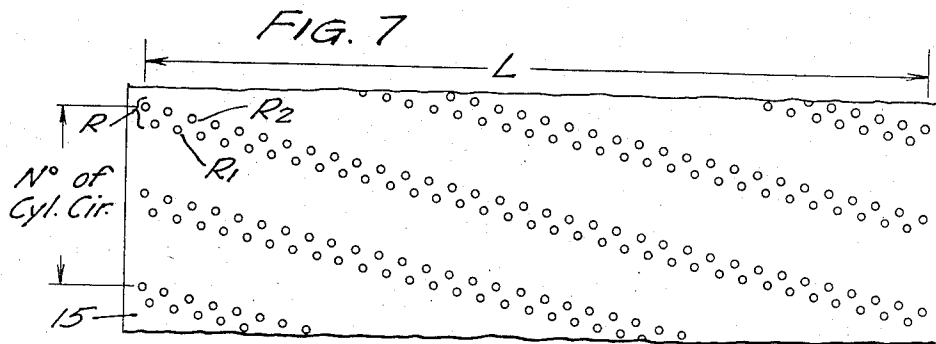
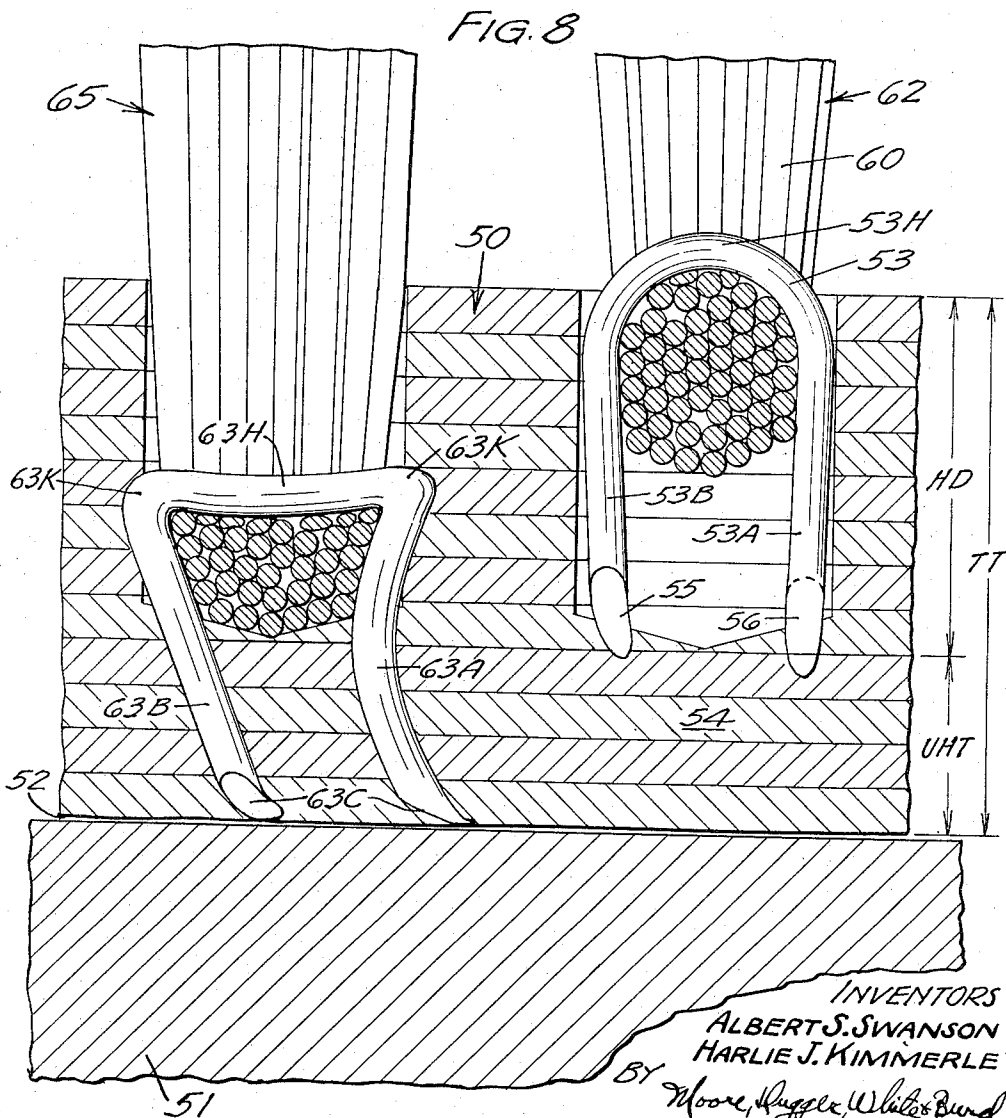
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ROTARY BRUSH

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3 Sheets-Sheet 3



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2,879,534

ROTARY BRUSH

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Application April 19, 1956, Serial No. 579,199

17 Claims. (Cl. 15—179)

This invention relates to rotary brushes. More particularly, this invention relates to cylindrical brushes of large diameters and great axial length that are used in power driven floor, area, dock, roadway and the like maintenance machinery for sweeping, polishing, scrubbing, scarifying and the like operations. For such purposes, cylindrical brushes having diameters at the bristle tips ranging from six inches upward to eighteen inches and even larger diameters and nominal axial lengths from one to six or even more feet are used. In such power driven maintenance machinery, the rotary brush bristles may be of natural or artificial fibers and/or wire of fine or coarse diameters, the bristle materials being used singly or intermixed. Power driven service to which such brushes are subjected is unrelenting and of heavy or extreme loading and frequently under adverse condition of wetness or humidity. It is to this special class brush that the present invention is directed.

Heretofore in making such heavy duty rotary brushes it has been customary to provide a rotary reel frame, generally of wood or metal upon which the bristles (whether of fiber or wire) were carried by means of separate carrier elements of wood or metal. Hence it has been customary to provide a rotary reel frame and upon it mount a plurality of straight or spiral bar elements each carrying one or more rows of outwardly extending bristles, the bristles being attached by wire stitching or metal crimping in the case of metal bar elements or in the case of wooden bar elements, by wire stitching, stapling or cementing. Such brush assemblies composed as they are of separate rotary reel and bristle bar elements, are sturdy, but expensive to manufacture, and the replacement on rehabilitation of such brush assemblies involve considerable down-time and consequent cost, to say nothing of the replacement brush elements required. In addition, such brush assemblies are heavy and cumbersome to install, and require increased weight and sturdiness, and hence cost of the machines of which such assemblies are components.

It is an object of the present invention to provide an improved heavy duty cylindrical power driven brush constructions, wherein greater simplicity, lighter weight, and lowered cost of construction is achieved.

It is another object of the invention to provide an improved heavy-duty, cylindrical, power driven brush which utilizes a hollow core and which can be manufactured by methods heretofore usable only for the manufacture of small and light duty rotary brushes or brush stick elements.

Other and further objects are those inherent in the

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invention herein illustrated and described and will be apparent as the description proceeds.

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

The invention is illustrated in the drawings in which the same numerals refer to corresponding parts and in which:

Figure 1 is a side elevational view, partly sectioned along a longitudinal axis, of a representative brush made in accordance with the present invention;

Figure 2 is an end view of the brush shown in Figure 1;

Figure 3 is a much enlarged view of several bristle tufts and a portion of the central brush tube core of a brush embodying the present invention, the tube being sectioned along the longitudinal axis of the brush. This figure illustrates natural or artificial fiber or straight wire material for the bristles;

Figure 4 is a view similar to Figure 3, but showing varying forms of bristle wire formation;

Figure 5 is an end view, similar to Figure 2 except that the tufts are arranged in rows with untufted spaces between rows. This figure also shows the brush cylinder while still mounted on the forming mandrel;

Figure 6 is also an end view similar to Figures 2 and 5 except that twice as many rows of bristles are shown as compared to Figure 5, and alternate rows are composed of different materials; and the mandrel has been removed;

Figure 7 is a fragmentary planar representation of the brush tube as though the tube were cut longitudinally and flattened. This figure illustrates the outer surface of the brush tube after drilling and before tufting, the pattern of location of the tuft holes being exemplary;

Figure 8 is a much enlarged fragmentary sectional view, longitudinally thru the brush tube and illustrating exemplary tufts while the brush tube is on the formation mandrel. This view illustrates for one tuft, the base of the tuft and the staple during the process of being placed and for another tuft, when the tuft and staple are secured;

Figure 9 illustrates typical staple shapes prior to setting;

Figure 10 illustrates typical staple shapes after setting such staples having been withdrawn from a typical brush;

Figure 11 illustrates two typical tufts of material fiber and the attaching staple, which were forcibly pulled out of a brush for examination.

It may be stated at the outset, that in the trade in which the inventions hereof form improvements of existing devices and methods, there is a certain confusion in nomenclature. In general, the subject devices are called "cylindrical" or "tubular" brushes but this is frequently a misnomer, because according to some modes of manufacture no cylinder at all is used in the construction; the brushes being held on "sticks" or "elements" or "panels" and assembled on some form of framework so that the bristle's ends terminate to form a generally cylindrical shape. In other constructions the bristles are set on a cylindrically shaped center either solid or tubular. Unless otherwise stated, term "cylindrical" is used herein to

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denote the general overall shape of the completed brush assembly.

Again such cylindrical brushes when separately considered, are spoken of as having a certain "diameter" and "length." "Diameter" is usually taken to mean the overall diameter of the brush, measured to the ends of the bristles, and will be understood herein to mean such overall apparent brush diameter. The length of bristles protrusion beyond the support is usually spoken of as "bristle trim." "Length" is usually taken to mean the nominal dimension of the bristled area measured at the bristle ends and parallel to the axis of rotation of the complete cylindrical brush. The framework or central body on which the bristles are carried frequently extends in such axial direction beyond the effective bristled configuration to provide attachment facilities.

The above noted dimension "length" is completely lost when the rotary brush is installed in the power machine in which it is used, and is replaced by the term "width," which, of course, refers to the width of the area swept, scarified and/or polished by the brush as the brush is rotated and its axis translated in a direction parallel to the surface and generally normal to the rotational axis. For uniformity herein, the term "length," rather than "width," will be used.

According to the present invention there is first prepared a multiple ply paper tube which is built up by wrapping successive layers (turns) of paper on a cylindrical or tubular mandrel, the successive layers (turns) being held to each other by an adhesive. When the brush is used under wet or moist or humid conditions it is preferable that such adhesive be waterproof or at least moisture resistant. Such multiple ply paper tube can be built up in several ways.

According to one method, successive strips of paper are spirally wrapped on a cylindrical mandrel, with a slight interturn space between successive turns of the spiral. Each spiral layer is wrapped on with a generous lap over the interturn space of the layer below. Adhesive is applied between turns, preferably by precoat- ing the strip of which each spiral wrap is composed. Successive layers are applied until the desired tubular wall thickness is achieved. As a variation of this method, the spiral layers may be laid successively as right and left hand (thread) spirals. According to still another method, a paper strip, of generous width is simply wound up turn upon turn until the desired thickness is achieved.

Produced according to any of the aforesaid winding methods, the successive layers (or turns) are held together tightly by adhesive, which, as stated, is preferably a waterproof or water resistant adhesive which, when relatively thin paper stock is used, may penetrate to some extent thru the thickness of the paper stock. Each turn is wound under tension and outer layers compressively stress the inner layers.

The paper that, according to this invention, is used to form the tube, is of tough and durable quality and may be single thickness or paperboard stock ranging from 0.010" to 0.040" thickness. Penetration of the interturn adhesive, into the thickness of the stock, decreases and regions of negligible penetration are to be found between opposite faces of a layer, particularly where thicker stock is used. This is an advantageous feature of the invention. Paperboard stock gives good results, but the use of higher quality stock and/or single sheet thickness, are not excluded.

Upon formation of the desired multi-layer tube, the built up tube is then impregnated with a material capable of being hardened by drying, heating or chemically, or by a combination of these factors. We prefer to accomplish impregnation by dipping the multiple layer tube component in a liquid phase heat hardenable material such as a varnish or resin preferably of the type which is waterproof or moisture resistant. For this purpose, a phenolic resin in liquid phase such as phenolic resin

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solution, may be used, the tube being dipped therein, after which it is baked to harden the resin in situ. A wide variety of impregnating solutions may be used, the criteria being that reasonable penetration into the thickness of the multiple layer tube wall should be achieved; the impregnating material should be compatible with the paper stock and the interturn adhesive and not produce deleterious effects thereon; the impregnating material should harden either by drying, or by polymerization, with or without heat, to harden and hence stiffen those portions of the tube into which the impregnant has penetrated. Where the completed brush is intended to be used in wet moist or humid conditions, it is, according to this invention, preferable to use as the impregnant, a material which is moisture resistant or water insoluble when set (polymerized). In this way there may be achieved a hardened and resistant tube surface and some increased hardness of the tube wall to the extent of impregnation. Such hardness decreases with depth as the degree of impregnation decreases.

While it is feasible to impregnate from only the outside of the tube, and such is within the purview of the invention, it is preferable, according to this invention, to impregnate the tube wall from the inside and outside, and this is easily accomplished by simply dipping the tube components in the impregnating fluid. Impregnation of the tube from its outer surface can easily be accomplished by dipping it into the impregnating liquid while the tube is still on the mandrel. When impregnation is desired from both the inner and outer faces of the tube wall the tube is pressed off the mandrel on which it has been formed and is then dipped to impregnate from both faces. The in-drawing of the impregnating fluid by simple immersion is usually sufficient, but deep impregnation of thick-walled tube components composed of paperboard or paper stock which resists penetration, may be accomplished more rapidly by successive application of vacuum and then pressure, while the components are immersed in the impregnating fluid.

It has been discovered, according to the invention, that impregnation need not, and preferably should not be completely thru the tube wall. The degree of impregnation decreases from the surface (at which the impregnating material is applied) to the interior of the tube wall thickness.

After the impregnating fluid has hardened there results a tubular component having on the outer surface of its wall (or on its inner and outer surfaces, where impregnation is made from both surfaces), a condition of maximum hardness and water resistances, and at successively deeper locations into the thickness of the tube wall, the degree of hardness decreases, being a minimum at inside surface of the tube wall (where impregnation is from the outside only), or the degree of hardness may be a minimum at a zone about halfway between the inner and outer surfaces (where impregnation is from both the inner and outer surfaces). According to this invention, it has been discovered that such decreasing degree of hardness at zones farther and farther removed from the surface to which the impregnating material is applied, is an advantage, and the deepest zones may according to this invention be only slightly impregnated or be free from impregnation.

Impregnation can be accomplished simultaneously with formation of the multiple ply tube by using paper stock which is relatively thin and by using a generous amount of interturn adhesive, which then, in addition to serving as an adhesive, also penetrates into each layer from the adhesively coated surface and hence the adhesive serves as the penetrating (or impregnating, however denoted) component. Varnish type adhesives, many capable of being hardened into tough moisture resistant materials by drying or heating may thus serve not only as the adhesive between layers for holding the layers together but also as the impregnation material by which the thickness

of the paper stock in each layer is impregnated and hardened.

The effect of impregnation (after hardening of the impregnating fluid or combined adhesive—impregnating agent) is several-fold. The tube structure is made water resistant and hence durable under conditions of moisture and high humidity. Of equal importance, the hardening effect of the impregnating material upon the fibrous structure of the multiple layer paper tube, immensely facilitates drilling of the tuft holes. It was found that an unimpregnated multiple layer paper tube could be drilled only with great difficulty and that the paper tore, fuzzed, and was not readily removed as chips from the holes. The drilling is done at high speed and preferably with a drill that produces a hole in which the conical bottom approaches as nearly as possible a flat surface. In such high speed drilling of a multiple layer paper tube which had not been impregnated, the holes were torn, the bit heated during drilling and bit life was short. The holes were irregular, fuzzy and full of paper residue chips. The same tube structure, but impregnated as herein described, was discovered to be drillable at high speeds even with minimum impregnation at the zones most removed from the surface of impregnation. The holes are smooth, hard walled, the chips ejected cleanly. This is an advantage of the herein described invention.

The factor of decreasing impregnation at the deeper zones within the tube wall leaves unimpaired the tough and resilient and clinging fiber effect of the paper stock. This is found to be distinctly advantageous in respect to holding power of the staples that are used for holding the tufts.

The hole size is varied within limits to accommodate the varying bristle material available. According to this invention the hole depth exceeds the diameter and the hole is drilled, using a drill that produces a hole bottom of shallow conical shape. This is desirable since a shallow conical bottom permits that portion of the tube under the hole to remain undisturbed and does not waste tube wall thickness which is needed for adequate setting of the staples. The following schedule of hole diameters and depths is exemplary.

Tuft hole diameter, inches:	Tuft hole depth, inches
$\frac{3}{16}$ -----	$\frac{3}{32}$
$\frac{1}{4}$ -----	$\frac{1}{16}$
$\frac{5}{16}$ -----	$\frac{3}{8}$
$\frac{3}{8}$ -----	$\frac{1}{2}$
$\frac{7}{16}$ -----	$\frac{1}{2}$ to $\frac{9}{16}$
$\frac{1}{2}$ -----	$\frac{1}{2}$ to $\frac{5}{8}$

The tuft hole depth is measured at its deepest place in conical bottom. The bit should preferably be sharpened so as to produce just as shallow a conical bottom as consistent with adequate centering of the bit. The hold depth (HD, Figure 4) is always less than (preferably about 50% to 75% of) the tube thickness (TT, Figure 4) and consequently a generous underhole thickness (UHT, Figure 4) is always provided and is the stock into which the staple penetrates and holds. According to this invention it has been found that a tube thickness (TT, Figure 4) of $\frac{1}{2}$ inch to $\frac{5}{8}$ inch is adequate for most service but may be increased to $\frac{3}{4}$ inch to 1.0 inch or more where the bristles are heavy or are of wire rope, or for largest sizes and heaviest duty brushes. The under-hole dimension can be increased by thickening the tube wall dimension TT. The proportions in Figure 4 are not indicative.

In drilling, high speeds (as for example 8000 to 12,000 r.p.m.) may be used at the drill spindle. Good cutting of the material is achieved due to the hardening effect of the impregnating material upon the fibrous structure of the paper. The impregnated material cuts well and the hole wall causes no undue drag upon (and hence heating of) the bit and adequate throw-out of chips occurs. By contrast, the drag of the paper fibers in unimpregnated

tubes of similar dimension so heats the drill as to preclude commercial operations and clean, accurate and chip free holes are not obtained. Also unimpregnated material fuzzes and does not drill cleanly, while holes in impregnated tubes, as herein described are clean and true, and have strong walls.

Widely varying tuft holes patterns may be utilized, depending on the service. The following are some examples:

10 For polishing and wet scrubbing brushes an "over-all" tuft distribution may be used, with the holes in rows set parallel to the axis of rotation, with the holes of successive rows staggered. Thus Figures 1 and 2 may be considered as showing a 5-inch diameter multiple ply 15 impregnated paper tube, generally designated 10 of $\frac{1}{2}$ inch wall thickness and approximately 15 inches to 16 inches long having 32 rows of $\frac{1}{4}$ inch diameter, $\frac{5}{16}$ inch deep tuft holes. Each row contains 40 holes making a total of 1280 holes (less 4 holes which are eliminated to allow the tube mounting slots 11 to be cut therein). The over-all diameter of this exemplary brush is 6.75 inches or stated another way, the "bristle trim" is $\frac{3}{8}$ inch.

In this exemplary brush palmetto fiber is used when the service is "wet scrubbing." For soft polishing, tampico fiber is used and for heavy polishing stiff tampico fiber is used.

In another exemplary brush of larger power driven size and used for heavier service the central tube 10 may for example be 7 or 8 inches in diameter or even larger and of multiple ply constructed as hereinbefore described, impregnated and baked. For many types of service the bristles are preferably set in spaced rows which spiral around the tube. "Multiple" rows of holes, staggered and close together, considered together form 35 one "row" of bristles as at B—B in Figure 5, these being separated by spaces S—S. In Figure 7 each "row" is a "double row." Thus referring to Figure 5, tube 15 has eight "rows" of bristles. As shown in Figure 7, which is a developed view, there are shown "double rows," the holes being staggered in each "double row." For example, double row R contains two rows R1 and R2 in which the holes of one row are spaced between those of the companion row. The entire double row preferably "spirals" as for example N° for the example shown. 45 Thus a spiral of 90° in 36 inches of brush length L gives good results. The hole size and depth of the tuft holes is chosen according to the bristle used and the service intended. Each double row produces a circumferential width of bristles (in the row) of dimension B, and the spacing between rows at "S," Figure 5, thus results. 50 This spaced row mode of bristle pattern distribution produces excellent results for sweeping and trash pickup and scarifying, particularly, but it is also useful in some general service.

55 For other service, as general service and polishing a larger number of rows of bristles is usually desirable, as shown in Figure 6. The "rows" are usually composed of several closely spaced rows, as in Figure 7, and are curved to spiral. In Figure 6, alternate rows can be of different materials, as for example artificial fiber (example monofilament plastic bristles) and wire in alternate rows, or natural bristles (example tampico or bassine) and wire in alternate double rows; or artificial fibers and natural fibers in alternate rows.

65 As further exemplifying the invention but not by way of limitation several large size power driven brushes are specified herein. In the following example several types of basic tubes are specified, along with exemplary brush specifications therefor, as follows:

70 **Basic tube A.**—Tubes 15 or 17 (Figures 5 and 6) 6 $\frac{1}{2}$ inches I.D.; 7 $\frac{1}{2}$ inches O.D.; thickness (TT, Figure 4) $\frac{1}{2}$ inch; length 36 inches; 25 plys 0.020 inch thick paper-board stock; waterproof adhesive between plys; phenolic resin impregnated (from inside and outside of the tube wall) by dipping and then hardened and polymerized by

baking. Holes drilled in double rows; 146 holes $\frac{1}{4}$ inch dia. x $\frac{5}{16}$ inch deep or $\frac{3}{16}$ inch dia. x $\frac{5}{32}$ inch deep (depending on fineness of bristles) per row; spiral 90° in 36 inches; total holes: 8 double rows, 1168 holes; 16 double rows, 2336 holes.

For polishing: The aforesaid basic tube A having 16 double rows tampico, bristle trim $2\frac{1}{4}$ inches to $3\frac{1}{4}$ inches.

For general purpose sweeping: The aforesaid basic tube A, 18 double rows, mixed bristle tufts ("union mix") of tampico and bassine, bristle trim $3\frac{1}{4}$ inches, 8 double rows.

For sweeping: The aforesaid basic tube A; monofilament chemically resistant polystyrene (or nylon or Briston etc. may be used where costs do not impede); bristle trim $3\frac{1}{4}$ inches; 8 double rows.

For light sweeping: The aforesaid basic tube A horse-hair; 16 double rows; $3\frac{1}{4}$ inches bristle trim.

For heavier service the following examples may be given by way of further exemplification, but not as a limitation upon the invention.

Basic tube B.—Tube 15 or 17 (Figures 5 and 6) $6\frac{1}{2}$ inches I.D.; $7\frac{3}{4}$ inches O.D.; wall thickness (TT Figure 4) $\frac{5}{8}$ inch; plys 0.020 inch (or thicker or thinner plys to make approximately an equivalent thickness); waterproof adhesive between plys impregnated (from the inside and outside of the tube wall) by dipping in phenolic resin liquid and then hardened and polymerized by baking. Holes drilled in double rows, either 8 double rows or 16 double rows. Hole diameters and depths depending upon bristle materials, diameters and depths as hereinbefore specified; 100 holes in each double row (staggered, as in Figure 7); 90° spiral per 36 inches length; total holes approximately 800 for 8 double rows; approximately 1600 for 16 double rows.

For light scarifying: basic tube B, 8 double rows; 30 gauge steel brush wire .014 inch dia., the wire being slightly kinked at $\frac{1}{8}$ inch to $\frac{3}{16}$ inch intervals as shown in Figure 4; bristle trim $3\frac{1}{2}$ inches.

For heavy sweeping: basic tube B, 8 double rows; 4 double rows steel brushwire as in the preceding paragraph alternating with 4 double rows nonfilament chemically treated polystyrene ("Algil"); bristle trim $3\frac{1}{2}$ inches.

Figure 4 shows two tufts composed of wire, preferably steel wire. The right hand tuft is composed of brush wire of appropriate gauge which is kinked slightly (15° to 30°) at intervals of $\frac{1}{8}$ inch to $\frac{3}{16}$ inch. The lefthand tuft in Figure 4 is composed of wire rope bristles, the rope being composed of brushwire spirally twisted together.

In all the foregoing examples the bristles of each tuft whether natural or artificial fiber or wire or mixtures thereof, were held by staples, set as hereinafter described. The staples were cut from steel staple wire which may range from 26 ga. (0.181 inch) for light bristle materials and light service to 14 ga. (0.080) for heavy bristle materials and heavy service. 18 ga. (0.0475 inch) staple wire is satisfactory and produces good results in most applications.

Reference is now made to those figures of the drawings which show the staples, particularly Figures 1, 3, 4, 8, 9, 10 and 11. According to this invention it has been discovered that adequate holding power of the staples in large, power driven, cylindrical brushes can be achieved by utilizing as the core of a multiple ply paper or paper board tube, made as hereinbefore described and impregnated and baked. With such a tube component the holes are drilled and the tufts of bristles are then formed and the staples cut and set by suitable machine or by hand. Machine stapling is preferred for economy and can readily be accomplished by utilizing the specifications and methods herein set forth.

Figure 9 shows the typical staple shapes before setting.

In Figure 10 are shown typical staple shapes after setting

and after withdrawing worn tufts and staples from a worn out brush. Staples 20-24 were from a heavy duty brush with wire bristles, used in scarifying service. The staples 20-24 are widened and levelled out at their tops, and are closed (to varying degrees) at their lower ends. Most are blunted (clined) to some degree on at least one tine, and in all except one (24) the tines are bent sideways to some extent. Staple 25 was for a "union" mixture brush (tampico and bassine) and it is also spread at the top. The diameter of the holes in which these staples (and the bristles held thereby) were set are shown by the approximate dimension D adjacent the top of each staple illustrated in Figure 10. In every case, the setting of the staple by the staple driver acts to spread the top as the staple is driven and the tines thereof penetrate the underhole thickness (UHT, Figure 4) and reach or nearly reach the inner surface of the tube during setting. The resistance to penetration increases as the staple is driven and the staple driver (which is straight across at its lower end) straightens out the top of the staple and spreads the tines apart and against the hole walls. In so doing the staple holds four ways i.e. (1) by spreading of its top part against the hard (impregnated paper) sidewalls of the tuft hole; (2) by the tenacity of the impregnated paper fibers gripping the tines, (3) by clinching of one or both tines, and (4) by a certain amount of bending of the tines as they penetrate the tough paper tube stock.

In many instances both staple tines will not reach all the way into the inner surface of the tube wall. Figure 11 illustrates two tufts of "union" mixture (bassine and tampico fibers) and their staples which were forcibly pulled out of their tuft holes. In the tuft 26, staple 27 has nearly closed its tines together and one tine penetrated deeper than the other. In tuft 28 staple 29 did not close so much. In respect to each tuft shown in Figure 11, the tuft hole diameter is approximately shown by the dimension D. In each instance the head of the staple was straightened sufficiently to cause it to spread at the head and those portions of the tines adjacent the head were forced to bite into the tuft hole sidewalls thus providing great holding power. In each instance the holding power was entirely adequate for the tufts shown in Figure 11.

Figure 8 illustrates the mode of setting staples and Figures 3, 4, and 8 illustrate the set staples. In Figure 8 the thickness of the wall of tube 50 is shown by the dimension TT. This thickness is here made up of twelve plys of paperboard stock held together with waterproof adhesive and then impregnated by dipping in phenolic resin solution, drying and baking to set the resin. No attempt is made in Figure 8 to show the degree of impregnation. In placing the tufts and staples tube 50 is sleeved on mandrel 51 which is a diameter slightly less than the inside diameter of the tube 50 so as to leave clearance 52 which may be slightly irregular since the tube 50 does not always remain perfectly true to diameter on the inside. Also the clearance 52 facilitates sleeving the tube 50 onto the mandrel 51 and particularly facilitates its removal after tufting is completed since clinching of the staples produces some irregularity on the inside of the tube. The holes are drilled to depth HD and this leaves an undisturbed zone at 54 of thickness UHT, as previously mentioned. In machine setting the staple 53 is cut chamfered in one direction at 55 and in the other direction at 56. The bristles 60 in adequate number to provide good filling of the tuft hole are looped by the curved head staple 53 and drawn down into the hole as the staple is driven. For tuft 62 the staple points are just entering zone 54 and the oppositely chamfered points 55 and 56 tend to cause the staple legs 53A and 53B to assume a twist and to penetrate into the tube in slightly differing directions, which is desirable but not essential.

Experience shows that widely different staple penetration patterns of the staple tines will occur without dele-

terious results. The illustrations herein are therefore to be considered as exemplary.

As penetration of the tines 53A and 53B continue the resistance to penetration increases and the flat bottom staple driver (not shown), which engages against the curved head 53H of the staple causes it to become "squared out" to some degree. Clinching, as shown for staple 63 of tuft 65 can of course occur only when the tines 63A and 63B of the staple are sufficiently long and pursue a direction to reach thru the underhold dimension UHT and strike the mandrel 51, and while, according to this invention, clinching is regarded as desirable, good results are also obtained when the underhole thickness is great enough to allow complete penetration of the tines without clinching.

Squaring of the heads of the staples always occurs at 63H to some extent and pushes the corners 63K—63K into the tuft hole sidewalls. This is believed to be due to the resistance to penetration offered by the staple tines as they penetrate, even without the extreme resistance to penetration encountered in clinching.

The seated staple is exemplified for tuft 65, and it will be noted that tines 63A and 63B are clinched at 63C—63C. Some roughness or slight lumpiness therefore is evident on the inner surface of the tube wall but it is not a disadvantage. The tube 50 has sufficient resiliency to take up clearance 52 and settle upon mandrel 51 as the staple is set, to allow adequate clinching, where the staple dimensions, underhole thickness UHT and volume of tuft materials is such as to permit clinching penetration.

For wire bristles, it is, according to this invention preferable to employ wire which is slightly preinked or gently spiralled. This is a feature of the invention. It is found that in most cases, life of wire bristle brushes is much increased by this expedient. This expedient may also be used with good results with many plastic bristles, particularly in respect to those showing a tendency to failure in fatigue, and this is a feature of this invention.

According to this invention the completed and tufted brush may be dipped into a coating solution, drained and baked or otherwise treated to dry, consolidate (polymerize) the coating. This provides repenetration of the coating solution into the drill holes; it seals the tuft holes and provides corrosion resistance particularly for ferrous wire bristles which are required to operate under humid or wet conditions. As the coating solution there may be used varnish or drying or polymerizing resin in solution. Any compatible resins may be used, such as phenolic resins, polyamide resins, urea resins, melamine resins and the like. When applying such dipcoating, it is desirable to subject the submerged brush to successive vacuum and pressure to draw out air from the tuft holes and hence allow the dip-coating to penetrate deeply into the base of the tufts in the tuft holes. The dipped brush may then be spun to spin off excess dipcoating fluid and then dried with heat. This provides good protection deep in the tuft holes right down to the base of the tufts.

No attempt has been made herein to illustrate the various keying devices or shapes that can be used for transmitting the rotation power forces to the tube (10 of Figures 1 and 2; 50 of Figure 8). In Figures 1 and 2 there are shown slots 11—11 which are engaged by the brush drive mechanism to rotate the brush. It will be understood that these are merely exemplary of any form of surface or protuberance on or attached to the tube for rotating the brush.

It is apparent that many modifications and variations of this invention as hereinbefore set forth may be made without departing from the spirit and scope thereof. The specific embodiments described are given by way of example only and the invention is limited only by the terms of the appended claims.

We claim as our invention:

1. A rotary cylindrical brush for power sweepers, polishers, scarifiers and the like comprising a cylindrical tube composed of a plurality of plies of paper wound tightly, one layer upon another and held together adhesively, said tube being impregnated with a hardening agent, the amount of impregnation gradually decreasing in a direction away from the surface of said tube, said tube having a plurality of holes drilled thereinto from its exterior surface and partly thru the tube wall thickness, and tufts of bristles stapled into said holes.
2. The brush defined in claim 1 further characterized in that the adhesive between plies is water resistant.
3. The brush defined in claim 1 further characterized in that the hardening agent is a polymerized plastic.
4. The brush defined in claim 1 further characterized that the hardening agent is a heat hardening plastic.
5. The brush defined in claim 1 further characterized in that said tuft holes are in spaced rows extending substantially from end to end along the cylinder and slightly spiralled.
6. The brush defined in claim 1 further characterized in that said tufts of bristles are composed of natural bristle fibers.
7. The brush defined in claim 1 further characterized in that said cylinder is provided with a keying surface shaped so as to be engageable by a driving device for rotating the brush about the cylindrical axis thereof with power.
8. A cylindrical brush for large power driven sweeping, polishing, scarifying and the like machines comprising a multiple layer built up paper tube greater than substantially 4 inches in diameter and a length of greater than substantially one foot composed of plies having a thickness of from 0.010 inch to 0.040 inch thickness, said plies being secured together with adhesive, said tube material being impregnated with a hardened impregnant, the amount of impregnation being gradually decreased at positions of increased distance from a surface of the tube said tube being provided with rows of tuft holes extending from the outer surface of the tube and partly thru the tube wall and bristle stapled into the bottom of said tuft holes, said brush having an overall diameter of more than 5 inches at the bristle tips and a length of more than 12 inches, said staples being spread at the top into engagement with the walls of the tuft holes.
9. The brush defined in claim 8 further characterized in that the adhesive and hardened impregnant are waterproof.
10. The brush defined in claim 8 further characterized in that the bristles are ferrous wire.
11. The brush defined in claim 8 further characterized in that the bristles are prebent ferrous wire.
12. The brush defined in claim 8 further characterized in that the entire brush has a hardened dip-coating of protective material thereon.
13. The brush defined in claim 1 further characterized in that said tufts of bristles are composed of plastic fibers.
14. The brush defined in claim 1 further characterized in that said tufts of bristles are composed of metallic wire.
15. The brush defined in claim 1 further characterized in that said tufts of bristles are composed some of natural bristle fibers and some of metallic wire.
16. The brush defined in claim 1 further characterized in that said tufts of bristles are composed some of non-metallic fibers and some of metallic wire.
17. A rotary cylindrical brush for power sweepers, polishers, scarifiers and the like comprising a cylindrical tube composed of a plurality of plies of paper wound tightly, one upon the other so as to form a thick walled tube, said tube being impregnated with a hardening agent, the amount of impregnation at positions on the interior of the tube wall being less than on the surfaces of the

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tube wall, said tube having a plurality of holes thereinto
 from the exterior surface of the tube wall but only partly
 therethrough so as to leave a portion of the tube wall
 forming bottoms of said holes, and tufts of bristles in
 said holes, said tufts being held in place with staples 5
 driven into the bottoms of said holes.

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