Dec. 26, 1961 S. BATESON ETAL 3,014,453

COATING APPARATUS

Filed June 3, 1958 2 Sheets-Sheet 1

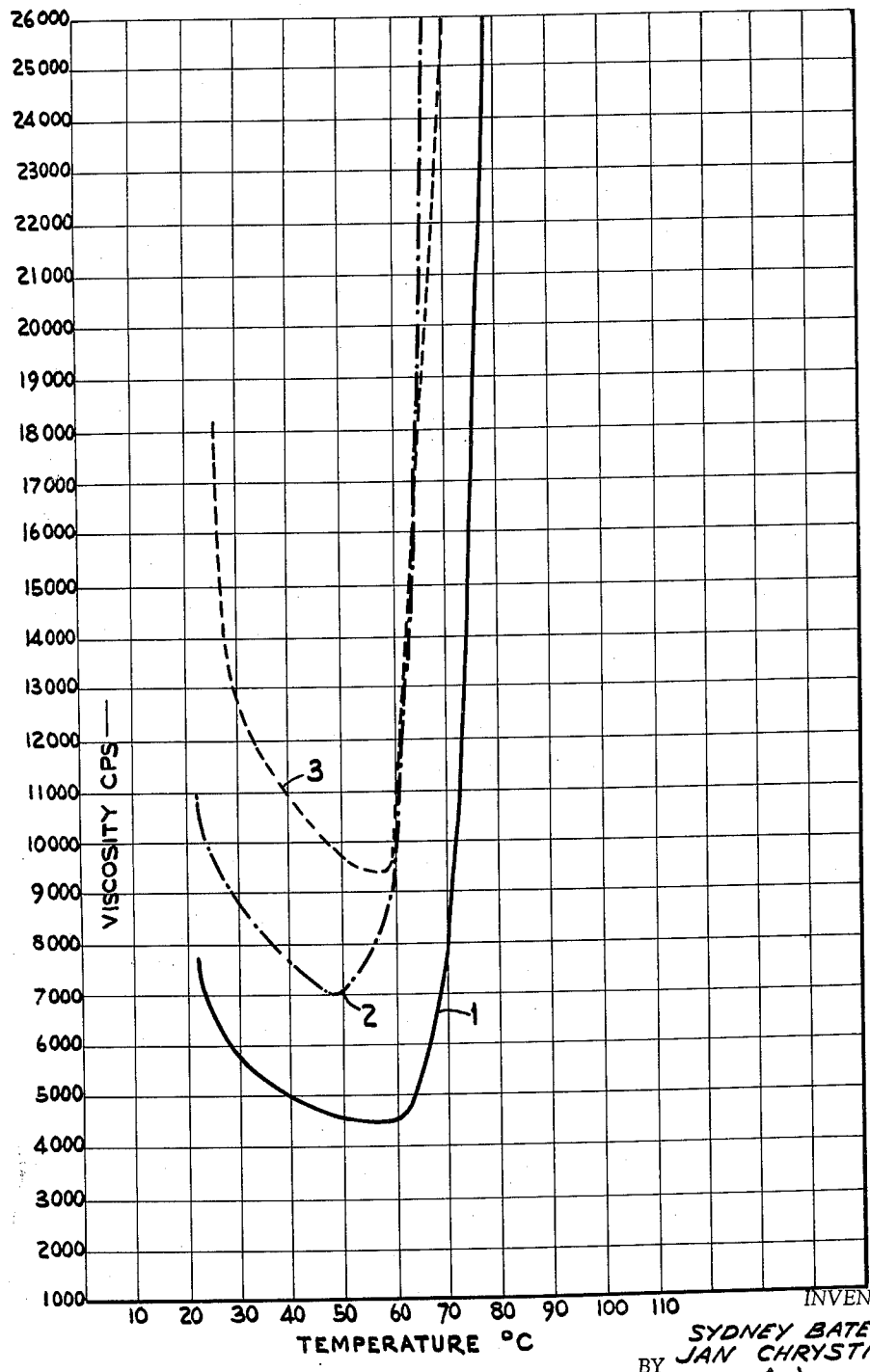


FIG. 1

INVENTORS
SYDNEY BATESON and
JAN CHRYSTMAN
BY Oscar Spencer
ATTORNEY

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FIG. 2

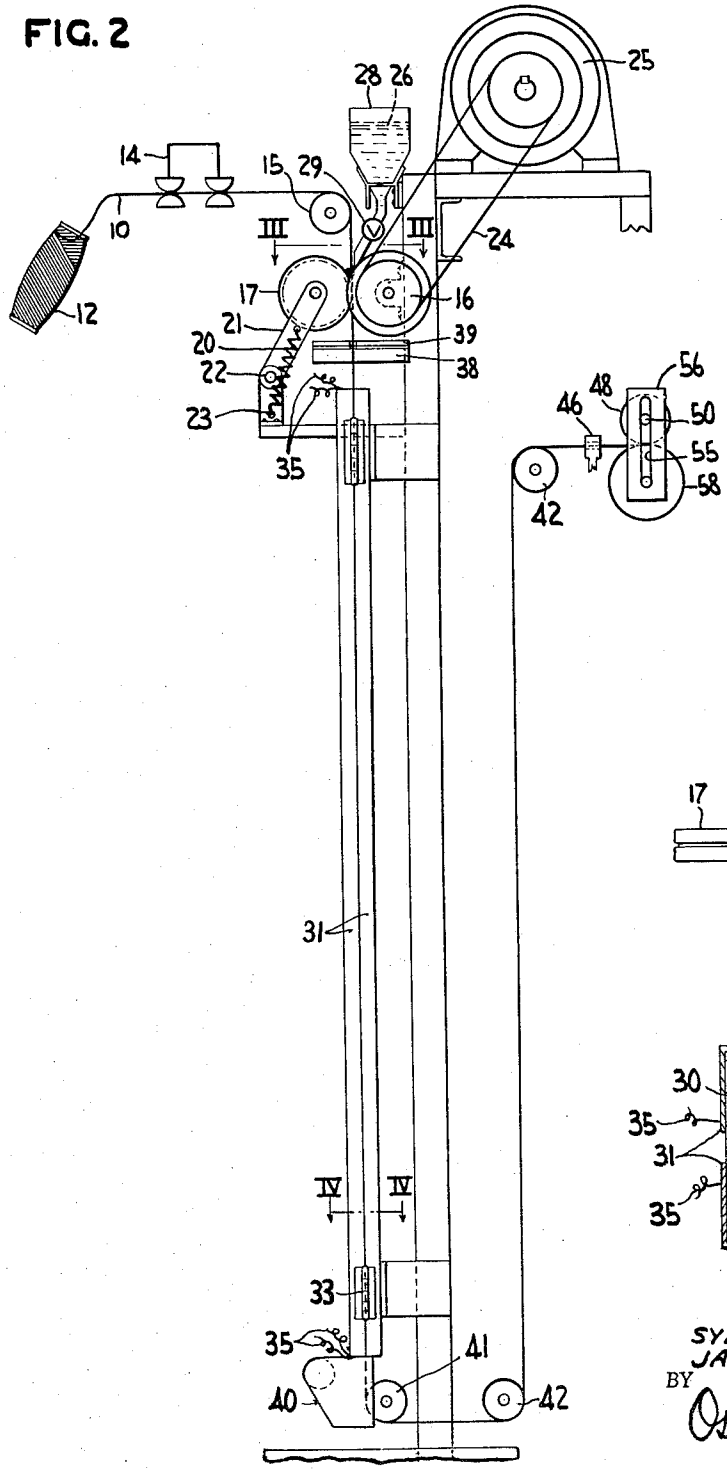


FIG. 3

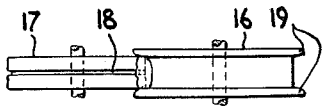
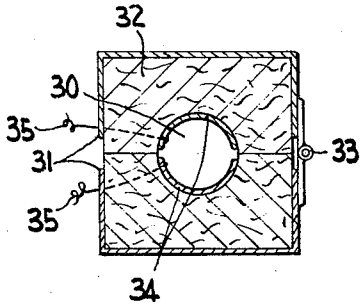


FIG. 4



INVENTORS
SYDNEY BATESON and
JAN CHRYSTMAN
BY
Oscar L. Spencer
ATTORNEY

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3,014,453

COATING APPARATUS

Sydney Bateson, Oshawa, Ontario, and Jan Chrystman, Rexdale, Ontario, Canada, assignors to Pittsburgh Plate Glass Company, Allegheny County, Pa.

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The present invention relates to an apparatus for coating a base material with a plastisol and it has particular relation to an apparatus for applying a plastisol to a strand of glass fibers moving at a high rate of speed so that each individual filament making up the strand is coated with the liquid and a uniform overall coating is applied to the strand.

Glass fiber yarns coated with a plastisol are now being woven in large quantities into insect screening. The plastisols used are dispersions of a high molecular weight polymer such as polyvinyl chloride in a liquid plasticizer. Small amounts of other materials such as coloring pigments or dyes are also present in the dispersions. The glass fiber yarns which are preferably employed are known to the trade as 75–1/0 and 150–1/2 glass fiber yarns. A 75–1/0 yarn contains approximately 7,500 yards to the pound and is composed of a single strand made up of 204 individual glass filaments, each of said filaments having an average diameter in the neighborhood of .0005 inch. A 150–1/2 glass fiber yarn is made up of two continuous filament strands twisted and plied together, each strand containing approximately 15,000 yards to the pound and being made up of 204 individual glass filaments having an average diameter in the neighborhood of 0.00038 inch.

The outside diameter of the two yarns is about the same. It is preferred to employ the 75–1/0 yarn because it is much less expensive than the 150–1/2 yarn. On the other hand, the 150–1/2 yarn is much more susceptible to coating with the plastisol because it is relatively free from fuzzing and consequent contamination of the plastisol during the coating operation. The fuzzing is brought about by the shearing off of broken ends of individual filaments of the yarn as the yarn passes through the plastisol. As the fuzzing progresses, the broken ends build up in number in the plastisol and clog the various types of dies or other equipment used in the coating process. Thus it is an object of this invention to provide an apparatus which permits coating glass fiber yarns, particularly 75–1/0 yarns, with a plastisol without the occurrence of fuzzing during the coating operation.

In the application of a plastisol to a glass fiber yarn, it is important that the plastisol penetrate the yarn and flow around and coat the individual filaments making up the yarn. The plastisol coating on the individual filaments acts as a lubricant for each individual filament to prevent breakage of the filaments caused by abrading on each other. A further object of the invention is to provide an apparatus for coating and impregnating a glass fiber yarn so that the individual filaments are coated with the plastisol.

A conventional method of applying a plastisol to a glass fiber yarn involves passing the yarn through a bath of the plastisol to pick up an excessive amount of the plastisol and thereafter passing the coated yarn through a die or a pair of matching grooved rollers. The use of grooved rollers has been found preferable to attain the desired impregnation of the plastisol on the yarn. When relatively thick coatings of the plastisol on the yarn are required, the usual practice is to make several passes of the yarn through the plastisol and dies.

When the yarn has been coated with the plastisol, it is subjected to sufficient heat, about 150° to 200° C. for polyvinyl chloride dispersions, to fuse the plastisol into a solid coating. This heating may be accomplished by the use of radiant heaters or other conventional heating systems. It has been noticed that during the heating of the plastisol there is a tendency for it to flow just prior to fusion and form irregular knobs or bumps along the yarn. This is highly undesirable for it is of the utmost importance that the yarn be uniformly coated. Any irregularities in yarn diameter show up glaringly when the yarn is woven into screening. Thus, a further object of the invention is the provision of an apparatus to produce a yarn of uniform diameter throughout its length and free from any irregularities such as knobs or bumps along the yarn.

It has been found that the choice of the plastisol to be employed is of prime importance in achieving the production of a satisfactory product at high rates of production. Further, it has been found that the property of viscosity of the plastisol is of great importance. In order to obtain adequate impregnation and prevent fuzzing, it is desired that the viscosity of the plastisol be as low as possible, for example, about 5000 to 15,000 centipoises at room temperature. The viscosity of a plastisol may be decreased by increasing the amount of the plasticizer and by using certain types of plasticizer and in some instances volatile solvents may be added to produce a material of low viscosity. When volatile components are added to a plastisol, it is then known as an organosol and ordinarily organosols are not satisfactory for use in the high speed coating of a glass fiber yarn. This is because of the extremely slow rate at which the organosol must be heated to fusion in order to allow the volatile components to be removed without the formation of blisters in the coating. Thus the use of an organosol does not lend itself to high speed coating of glass fiber yarn but it may be used for slow speed coating where long, slow heating is employed.

Although use of a plastisol of low viscosity is desirable to achieve impregnation and prevent fuzzing, there are several disadvantages in using low viscosity plastisols. First, the low viscosity plastisol is more subject to the formation of bumps or knobs on the yarn for it will not remain in place on the yarn during the preliminary heating after the coated yarn has been passed through the dies and prior to fusion. Secondly, the final properties of plastisols having low room temperature viscosities are not as satisfactory as those having higher room temperature viscosities. The lower viscosity plastisol coated yarns do not have as good tensile strength or abrasion resistance. Also, their weathering properties are not as good. The plasticizer is caused to migrate to the surface of the yarn where it is subjected to ultra-violet radiations. The moisture resistance of a yarn coated with a lower viscosity plastisol is also poorer.

In accordance with the present invention, an apparatus has been provided whereby a plastisol having a relatively high viscosity and providing the yarn with the desired physical characteristics may be utilized to thoroughly impregnate the yarn and produce a yarn free from irregular bumps and knobs thereon. This apparatus is employed to make use of the physical property of plastisols wherein the viscosity of the plastisol drops steadily upon rapid heating until it reaches a minimum viscosity whereupon further rise in temperature of the plastisol causes it to fuse and its viscosity to rise rapidly. It has been found that the minimum viscosity of a plastisol prior to fusion is roughly one-half of the viscosity of the plastisol at room temperature when it is heated very rapidly to fusion temperature, for example, within 1 to 10 seconds.

The apparatus contains means for heating the plastisol and for applying it to the yarn while hot so that the plastisol is applied at a viscosity much lower than its normal room temperature viscosity. This means may be in the

form of dies or heated, grooved rollers. The apparatus also includes means for passing the yarn through the dies or rollers and means for heating the coated yarn to cause the plastisol to fuse thereon.

The invention may be further described in conjunction with the drawing in which:

FIG. 1 is a graph illustrating the effect of temperature on the viscosity of a plastisol;

FIG. 2 is a diagrammatic elevation of apparatus suitable for practice of the invention;

FIG. 3 is a plan view of a portion of the apparatus shown in FIG. 2 taken along lines III—III of FIG. 2; and

FIG. 4 is a sectional view taken along lines IV—IV of FIG. 2.

As stated, a property of plastisols is that during the heating and fusing process, the viscosity of the plastisol decreases from room temperature to a minimum and then rises rapidly. This is shown on the graph in FIG. 1 of the drawings. The ordinate of the graph is viscosity in centipoises and the abscissa is temperature in degrees C. The various curves show the viscosity properties of the following materials:

(1) A plastisol containing 66 parts by weight of dioctyl sebacate per 100 parts by weight of polyvinyl chloride particles having a particle size of about 0.03 to 0.05 micron.

(2) A plastisol containing 67 parts by weight of diisooctyl phthalate per 100 parts by weight of polyvinyl chloride.

(3) A plastisol containing 65 parts by weight of 50/50 mixture of dioctyl sebacate and dioctyl adipate per 100 parts by weight of polyvinyl chloride.

It can be seen from the graph that the viscosity of the various plastisols decreases roughly by about one-half as the plastisol is heated rapidly from room temperature to a temperature approximating 50 to 60° C. where it reaches a minimum. As the temperature of the plastisol is raised slightly above this minimum viscosity point, the viscosity of the plastisol rises very rapidly as it begins to fuse.

Results of various experiments have shown that plastisols having viscosities above 8000 at the time of application do not provide proper penetration for a high speed, i.e., 500 to 600 feet of yarn per minute, application of plastisol to glass fiber yarns. On the other hand, it has been found that plastisols having viscosities above 8000 centipoises and up to 16,000 or more centipoises at room temperature provide the yarn with the best coating as far as tensile strength, abrasion resistance and weathering is concerned when fused to the yarn. Thus, by applying the plastisol at its minimum viscosity in accordance with the teaching of the present invention, these higher room temperature viscosity plastisols may be used.

The apparatus is shown in FIG. 2 of the drawing. Glass fiber yarn 10 from a suitable package 12 passes through a twin disc tension compensator 14 over an idler pulley 15 vertically downward between rollers 16 and 17. Roller 17 has a peripheral groove 18 and roller 16 has edge flanges 19. The rollers are spring-loaded by means of spring 20 fastened at one end to support arm 21 for roller 17. The support arm is pivotally mounted at 22. The spring 20 is fastened at its other end at point 23 on the supporting frame for the apparatus. The spring 20 causes the rollers to press against each other at a pressure of about 1 to 5 pounds per square inch. Roller 17 has its extremities fitted snugly inside and against the inner sides of the flanges 19 on the roller 16. Roller 16 is driven in the direction of strand travel by means of belt 24 operatively connected thereto and to motor 25. The groove 18 in the roller 17 is approximately in the shape of a horseshoe with the open end of the groove facing the roller 16. The dimensions of the groove may vary and may be, for example, 0.02 inch across the opening. 0.02 inch deep and having a radius of curvature at the inner portion of 0.01 inch. The groove may also be U-shaped or semi-oval or semi-circular.

As the yarn 10 passes through groove 18, plastisol 26 dropped from a reservoir 28 is forced into and around the yarn 10. The plastisol may be heated in the reservoir by suitable means (not shown) mounted in the reservoir or around the reservoir; however, this is not too desirable for the plastisol may prematurely fuse while standing in the reservoir. Preferably, the plastisol is maintained at room temperature in the reservoir. It has been found that applying the plastisol in this manner is preferred to passing the yarn through a bath of plastisol and then through a die. When the yarn is first passed through a bath of plastisol, shearing of broken ends of the yarn and fuzzing occurs thereby contaminating the bath and requiring its frequent replacement. This is especially the case with 75–1/0 yarns where broken ends are much more prevalent than with other types of yarns, for example, 150–1/2 yarns where broken ends created during manufacture are tucked in during the twisting and plying operations. Valve 29 in the flow line from the reservoir controls the flow of plastisol to the rollers. The flanges 19 prevent any overflow of plastisol from dripping over the sides of the coating rollers and also help to maintain a supply of the plastisol in the groove 18. The supply of plastisol between the rolls should be controlled so that it is just sufficient in amount to insure that there is enough for coating the strand. The plastisol should not remain on the rollers for an appreciable length of time, for example, in excess of one to five minutes.

The coated and impregnated yarn is then passed vertically downward through a heating chamber 30 open at both the top and bottom. The heating chamber is about 4 to 6 feet in height. It is formed of a steel shell 31 which is lined with asbestos 32. The shell is in two sections joined by hinges 33 which tend to hold the sections together. The asbestos 32 has a semi-circular portion removed from it in both sections so as to present a cylindrical passage through the heater having a diameter of about 1 to 3 inches. The semi-circular portions are lined with separate curved Nichrome strips 34 approximately 0.010 inch in thickness which strips are fastened at top and bottom to wires 35 which are attached to a source of electric current.

Air rises by convection in the chamber and heats the yarn prior to entering the chamber and heats the rollers 16 and 17. The rollers are also heated by radiation from the heating chamber below. The heated rollers in turn heat the plastisol dripped thereon so that it is at a temperature approximating its minimum viscosity at the time it is forced into and around the glass yarn. A shield 38 in the form of a piece of angle iron or other material may be mounted above the heating chamber 30 between the chamber and the rolls to shield the rollers if too much heat is being generated in the chamber. The shield may be protected by a sheet of asbestos 39 attached to its surface in a heat insulating manner.

The plastisol is fused in place on the yarn as it passes between the Nichrome strips 34. The coated yarn then passes out of the bottom of the chamber 30 past a blower 40 which blows air across the heated and fused plastisol coated yarn to cool it. The blower 40 may alternately be a suction fan which serves the dual purpose of cooling the coated strand and withdrawing organic vapors which may accumulate in the heating chamber 30. These vapors may be given off during the rapid heating of the plastisol coated strand. The coated yarn then passes over idler pulleys 41 and 42 through a suitable traverse 46 to a cylindrical tube 48 upon which it is wound. The tube 48 is mounted on a weighted spindle 50 which moves vertically in slots 55 of guides 56. The tube 48 and yarn wound thereon rest on rubber roller 58 which is driven at a constant speed by means of suitable driving means (not shown). The roller 58 in turn drives tube 48 which is resting on it. This method of indirect package drive insures a constant linear yarn speed throughout the coating operation, irrespective of the in-

creasing diameter of the yarn package collected on tube 48. A constant linear speed of yarn travel as well as a constant tension has been found to be desirable to insure uniformity of application of a plastisol to the yarn.

The operation of the apparatus shown in FIGS. 2 and 3 may be further described with respect to the application of the plastisol represented by curve 1 on the graph shown in FIG. 1 to a 75–1/0 glass fiber yarn traveling through the apparatus at about 500 feet per minute. The peripheral speed of the rollers 16 and 17 is 50 feet per minute but may vary between about 5 to 30 percent of the speed of the yarn.

The rollers 16 and 17 may be heated to a temperature of about 40 to 60° C. by air rising from the chamber 30 and the rollers in turn heat the plastisol as it is dripped onto roller 16 and subsequently carried into contact with roller 17. The temperature of the plastisol in the groove 18 as it is applied to the yarn is about 40 to 60° C.

After being coated and impregnated with the plastisol, the yarn is heated to a temperature of about 150° C. to fuse the plastisol on the yarn as it passes between the radiant heaters. By this operation approximately 1 pound of plastisol is applied to a pound of the 75–1/0 yarn and the finished yarn has a diameter of about 0.013 inch and a tensile strength of about 10.5 pounds per square inch.

The invention has been described with respect to the use of dispersions of polyvinyl chloride in a suitable, conventional, liquid plasticizer. The description of such dispersions is illustrative only and it is intended that dispersions of other resins in the form of plastisols be applied to glass fiber yarn in accordance with the teachings of this invention.

The resinous materials are more generally known as dispersion resins and they may be produced by emulsion polymerization. They are fine powders of a fusible resin or a resin which will coalesce when heated. Thermoplastic resins are preferred for use in the practice of the invention but thermosetting resins may be employed if they are in the A or B stage of polymerization or if they will readily fuse or coalesce in the form they are used upon the application of heat. Suitable thermoplastic resins include polyvinyl acetate and copolymers thereof with polyvinyl chloride, polyethylene, polymers of acrylic acid and esters thereof such as methyl methacrylate, polystyrene, cellulose esters and ethers, vinylidene chloride and various copolymers of these resins. Suitable thermosetting resins in the state set forth above include phenol formaldehyde, amino-formaldehydes such as urea formaldehyde and melamine formaldehyde, epoxy resins such as polymers of epichlorohydrin and bis-phenol, silicones, alkyds and allyl esters such as allyl carbonates.

The plasticizers which may be used in combination with the above resins are well known in the plastics art and include numerous esters such as esters of phthalic acid, adipic acid, succinic acid, sebacic acid and others, sulfonamides and phosphates. Pigments, dyes, metallic powders, inerts, etc., may be incorporated in the dispersions to provide yarns of different color and appearance.

The present invention has provided a method for uniformly coating and impregnating glass fiber yarns, particularly unplied yarns such as 75–1/0 yarn with plastisols at very high speeds. These plastisol coated yarns are free from knobs and bumps and have uniform diameter throughout their length, high tensile strength, abrasion resistance and good weathering properties. The invention has provided means for using a wider selection of plastisols than previously available for high speed coating and has permitted the production of thicker coatings than normally producible at any speed without resort to multiple passes of the yarn through coating apparatus. Multiple passes may also be used to get even higher amounts of resin on the glass.

Although the present invention has been described with reference to specific details of certain embodiments thereof, it is not intended that such details be limiting upon the scope of the invention except insofar as included in the accompanying claims.

This application is a continuation-in-part of our copending application Serial No. 507,934, filed May 12, 1955, now abandoned.

We claim:

1. An apparatus for applying a heated liquid to a strand of material which comprises a pair of coacting, juxtaposed rollers, at least one of said rollers being peripherally grooved so as to form a passage between the rollers through which the strand can pass, means for supporting the rollers for rotation, means for rotating at least one of the rollers, means for supplying the liquid to a surface of at least one of the rollers, means for moving the strand vertically downward through the passage between the rollers so that it receives a coating of the liquid and means positioned directly under and closely adjacent the rollers in heat transferring relation thereto for supplying heat to both the coated strand and the rollers, said roller support means being located so as to permit the heat transfer relation between the rollers and the heating means and not prevent the passage of the heat from the heating means to the rollers.

2. The apparatus as described in claim 1 having in addition a shield mounted between the rollers and the heating means to deflect away from the rollers a portion of the heat emanating from the heating means towards the rollers.

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