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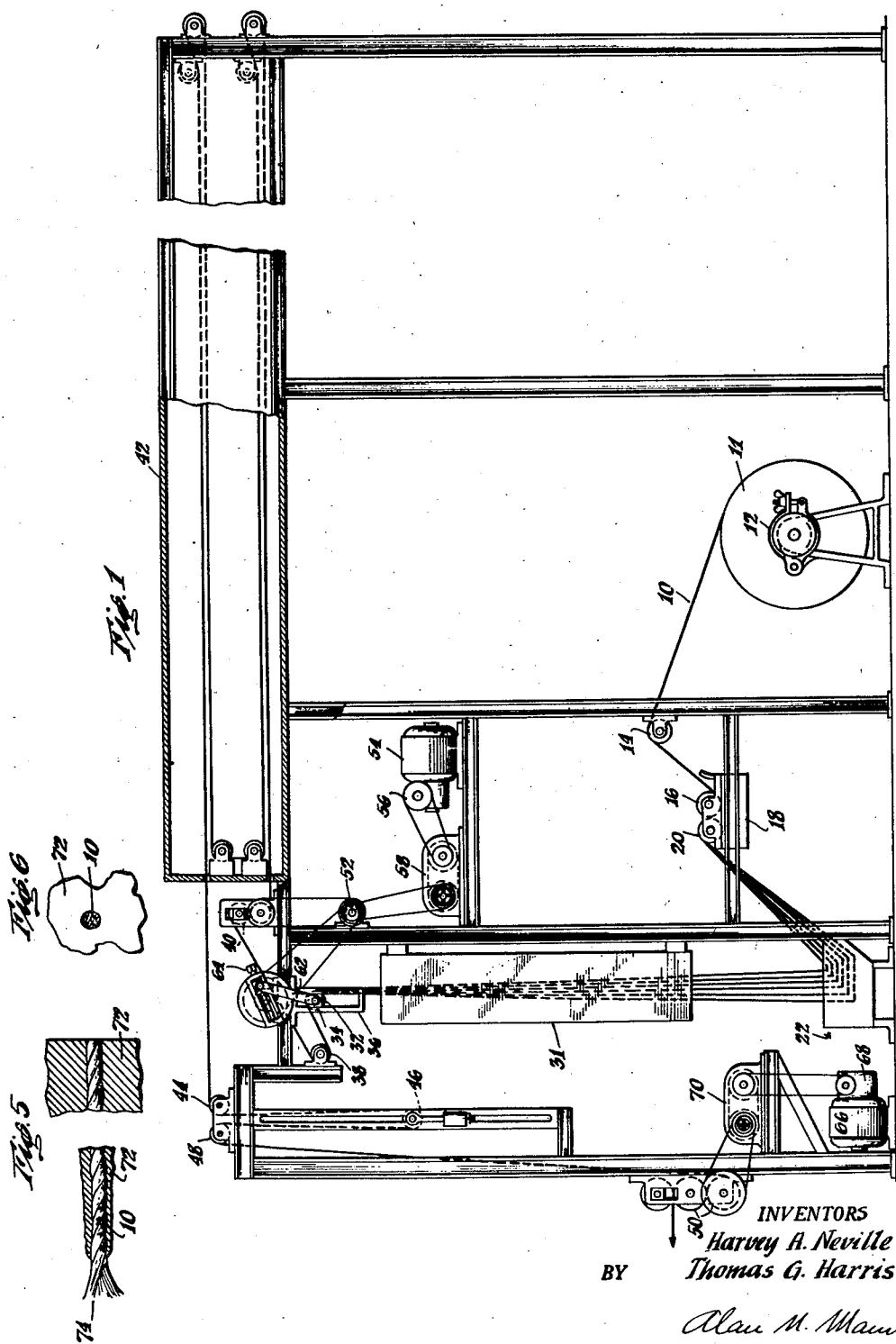
H. A. NEVILLE ET AL

2,426,896

PRODUCTION OF ARTIFICIAL BRISTLES

Filed June 15, 1943

2 Sheets-Sheet 1



Sept. 2, 1947.

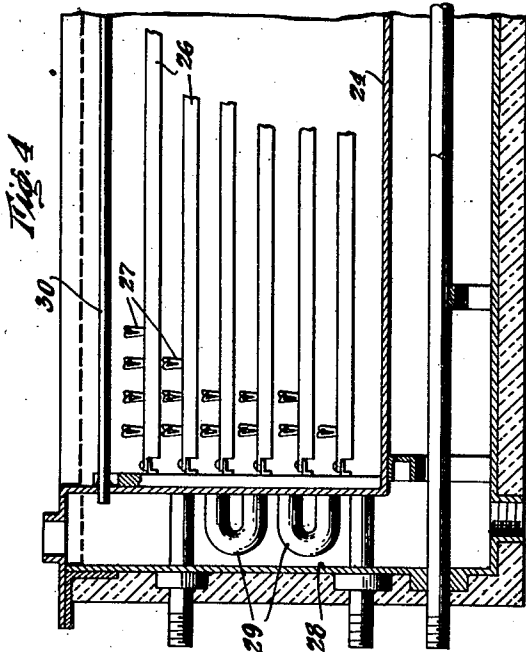
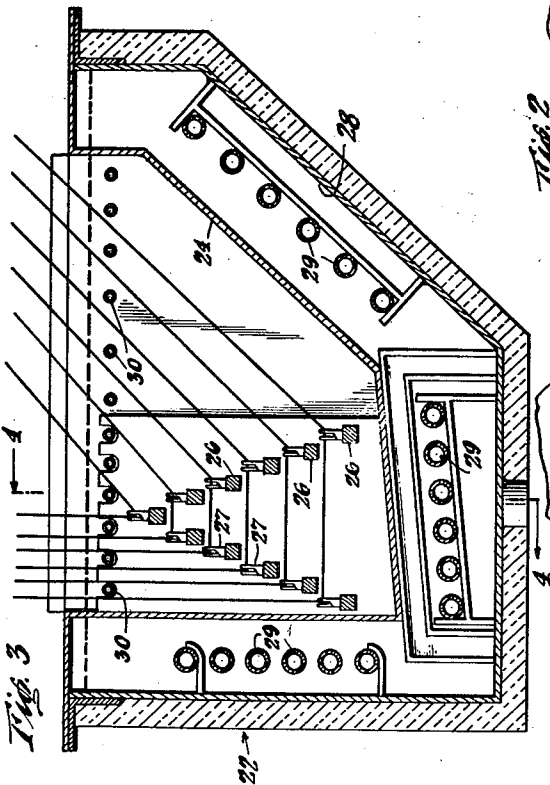
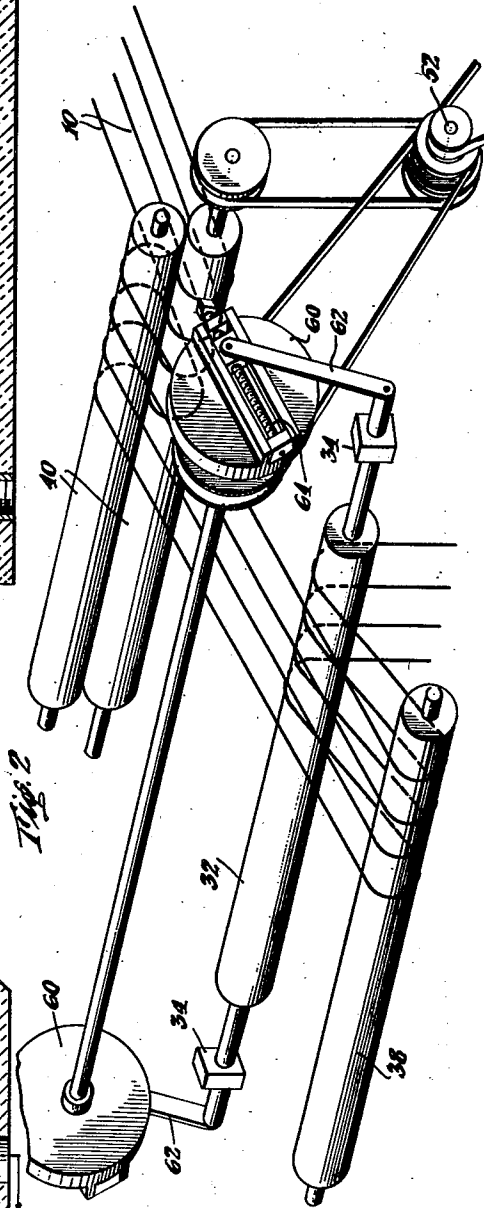
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2 Sheets-Sheet 2



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2,426,896

PRODUCTION OF ARTIFICIAL BRISTLES

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9 Claims. (Cl. 117-7)

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In United States Patent No. 2,267,597 a process is described for making artificial bristles by a batch process. A method is also illustrated schematically for making these bristles continuously. The apparatus and methods there indicated are capable of producing bristles on a limited basis, but we have found that substantial improvement over and above the processes therein set forth are necessary or valuable in order to produce bristles on a volume production basis. This application is a continuation in part of our earlier application Serial No. 432,594, filed February 27, 1942.

In the continuous commercial production by our process of synthetic bristles for paint brushes having tapers to correspond with natural bristles, a plurality of filaments are passed through an appropriate coating bath in such a way that the speed of movement of the filaments is varied as they emerge from the bath so that the coating will form zones of varying thickness on the filament cores. Subsequently the coatings are dried and hardened.

In this application, the term "filament" is used to designate the core on which the coating is built up. Such a filament may be a single integral strand, but ordinarily it will be built up of a large number of strands of fibrous material twisted together to form a thread. For example, we have obtained excellent results using a 150 denier yarn made up of 40 separate rayon strands. While such a thread is sometimes termed a "150 denier, 40 filament yarn," we use the term "filament" as applying to such an entire yarn or to other types of core material that may be used as referred to in the earlier patent specified.

In order to produce the bristles on an economical basis it is essential that a very large number of filaments be operated continuously through a common device. For example it has been found efficient to operate as many as 800 filaments simultaneously through a single apparatus. In order that these can eventually be cut up into the appropriate bristle lengths at the right points, they should be kept accurately in register and each strand of bristles should be substantially similar to the adjacent ones. The present invention relates to methods whereby this is accomplished.

In carrying out this operation, we have found that a number of features are important:

(1) A large number of core filaments are simultaneously passed in and out of a coating bath containing some appropriate plastic which will

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cling to the surface, and as these filaments emerge from the bath their speed of movement is constantly changing from a slow movement to a more rapid one and then back to the slow movement again. When the filaments are moving rapidly, they carry with them a relatively heavy coating of material and the final bristle is relatively thick at the point which emerges from the bath at the higher rate of speed. As the speed of the filaments slows down, the coating gradually decreases in thickness until a minimum thickness of coating is obtained at the point of minimum speed. The speed then accelerates and the coating again becomes heavier.

As the coated filaments leave the coating bath, they are given a preliminary drying and subsequently are passed through a final baking or hardening oven. We find that it is quite important that during this final hardening step the coated filaments be kept under substantial and practically constant tension, and as a practical matter we have found it efficient that they should be drawn through the baking oven at substantially uniform speed. In order to permit of this we find that it is advisable to use an apparatus which gives to the coated filaments a basic speed rate and then interposes in the movement of such filaments, at a point somewhere between the coating bath and the hardening oven, a device which alternately accelerates and slows down the speed of the movement of the filaments through the coating bath and yet feeds them at the basic speed rate to the drying oven where they are hardened under tension. In order that the coated filaments may not be distorted, it is desirable that they be given a preliminary drying at the variable speed rate so that the coating is sufficiently hard to permit it to be gripped at the uniform speed rate to maintain the proper tension in the baking oven. After the coated filaments have been dried and hardened under tension, they are cut into bristle lengths at approximately the points of maximum and minimum diameter.

Generally speaking, we accomplish our control of speed by having the filaments run upwardly out of the coating bath through a preliminary drying zone and over a speed-control roller. From the speed-control roller the coated filaments run at a substantial angle (preferably approximating a right angle) off to the side where they are gripped between driven rolls operating at a constant speed. The speed-control roller is an idler roll, but mechanism is provided so that this roll can be reciprocated up and down in

order that it may periodically approach and then move away from the coating bath. As it approaches the coating bath the speed of movement of the filaments through the coating bath is reduced and as it moves away from the coating bath, this speed is accelerated. Obviously, the speed of movement of this control roll should not at any time (or at least during its downward movement) be greater than the actual speed of movement of the filaments through the uniform-speed driven rolls, because in such case when the speed-control roll is moving toward the bath, the filaments would actually stop their movement and slack would be formed.

As a practical matter, the speed-control roll should be maintained at an approximately uniform distance from the roll alongside of it over which the coated filaments next pass. This distance can be maintained actually constant by mounting the speed control roll on arms pivoting about a point concentric with such an adjacent roll, but the distance will ordinarily be sufficiently uniform if the speed-control roll reciprocates in a straight line back and forth toward the coating bath and the filaments run from the speed control roll in a direction which is approximately at right angles to the line of movement of the speed control roll.

The length of the finished bristles can be varied by changing the time or period of movement of the speed-control roller relative to the basic speed of the filaments, and then varying the cutting mechanism accordingly.

This mechanism is one which we have found efficient for passing the filaments at variable speeds through the coating bath and then continuously and without interruption feeding them through a set of rolls which operate at constant speeds. We do not intend to suggest that this is the only form of mechanism that may be employed for this purpose, for obviously there are mechanical equivalents of the system suggested. For example, the filaments could pass in a straight line from an idler roll to a pair of rolls driven at constant speed and an additional idler roll could be supplied which would periodically press against the coated filaments between these rolls to force them out of their straight line movement and then permit them to return.

In any event, the important feature is that means be supplied for drawing the filaments through and from the coating bath at speeds varying at predetermined rates from a minimum to a maximum and then from such maximum back to the minimum in a substantially uniform cycle to form coatings comprising a series of tapers, with an opportunity being provided to permit such coating to gel, and that means be then supplied so that the coated filaments can pass progressively through a hardening oven while held under substantial tension. Further, we have found that the tension during final hardening should be greater than the tension exerted on the filaments when they emerge from the bath at their slower speed.

The initial gelation of the coating is the result of a relatively slight evaporation of solvent accompanied by a drop in temperature and takes place very rapidly with no great shrinkage in volume. As a result, no great amount of tension is necessary to hold the filament straight at this time. Since unnecessary tension at this point increases the mechanical difficulties, the tension through the first gelation stage should be only such as is necessary to cause the fila-

ments to move through the mechanism without becoming entangled or sagging unduly. This tension must be subject to accurate control, for any undue tension here which stretches the filaments may cause the final bristles to twist and curl, and this is particularly noticeable if the humidity is high. In the final hardening operation, a relatively large amount of solvent must be driven out of the coating which causes it to shrink. During this stage of the process, a different and substantially increased tension must be provided. This means that two sets of tensioning apparatus have to be employed, and we have found it advantageous to associate the variable speed mechanism with the first set so that when the filaments are passing through the hardening oven they move at a substantially constant speed.

(2) With the work which we have done to date, using a coating bath in the form of a solution, we have found that if the coating is to be capable of being applied with variable thicknesses according to a constant cycle, the bath should preferably be very close to the gelation point so that the coating material gels almost immediately upon the withdrawal of the filaments. It must be borne in mind that this operation involves substantially more than the formation of a thin surface film, for at the thickest points the finished coated product has a diameter several times thicker than the diameter of the core filament.

Certainly the bath should be sufficiently viscous to permit the formation of a coating averaging at least as thick as the diameter of the uncoated filaments. Using a coating bath in the form of a solution, this is best accomplished by having the concentration of solids kept as high as possible and by operating at a slightly elevated temperature. By maintaining these conditions a coating of desired thickness can be formed. Also by maintaining the maximum permissible concentration of solids, less distortion of the bristles (particularly in their thicker portions) takes place on drying. While the bristles made by this process have the general shape and conformation of natural bristles, a magnified examination will show that the shrinkage due to the evaporation of solvent causes some distortion in the cross-sectional shape. It is advantageous to keep this distortion reduced to a minimum and this can best be accomplished by maintaining the concentration of solids very high relative to the amount of solvent employed.

If the bath is not near the gelation point and if the coating material remains fluid on the filaments after they emerge from the coating bath, the liquid will run and collect as beads or droplets. On the other hand, if the bath is too close to the gelation point, the surface may gel sufficiently to form skins or films. These may extend between the emerging filaments so that masses of the surface are picked up and spoil the product.

In the former patent it was stated that the container for the coating bath must be filled as near the top as possible to eliminate a surface layer of vapor. We have found that with continuous production using a large number of filaments, the direct opposite is true, and the bath can be maintained sufficiently concentrated and sufficiently close to the gelation point and yet not form surface skins, only if a vapor layer or blanket of appreciable thickness is maintained over the surface of the bath and if the bath is maintained at

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the desired temperature close to the surface where the filaments emerge. These results are best obtained by the use of a controlled atmosphere over the bath, preferably assisted by the use of heating coils in the bath.

We have found that the vapor layer (due to the fact that it is heavier than air) can be adjusted and maintained by supplying a wall or dam around that portion of the surface of the liquid from which the filaments emerge, and by adjusting the height of this dam above the liquid surface. This can be done either by maintaining a constant level in the coating bath or by floating the dam in the coating solution. Ordinarily this dam will run around the whole group of emerging filaments, but if desired separate dams may be employed for groups of filaments or for individual filaments. In such case, the dams do not need to be as high as we otherwise specify herein, as the vapor layer is more localized. The use of these smaller dams adds somewhat to the complexity of threading up the machine. In any event, the dam must be closely adjacent to the outer lines of the points of emergence of the filaments and the surface of the coating fluid should be kept free from drafts. When working on a large number of filaments, if one attempts to blow air through them as they emerge from the coating bath, we have found that it is extremely difficult to prevent the formation of skins or films over the surface of the coating bath.

The critical point of the whole operation is here at the surface of the coating bath, and many variables must be properly interrelated to carry out the operations successfully. If the bath is not sufficiently close to the gelation point, the coating material will flow on the surface of the filaments and form beads or droplets. If the filaments are too close together or move at too high a rate of speed, they will tend to lift the surface of the bath which will form strings or skins running from one filament to another. This danger is exaggerated if the rate of evaporation is increased on the surface of the bath, or if it is chilled.

It is only by the use of the protecting vapor layer and careful control of temperatures that we have been able to coordinate these factors to give satisfactory commercial results, for the bath which we prefer to use is one so saturated that it would immediately form a surface skin if cooled to room temperature and exposed directly to the air. Thus employing a bath of cellulose acetate dissolved in acetone and maintained close to its gelation point, at a temperature of about 50° C., and employing a vapor layer of substantial thickness, we are able to move the filaments through the bath at an average speed of as much as 3.5 feet per minute and to have these filaments as close together as $\frac{3}{8}$ of an inch apart in rows, with the rows spaced about $\frac{5}{8}$ of an inch apart without forming skins and without the coating liquid flowing to form beads.

Ordinarily the limits of the rate of speed of movement through the coating bath will be between a minimum rate not below a value over zero and a maximum not greatly exceeding 10 feet per minute, that is, the average speed will be not more than about 5 feet per minute.

The thickness of this vapor layer may be considered to be approximately equal to the height of the dam or rim around the bath above the surface of the bath, and we have found that to get commercial production this should be at least $\frac{1}{2}$ of an inch and preferably between $\frac{5}{8}$ of an inch

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and 1 inch in height. In operation, the aim should be to maintain the vapor layer just as thick as possible without causing the coating to move on the filaments to form beads or droplets.

In some cases when a bath has been running with entire satisfaction, it may suddenly indicate a tendency to form skins on the surface. This probably is due to a change in the vapor layer such as may be caused by some slight draft or by a change in the relative humidity or by some other factor affecting the rate of evaporation of solvent. If such a skin formation is indicated, the operator may have additional solvent available which can be sprayed over the surface of the bath to increase the concentration of the solvent vapors over the bath surface and also to lower its viscosity.

(3) If the coating is applied to the filaments from a bath where the coating material is in solution and very close to the gelation point, it will mean that the bath is sufficiently viscous so that ordinarily there will not be sufficient opportunity for the coating material in the bath to work its way through between the various fibers or strands that go to make up the basic core filament.

In the issued patent already referred to, it was suggested that these core filaments might be impregnated with thermo-setting resin which should be hardened before the coating is applied. We have found that it is much better to subject the filaments to a preliminary impregnation of plastic material which is not set-up before it reaches the coating bath. This may be a thermo-plastic material or a thermo-setting material or a mixture of the two, but if a thermo-setting material is employed for the preliminary impregnation, we have found that it should be kept in its B stage so that it is capable of being softened in the coating bath. Also the material used for impregnating should be compatible with the material used for coating so that a firm bond or coalescence will be had between the two. Actually, we have obtained the best results when the impregnating bath is made up at least in part from the same plastic material as is employed in the coating bath.

While we refer to the filament as being impregnated in this first bath, we do not mean that this treatment must actually penetrate into the separate strands. It is rather a case of having the impregnating bath enter the filaments between the various strands so that these are cemented together to form a unified filament to which the coating can readily adhere. By controlling the degree of this impregnation, bristles can be made which in use will fray out slightly or "flag" at their tips. This is highly important, for a proper "flag" on the bristles greatly improves the evenness with which paint will flow from the finished brush. The amount of impregnation should be sufficient to bond together the separate strands and serve as a base for the finishing coat, but not too much to prevent such flagging. The ability of the bristle to "flag" properly is also assisted by having the outer coating quite thin at the tip end. The desired result can be assisted by varying the concentration of solids in the impregnating bath.

After the filaments leave the impregnating bath they should be permitted to dry sufficiently so that the impregnating material will gel, but if a thermo-setting material has been used for the impregnation, it is preferable that it should not be hardened to the point where it will set-up

and thus not soften to serve as a base for the coating material.

By giving the filaments this preliminary impregnation with plastic material that is compatible with the coating material and which preferably is soluble in the solvent of the coating bath, we have found that the filaments need to stay in the coating bath only for a brief interval of time and that there appears to be very little difference in result if some of the filaments remain in the coating bath through a longer path of movement than others because a good bond for the coating is had almost immediately. This simplifies the mechanical arrangements of the process.

Our tests have indicated that where we employ a preliminary impregnating bath which is compatible with the coating material, the bristles will have a relatively long life and withstand substantial flexing. On the other hand, where the coating is not bound to the filaments through the medium of the impregnating material, there may in some cases be a tendency for the coating to split and crack off from the filaments in use.

The coating bath employed is a solution of a resinous film-forming material so constituted that as the filaments emerge from the bath, the coating will gel quite rapidly. As previously stated, this ordinarily demands the use of a volatile solvent, and the maintenance of the solution just short of the gelation point. However, the factors affecting gelation vary with different types of resin.

In United States Patent No. 2,267,597 already referred to, a number of types of coating compounds are suggested, and various other resinous bodies may be employed provided they have the proper characteristics to meet the particular service demanded. One coating composition which we have found excellently adapted for use in our process consists of a mixture of equal parts of high viscosity and low viscosity cellulose acetate and a plasticizer such as dimethyl phthalate or other similar type of plasticizers known in the trade, in an amount equal to about 10 or 11% of the cellulose acetate. These materials are dissolved in a volatile solvent such as acetone to give a viscosity ranging from Z₁ to Z₂ on the Gardner-Holdt scale (at 25° C.). If desired, some methyl alcohol may be used with the actual solvent material and the solutions may be otherwise modified as is known to those skilled in the art. A solution such as we have specified is advantageously employed at a temperature of from about 10° C. to 40° C. above room temperature, as for example a temperature of about 50° C.

In some circumstances, we have found it desirable to incorporate a thermo-setting resin with the thermo-plastic material, and for this purpose have employed furfuryl alcohol which has been given a partial polymerization. However, this adds somewhat to the complexity of the operation and we have not found it essential in order to produce satisfactory bristles. In some cases we have employed such a mixture, diluted to a low viscosity, in the preliminary impregnating bath and have used the acetate composition, without the furfuryl alcohol, in the coating bath. This has given good results.

By combining these various features we are able to make bristles with commercial rapidity which are cut off and collected in substantial bunches so that they can readily be made up into paint brushes.

The operation of our process and the machinery which we have employed for carrying it out are illustrated in the accompanying drawings in which Fig. 1 shows a side view of the apparatus with the drying oven illustrated in section. Fig. 2 is a perspective view of certain of the moving parts; Fig. 3 is a sectional view on an enlarged scale through the coating bath; Fig. 4 is a sectional view taken on line 4-4 of Fig. 3; Fig. 5 is a sectional view greatly enlarged of a typical finished bristle after some use (with the center broken away) and Fig. 6 is an end view of the bristle of Fig. 5.

The base filaments 10 are wound on a drum 11, the rotation of which is controlled by a brake band 12 which is adjustable so that proper tension can be maintained on the filaments. The filaments pass over a roller 14, then under a roller 16 into the preliminary impregnating bath 18. From the bath 18 the filaments pass up over the roller 20 and down to the coating bath 22.

The coating bath 22 comprises an inner vessel 24 to hold the actual coating liquid. In this are arranged a series of bars 26 each of which carries a number of guides 27. The strands pass through the guides as illustrated and up out of the coating bath.

In order to maintain the liquid in the coating bath at a desired temperature there is an outer shell 28 serving as a jacket to receive oil or other heating media. This oil is heated by any desired means such as the coils 29. Additional coils 30 are preferably supplied passing through the actual liquid in the heating bath to carry hot oil and thus maintain the bath at the desired temperature near the exposed surface.

The filaments pick up a coating of plastic material in the coating bath 22 which gels promptly, as has been previously described. Due to the fact that the coating material is maintained near its gelation point the level of the coating material in the vessel 24 is carefully controlled and ordinarily should range at a height of from one half inch to one inch below the top edge of the vessel 24. This serves to maintain a layer of vapor over the bath which tends to prevent the formation of skins.

From the coating bath 22 the coated filaments pass upward to a preliminary drying oven 31 where the filaments are dried sufficiently so that they can be passed over other rollers without undue distortion or sticking. This oven is heated in any desired manner to a temperature of about 80° C. The coated filaments pass over a movable roll 32, which rotates in slide blocks 34 (see Fig. 2) which reciprocate in hangers 36 (the hangers 36 are omitted from Fig. 2 for the sake of clarity). Due to the reciprocation of the roll 32 the speed of withdrawal of the filaments from the coating bath 22 can be varied in a predetermined manner to form tapered filaments.

After the coated filaments have passed over the roll 32 they go around roll 38 and then through between the driven rolls 40 and thence pass into the drying oven 42 where they go back and forth a number of times so that they can be adequately hardened. The drying oven 42 is maintained at a desired temperature (for example, about 120° C.) by heating means not shown.

When the filaments emerge from the drying oven 42 they pass over a roll 44, thence around the tensioning roll 46, over the roll 48 and through the driven rolls 50. After coming out of the driven

rolls 50 the filaments are cut to length by any desired mechanism not shown.

The rolls 40 are driven from a jack shaft 52 which in turn is driven by a motor 54 acting through gear reduction mechanism indicated at 56 and a speed control mechanism 58.

Likewise driven from the jack shaft 52 are the crank wheels 60 to which are attached the connecting rods 62 that control the reciprocating movement of the roll 32. The degree of eccentricity of the attachment of the connecting rods 62, and this is adjusted by the screws 64. It will be noted that by turning these screws 64 this eccentricity can be reduced to zero so that there would be no movement of the rolls 32 in which case the filaments would be withdrawn from the coating bath 22 at constant speed and therefore would have uniform diameter.

The tension from the drum 11 through to the rolls 40 will depend upon the friction generated by the friction band 12 and in general this tension should be only enough to prevent the filaments from sagging or becoming entangled; for example this may amount to between one half ounce and two ounces per thread. On the other hand, the tension on the coated filaments as they pass through the hardening oven 42 will be substantial due to the action of the tensioning rollers 46 and may amount to about 5 ounces per thread. The rollers 50 which draw the coated filaments through the hardening oven 42 are driven by a motor 66 operating through gear reducing mechanism 68 and a speed control mechanism 70. The speed with which the filaments are withdrawn from the coating bath will alter the thickness of the coating and the average speed can be adjusted readily through the speed control mechanism 58. Obviously, the speed with which the filaments are finally withdrawn must be coordinated with the average coating speed, and this is done by the speed control mechanism 70.

It will be noted that while the filaments in general pass through the coating bath at a constantly varying speed ranging between a predetermined minimum and maximum they are brought to a substantially uniform speed before entering the hardening oven 42 and are then placed under an increased tension so that they will dry and harden substantially straight.

The length of the final bristles will depend upon the rate of reciprocation of the roller 32 relative to the average speed. In the drawings no mechanism is shown for varying this relationship but obviously if bristles of a different length are to be made the variation can be controlled by varying the size of the pulley wheels on the jack shaft 52.

By operating as outlined above, we have found it possible to produce on an efficient commercial basis bristles which taper so that they have an external shape and size that approximates that of a natural bristle. They further have the added advantage that when these bristles are used in a paint brush, the tips fray out slightly to form a flag (somewhat like that of natural bristles) which provides a mopping action and causes the paint to flow on very evenly. This effect is illustrated in Figs. 5 and 6 which indicate a typical bristle greatly enlarged. In Fig. 5 the central part of the bristle is broken away, as a bristle of this diameter if shown in full proportion would be very long.

In these figures the base filament 10 is indicated as made up of a twisted yarn comprising a num-

ber of strands. The impregnating resin is not specifically indicated, but the coating resin is designated by the numeral 72. It will be noted in Fig. 5 that this varies from a very thin coating near the tip to a coating at the butt which has an average thickness considerably greater than the diameter of the filament 10. Due to this taper, the bristles have the general shape and size of the natural bristles but an enlarged view shows that they are not absolutely circular in cross section. Particularly at the base where the coating material is thick, the evaporation of solvent and shrinkage may cause some distortion and a typical butt end section might have an appearance such as is indicated in Fig. 6.

When the bristle has been used for a short time, the coating near the tip breaks away and the core filament 10 frays out to form the flag 74.

These bristles have a substantial water resistance and with reasonable care resist the action of the solvents contained in the paint so that they have a good commercial life. By using the features shown in this application, they can be produced at relatively low cost and they make paint brushes which apply paint in a very efficient manner.

It is understood that the specific details given are intended only by way of illustration and that the same may be modified in many particulars without departing from the spirit of our invention.

What we claim is:

1. A continuous process of making tapered bristles which comprises the steps of passing a plurality of continuous core filaments into and out of a coating bath of plastic material which is sufficiently viscous to cling to the filaments to form coatings of substantial thickness and not to run substantially on the filaments as they are withdrawn, intermittently varying the speed with which the filaments emerge from such bath between a minimum rate of speed which involves positive forward movement and a maximum rate of speed not in excess of ten feet per minute, followed by a variation from such maximum to such minimum, each such variation lasting a length of time equivalent to the time for one bristle length of each filament to emerge from the bath whereby tapered sections of bristle length are formed, and without stopping the movement of the filaments bringing them to approximately constant and uniform speed of movement and hardening the coatings under a positive tension sufficient to maintain the filaments taut while hardening whereby substantially straight filaments are produced, and subsequently cutting the continuous filaments into bristle lengths.

2. A process as specified in claim 1 in which each of the filaments comprise a plurality of strands and such strands are passed through a solution of plastic material sufficiently fluid to impregnate the filaments to bond the strands together and such plastic is permitted to gel before the filaments are passed through the specified coating bath.

3. A process as specified in claim 1 in which the filaments after emerging from the bath are straight and under tension until the coatings gel, after which they are passed while still under tension to a heating zone adapted to harden the coatings.

4. A process as specified in claim 1 in which the coating bath has a viscosity sufficient to form

coatings on each filament averaging at least as thick as the diameter of such filament, and the formation of skins on the surface of the bath is prevented by maintaining over the surface of the bath a thin layer of controlled atmosphere adapted to reduce the rate of evaporation from the surface of the bath below the normal rate which would take place if the surface were freely exposed to the air.

5. An apparatus for making tapered bristles to be used in conjunction with a coating bath of plastic material adapted to cling to the filaments to form coatings of substantial thickness, comprising a source of a plurality of core filaments, a container for holding such bath, means for passing such plurality of filaments into and out of such bath including means for intermittently varying the speed of withdrawal of the filaments from the bath and including means whereby the speed of movement of the filaments may be brought to an approximately constant and uniform speed without stopping the movement of the filaments, an oven in which the filament coatings can be hardened, and means for moving the filaments through such oven at such constant rate of speed under a tension sufficient to maintain the filaments substantially straight while hardening.

6. An apparatus for making bristles for paint brushes and the like comprising a source from which a plurality of filaments can be withdrawn under tension, a container for holding a coating bath and a preliminary drying oven associated therewith, a set of driven rolls adapted to draw the filaments through the bath and through such oven, means associated with such rolls whereby the speed of withdrawal of the filament may be intermittently varied, a second oven in which the coated filaments can be hardened, a second set of driven rolls for drawing the filaments through such second oven, and means for maintaining the filaments under substantially greater tension in said second oven between said two sets of driven rolls than that maintained on the filaments while they are passing through the coating bath.

7. An apparatus as specified in claim 6 which further includes mechanism associated with said first set of driven rolls whereby the speed of movement of the filaments through the coating bath is varied in substantially uniform cycles, while the filaments pass through the second oven at substantially uniform speeds.

8. An apparatus for making tapered bristles to be used in conjunction with a coating bath of

plastic materials adapted to cling to the filaments to form coatings of substantial thickness comprising a source of a plurality of core filaments, a container to hold such a coating bath, means for drawing the filaments simultaneously and substantially parallel into and out of the coating bath, means for varying the average speed of the filaments simultaneously and means whereby the speed of the filaments can be caused intermittently to vary back and forth between a minimum and a maximum relative to such average speed.

9. The combination with an apparatus for producing artificial bristles comprising a source of core filaments, a container for a coating bath, a drying oven, a baking oven and means for drawing the filaments from their source and through the coating bath and baking oven, the filaments being drawn out of the baking oven at approximately uniform speed, of means whereby the speed with which the core filaments are withdrawn from the coating is alternately accelerated and slowed down while the core filaments are maintained substantially under tension from the coating bath until they emerge from the baking oven, such speed-varying means comprising a roller over which the coated core filaments pass which reciprocates back and forth in the approximate path from which the coated core filaments are moving while remaining an approximately constant distance from an adjacent roll towards which the coated core filaments are moving.

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