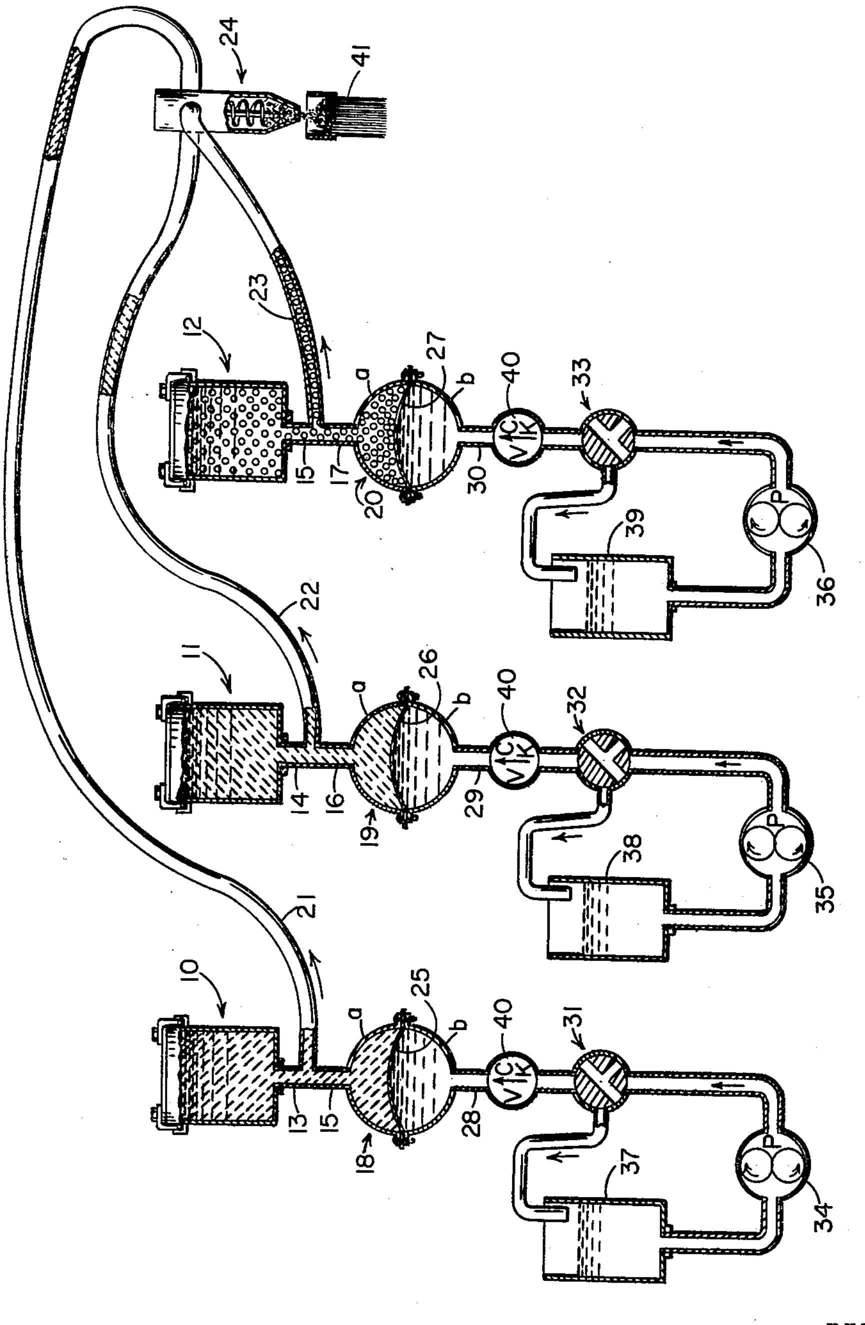
Nov. 14, 1961 | J. L. BEEN | 3,008,193

BRUSH MANUFACTURING

Filed Feb. 11, 1958

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United States Patent Office

3,008,193

Patented Nov. 14, 1961

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3,008,193

# BRUSH MANUFACTURING

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Filed Feb. 11, 1958, Ser. No. 714,584
4 Claims. (Cl. 18—59)

This invention relates to the manufacture of brushes and particularly to the dispensing of resinous compositions for bonding bristles into a setting.

In a typical brush used for applying paint and varnish products, there are four principal structural components: the cluster of fibers known as the bristles, the clamping shell known as the ferrule, the setting which holds the bristles together and within the ferrule and the handle which is held in the other end of the ferrule. The typical method of manufacture comprises placing the cluster of bristles within the ferrule and dispensing into the ferrule a quantity of a fluid composition which when hardened provides a setting, holds the bristles in place and is adherent to the ferrule.

Bristles may be of animal, vegetable or synthetic origin. Most commonly they are animal fibers such as hog bristles and horse hair, but more in recent years synthetic fibers such as linear polyamides (nylon) and vinylidene chloride (Saran) have become popular because of their more uniform properties, sterility and increased water resistance.

Ferrules are typically made of tin or nickel plated steel, with some experimental ferrules being molded from plastics.

The brush setting compositions are typically fluid natural rubber or synthetic rubber compositions which are formulated so as to cure to a hard, tough, solvent-resistant setting after being dispensed into the ferrule holding the clumps of bristles. Even though only comparatively small amounts of such compounds are needed in the manufacture of brushes, the properties of such compounds are exceedingly important if the brush is to be made and to perform successfully.

Thus, the area of bonding surface is dependent upon the depths of penetration of the setting compound between the bristles. If penetration is not uniform, the brush lacks uniform strength characteristics with the result that either bristles will fall out after a certain amount of use or they may be difficult to flex. Further, control of the depth is important economically since the cost of a bristle varies exponentially with the length of the bristle. Excessive depth is thus more costly than any advantage gained by extra strength in the setting. Further, with natural bristles, the shape is not uniform and there is a bulbous root end, so that a selected mixture of bristles with a resultant uniform packing factor and cross section is required. Different styles of brushes, even of the same bristles, require different viscosities of setting compositions with the result that the brush manufacturer must at all times maintain a large stock of different viscosity grades. It is thus an art rather than a science to produce brushes that are uniform and economical.

In addition to these problems, the brush manufacturer is also confronted with the difficulty of controlling the temperature where heating is required to change the composition from a fluid to a tough solid. Heat reduces the flexibility life of natural bristles and renders the synthetic thermoplastic bristles difficult to use in a brush. Further, very fine natural bristles (artists' brushes) are weakened or excessively discolored by heat. Where room temperature curing of compositions has been tried, the change in viscosity due to the initial reaction proceeds so rapidly that proper penetration control is almost impossible with a considerable proportion of rejects.

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One object of this invention is to provide a process and machine for selectively and controllably providing the desired material to a cluster of bristles. A further object of this invention is to provide such a process and machine wherein only three basic materials would be needed for setting a wide variety of bristle assemblies.

The three materials consist of a first fluid of high viscosity, a second fluid of low viscosity and compatible with said first fluid, and a third fluid. These three fluids are characterized in that at least one of them is a room-temperature curable brush-setting composition and at least one of the other two is a hardening composition reactive at room temperature with each such brush setting composition. The three fluids are further characterized in that a mixture of the three fluids in selected proportions provides a hardenable mix of the desired viscosity. Further, the mix is substantially solventless; such being achieved by using substantially solventless brush-setting compositions and a minimum of any necessary solvent in a hardener component.

In carrying out this invention, a separate source for each of the three fluids is provided in, for example, a separate reservoir. The high and low viscosities are chosen in accordance with the requirements of the brush-maker as to his shallowest and deepest penetration brushes. The high viscosity would be higher than the viscosity the brush-maker would require for the short penetration in his shallowest penetration brushes while the low viscosity would be lower thatn the viscosity required for the deep penetration in his deepest penetration brushes. The process of the invention comprises simultaneously supplying from each fluid source to a single chamber a separately selected and controlled amount of each fluid. In the chamber, the three volumes are substantially instantaneously mixed and then immediately totally dispensed to the desired location such as a cluster of bristles in a cavity such as a ferrule.

In one form of this invention, two of the fluids are substantially solventless room-temperature curable fluid brush setting compositions compatible with one another, one being of the low viscosity and the other being of the high viscosity. The third fluid source comprises the hardener composition reactive with each other fluid. In the discussion below, Examples 1 and 2 are with reference to this form of the invention.

The selection of the proper high and low viscosity is governed by the brush makers' needs, since some brush makers have a wider range of penetration requirements than others. In general, however, the viscosity of approximately 100–300 centipoises for one composition and approximately 150,000–200,000 centipoises for the other composition would meet the normal requirements of most brush manufacturers.

In practicing this invention, any suitable positive displacement metering device may be used. However, it is preferable to use a thin stable-liquid system (such as oil) for the metering, with diaphragm chambers or the equivalent for translating the oil movement to resin movement, because of the practical difficulties of directly handling viscous tacky hardenable materials in many common pumping and metering systems. Thus, each reservoir is provided with separately controllable means for expelling on a predetermined time bias a selected quantity of fluid into the mixing chamber simultaneously with the expelling of required volumes from the other two reservoirs. In this fashion, a "shot" is practically instantaneously formed, mixed and delivered to the brush setting, thus avoiding any aging problem or temperature control problem. The setting is usually allowed to harden at room temperature, but may be heated to accelerate hardening where such heating would not be deleterious to the particular bristles or setting.

The fluid resinous compositions usable in this invention include fast setting potting compounds such as liquid phenolic casting compounds and compounds based on epoxy resins of different molecular weights. Epoxy resin casting compounds are especially preferred because of excellent bonding to bristles and ferrule and low shrinkage. By use of appropriate fillers, the viscosity can be made high while the use of low molecular weight epoxy resins will yield low viscosity liquids. For such epoxy resins a large number of aliphatic polyamine hardeners are available such as, for example, diethylene triamine. Compounds other than epoxy resins may be used; as, for example, polyester casting resins, which ordinarily require an organic peroxide as the hardener but which are not as rapidly curable at room temperature. Likewise conventional, previously described substantially solventless plastic rubbery compositions may be used for natural bristles although usually some heating may be required. It has been found that although other potting compounds can be used, that the compounds containing a major quantity of epoxy resins are substantially superior as regards adhesive strength to both ferrule and bristle and freedom from cracks and splits. However, any previously successful brush compound can be used with this invention with uniform controllable penetration.

One embodiment of this invention is described below and is illustrated in the drawing wherein FIGURE 1 is a schematic diagram of an apparatus capable of carrying out the process of this invention.

The illustrated apparatus comprises a closed reservoir **10** in which fluid hardener is stored, closed reservoir **11** in which low viscosity fluid resinous composition is stored and closed reservoir **12** in which high viscosity fluid resinous composition is stored. The reservoirs have single open conduits **13, 14** and **15** leading to a **Y** connection wherein one branch **15, 16** and **17** leads into a pressure vessel **18, 19,** and **20** and the other leg of the **Y** through a conduit **21, 22,** and **23.** The conduits **21, 22,** and **23** connect to the input of a mixer-dispenser **24,** which can be for example a high-speed (3000 r.p.m.) homogenizer (such as an Eppenbach mixer) or a low-speed helix mixer (200 r.p.m.) or any similar device capable of handling heavy viscous material. Each pressure vessel **18, 19** and **20** contains a flexible but impervious diaphragm **25, 26** and **27** so as to divide each vessel into two isolated compartments **18*a*** and **18*b*,** **19*a*** and **19*b*,** and **20*a*** and **20*b*.** Each "B" compartment is connected to a separate conduit **28, 29,** and **30** which connects to one side of a solenoid-operated 3-way valve **31, 32, 33.** Each valve is connected to the output side of a separate positive displacement proportioning gear pump **34, 35, 36** and to the input of a separate oil reservoir **37, 38** and **39.** The output side of each oil reservoir is connected to the input side of the pump. Check valves **40** are provided to prevent back flow. The pumps operate continuously and the valves operate simultaneously, either by manual switch or ordinary electric time control means. When the valves are actuated, flow goes to "B" compartments, otherwise to oil reservoirs. The control of speed of each pump such as by a variable resistance provides the proper ratio of volumes, while control of the time of duration that the valves open to the pressure reservoirs provides the proper "shot" volume.

The volume of each oil reservoir is substantially equal to the volume of its corresponding pressure vessel. Thus, both the resin and oil systems are filled with the appropriate compounds so that there is no air in the system and each pump is adjusted as to speed for proper ratio, and the solenoids time-controlled for proper control of shot volume. When the valves are opened to the pressure vessels, each pressure vessel receives an additional selected increment of oil, which causes the diaphragm to move, thus displacing to conduit **21, 22,** and **23** corresponding identical increments of compound fluid which are simultaneously received, mixed and totally dispensed by the mixer **24.** The mixer is constantly moving and has an appropriately small volume to mix and dispense the "shots." The conduits are full but the mixer is empty so that the volumes to be displaced are already adjacent to the openings in the mixer. Suitable temperature control can be provided by jacketing the mixer, conduits, and vessels.

The term "epoxy resin" as used herein refers generally to the polymeric reaction products of polyfunctional halohydrins such as epihalohydrins with polyfunctional hydrogen-donating reactants such as polyfunctional phenols, alcohols and amines. Common epoxy resins include the reaction products of epichlorohydrin with biophenol. The preparation of epoxy resins is described in many U.S. patents including 2,500,449; 2,444,333; 2,528,932; 2,500,600; and 2,467,171. Shell Epon Resins 834, 828 and 815 are examples of commercial epoxy potting resins of varying viscosity.

Examples of typical epoxy resin compounds which can be used in the invention are given below:

*Example I*

| | |
|---|---|
| Shell Epon Resin 834 | 100 |
| Micronized silica | 20 |

The above materials, measured by weight, were charged separately into a Baker-Perkins internal mixer, and mixed at room temperature until uniform. The result was a high viscosity paste material which barely flows at room temperature.

*Example II*

| | |
|---|---|
| Shell Epon Resin 828 | 50 |
| Shell Epon Resin 815 | 50 |

The above two ingredients were charged into a Baker-Perkins mixer and stirred until uniform. The result was a free-flowing at room temperature, light-amber colored liquid with a sticky feel.

A compound of Example I was charged to the reservoir **11,** and was identified as the "heavy component." The compound represented by Example II was charged into reservoir **12** and identified as "light component." The third reservoir **10,** identified as the "hardener reservoir" was charged with diethylenetriamine. A batch of hog-bristled, unbonded brushes was obtained from a manufacturer, of uniform composition and make-up, and characteristic of the average setting design typical of the industry. The dispensing device was set so as to dispense a mixture consisting of 120 parts by weight of heavy component (Example I), and 8 parts by weight of hardener diethylene triamine. This mixture was charged into the ferrules of brushes of this uniform test batch. The average depth of penetration attained was 1/16 of an inch, as measured after 24 hours at room temperature, at which time the resin-hardener mixture had set to a hard, tough, amber-like resinous composition. This amount of penetration was not considered adequate to support and bond the bristles within the brush, especially under the subsequent mechanical strains to be imposed.

The machine was set so that in another group of brushes dispensed a mixture consisting of 100 parts of thin component (Example II) and 8 parts of the same hardener. In this same batch of test brushes the penetration observed after allowing 24 hours at room temperature for hardening, was over one inch, with jagged spikes of resin having flowed down the bristle length to the bottom of the bristles (about three inches, in this case). This indicated excessive penetration.

The machine was then set to operate delivering a mixture consisting of 60 parts of the heavy component, 50 parts of the thin component, and 8 parts of the hardener. When observed in the same brushes after 24 hours at room temperature hardening, penetration was uniform and attained a depth of 3/8 of an inch, considered to be just correct for these brushes. There were no points where the compound had "spiked" down to the bottom of the bristles.

It was found that the repetitive operation of this same machine with the same components in the chambers, under various conditions of initial component temperatures and ambient room temperatures, provided only slight variations in penetration depth. These could readily and rapidly be corrected by very slight changes in the proportions of the heavy and light components. In addition, in actual tests in brush factories, where the whole range of normal variation were encountered between lots of brushes it was found that simple manipulation of the proportions of the heavy and light components permitted the operator to rapidly set the machine to deliver the proper penetration depth of compound. One test used is the heat-freeze or gel test where the material is allowed to penetrate at room temperature for 20 hours and then heated at 150° C. for one hour. The setting is then examined for penetration depth, uniformity, "spiking," adhesion, and "splits." It is required of the brush manufacturer only that he maintain the reservoirs with the two resinous components and the one harder component, These are the only materials necessary for him to stock, regardless of the variation in type of brush required.

In addition to the above desribed form of the invention wherein the high and low viscosity fluid compositions comprise reactive brush setting compositions and the third fluid is a room-temperature hardener for such compositions, there is another form of this invention wherein the high and low viscosity compositions comprise room-temperature hardener compositions, while the third fluid comprises the brush setting composition reactive with the hardener. In this second form of the invention the liquid hardener, which is usually quite thin, can be increased in viscosity by admixture of inert, viscosity-increased ingredients such as thermoplastic resins, soluble soap and colloidal minerals. Examples of these are ½-second cellulose-acetate-butyrate, calcium stearate and colloidal silica. In addition, materials which are non-reactive with the hardener but reactive with the brush setting composition can be used in admixture with the hardener to provide high and low viscosity components. An example of this, where an epoxy resin is the base for setting composition, is the use of polyamide resins in admixture with an epoxy hardener such as diethylenetriamine.

In this second form of the invention, it is desirable that the third or reactive resin fluid be of "average viscosity" and the first and second fluids be on the high and low ends of the desired viscosity range. The other aspects of this second form of the invention are similar to the first form and the same sort of apparatus can be used.

As an example of this second form using epoxy resin as the reactive resin of the brush setting composition is given below:

*Example III*

A mixture of ten parts by weight of diethylenetriamine and one part by weight of calcium stearate are charged into a Baker-Perkins mixer and stirred until uniform to provide a high viscosity paste which barely flows at room temperature. This high viscosity mixture is charged into reservoir **11**. Into reservoir **12** is charged diethylene triamine (the thin liquid hardener) and into reservoir **10** is charged a quantity of Shell Epon Resin 828 which is a thin low molecular weight epoxy resin. The dispensing device is then arranged to provide a mixture of ten parts of the material in reservoir **12** (low viscosity fluid), ten parts of the fluid in reservoir **11** (high viscosity fluid) and 100 parts of the reactive brush setting composition in reservoir **10**. When dispensed into the same type of bristle examples as described in previous examples, substantially identical results are obtained.

I claim:

1. In a process for manufacturing brushes in rapid succession wherein a fluid brush setting composition is



delivered to a cluster of bristles spaced within a cavity and then hardened to form the setting, the steps of providing a first separate fluid supply of a viscosity higher than required for setting any of the brushes desired to be made, a second separate fluid supply of a viscosity lower than required for setting any of the brushes desired to be made and compatible with said first fluid, and a third separate fluid supply and a plurality of successive cyles each consisting of providing a cluster of bristles within a cavity, simultaneously delivering a separately selected volume from each said fluid supply to a single chamber, substantially instantaneously mixing said volumes in said chamber and delivering the total resultant mixture to said cavity, and allowing the resultant setting to harden; said fluid supplies being characterized in that one consists of a room-temperature curable fluid brush setting composition, one comprises a hardener composition reactive at room temperature with each such brush setting composition in the mixture and the remaining fluid supply is a member of the group consisting of a room-temperature curable fluid brush-setting composition and a hardener composition reaction at room temperature with each brush-setting composition in the mixture; said fluid supplies being further characterized in that said mixture is substantially solventless.

2. The steps of claim 1 wherein the fluid brush-setting compositions contain epoxy resins as the major reactive component and the hardener is an aliphatic amine.

3. In a process for manufacturing brushes in rapid succession wherein a fluid brush-setting composition is delivered to a cluster of bristles spaced within a cavity and then hardened to form the setting, the steps of providing a first separate fluid supply consisting of a substantially solventless room-temperature-curable fluid brush-setting composition of a viscosity higher than required for setting any of the brushes desired to be made, a second separate fluid supply consisting of a substantially solventless room-temperature curable fluid brush-setting composition compatible with said first fluid but of a viscosity lower than required for setting any of the brushes desired to be made, and a third separate fluid supply consisting of a hardener composition reactive at room temperature with each said first and second fluids and a plurality of successive cycles each consisting of providing a cluster of bristles spaced within a cavity, simultaneously delivering a separately selected volume from each said fluid supply to a single chamber, substantially instantaneously mixing said volumes in said chamber and delivering the total resultant mixture to said cavity, and allowing the setting to harden; said fluids being characterized in that said resultant mixture is substantially solventless.

4. In a process for manufacturing brushes in rapid succession wherein a fluid brush setting composition is delivered to a cluster of bristles spaced within a cavity and then hardened to form the setting, the step of providing a first separate fluid supply consisting of a substantially solventless room-temperature curable fluid brush-setting composition, a second separate fluid supply consisting of a hardener composition reactive with said brush composition and having a viscosity higher than required for setting any of the brushes desired to be made, and a third separate fluid supply consisting of a hardener composition reactive with said brush-setting composition, compatible with said second fluid supply and of the viscosity lower than required for setting any of the brushes desired to be made and providing a plurality of successive cycles each consisting of providing a cluster of bristles within a cavity, simultaneously delivering a separately selected volume from each said fluid supply to a separate chamber, substantially instantaneously mixing said volumes in said chamber and delivering the total resultant mixture to said cavity, and allowing the setting to harden; said fluids being characterized in that said resultant mixture is substantially solventless.

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