Nov. 3, 1964 A. MARZOCCHI ETAL 3,155,543

APPARATUS FOR APPLYING LIQUID COATING MATERIAL TO A CONTINUOUS STRAND

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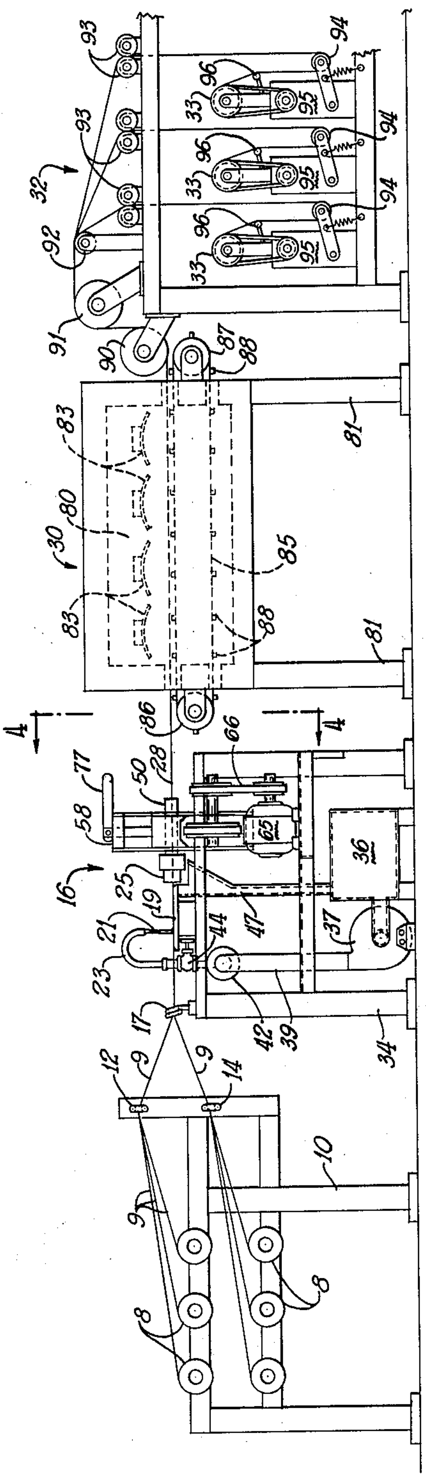

Fig. 1

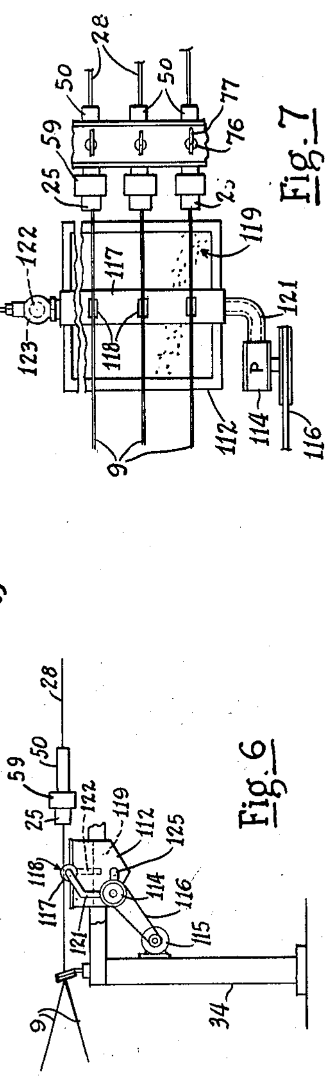

Fig. 6

Fig. 7

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Filed March 15, 1960 2 Sheets-Sheet 2

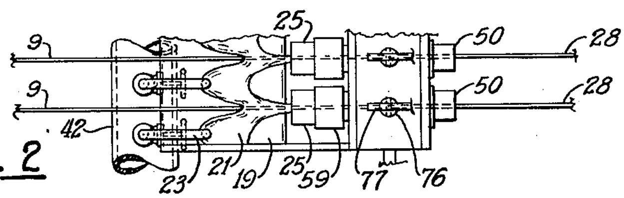

Fig. 2

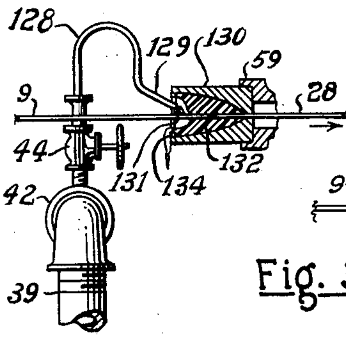

Fig. 8

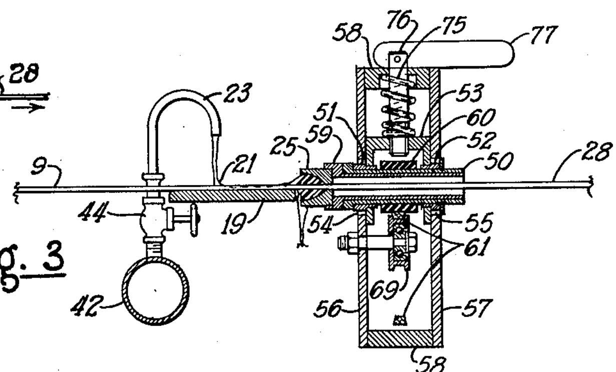

Fig. 3

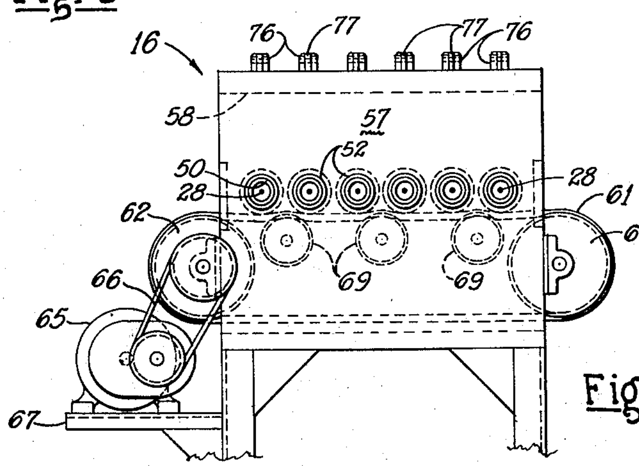

Fig. 4

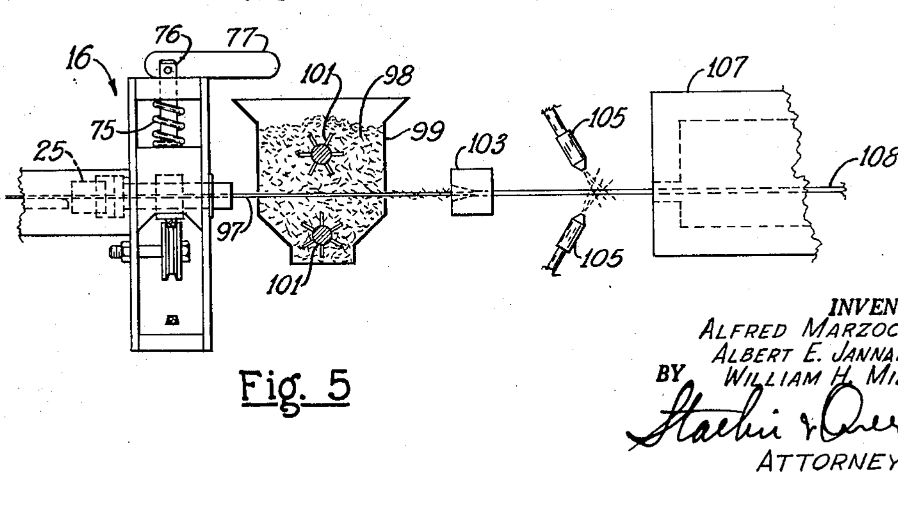

Fig. 5

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United States Patent Office 3,155,543
Patented Nov. 3, 1964

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3,155,543
APPARATUS FOR APPLYING LIQUID COATING MATERIAL TO A CONTINUOUS STRAND

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Filed Mar. 15, 1960, Ser. No. 15,191
7 Claims. (Cl. 118—405)

This invention relates particularly to apparatus for coating strands of fibrous glass, but also may be practiced advantageously for coating rovings, staple yarns, twine, cordage, and other types of strands of various other natural or synthetic fibers as well as monofilament strands such as solid metallic wire, or encased metal strand conductors. The invention is also capable of utilization in contour-truing and finishing precoated or preformed elongated, cylindrical bodies.

In order not to complicate the presentation of the invention, the description will be mainly directed to the use of the invention for coating strands of fibrous glass with reference to the adaptability of several, if not all of the features of the invention to the coating of strands of various other types.

Many procedures have been followed in coating strands of fibrous glass. Among these have been passing the strand over a pad saturated with the coating material or in contact with a roller or belt carrying the material, having the strand travel through a dip tank, spraying coating material upon a moving strand, and applying material to a strand and then directing the strand through a wiping die.

Of these methods, passing the strand over a saturated pad has proved very satisfactory when the coating material has been of light consistency and it is desired to apply only a thin film. For a comparatively heavy overlay of material, the method utilizing a wiping die has proved most successful.

There have, however, been serious difficulties encountered in this latter method. First, there has been a limit to how much material could be applied. This has required, in many instances, successive treatments to build up a coating of the desired thickness. It also has proved difficult to produce an even coating with this method.

Further trouble has been experienced with loose fibers or fuzz collecting in and clogging the die. This necessitates interruption of production to remove the clogging material. Another source of imperfect coating in this technique has been the settling of heavier components of the coating material.

The general object of this invention is to provide a more trouble-free method and apparatus for more uniformly coating strands.

A further object of the invention is the provision of a method and apparatus which enables a heavier coating to be applied.

Another object is to create a coating of consistently high quality.

A still further object is to apply novel coating compositions to both multiple and monofilament strands.

These and other objects and advantages of the invention are secured principally by rotating the wiping die in which the material is constricted and by which the amount of material applied to the passing strand is metered.

A supplemental feature of the invention is to so set the speed of rotation of the die in respect to its design and the nature of the coating material that at least a temporary twist in the strand is effected.

Should this twist be in a direction to tighten a twist already present in the strand, the strand is constricted

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and made more round. It consequently moves more freely through the orifice of the die and is thus more able to receive a heavier deposit of the material.

Conversely, if the twist given the strand acts to loosen a twist therein, the strand becomes more open and penetration by the coating material is improved.

These and other features and advantages of the invention will be hereafter described in more detail with reference made to the accompanying drawings in which:

FIGURE 1 is a somewhat diagrammatic, side elevation of a yarn coating production line incorporating coating devices embodying one form of this invention;

FIGURE 2 is a fragmentary plan view of two of the coating devices of the production line shown in FIGURE 1;

FIGURE 3 is an enlarged, side elevation and in part vertical section of one of the coating devices of FIGURES 1 and 2;

FIGURE 4 is an elevational view taken on the line 4—4 of FIGURE 1 of the assembly of coating devices;

FIGURE 5 is a schematic showing of an alternate arrangement of equipment in the production line of FIGURE 1;

FIGURE 6 is a side elevation of coating apparatus embodying a different form of the invention;

FIGURE 7 is a plan view of the apparatus of FIGURE 6; and

FIGURE 8 is a side elevation, with parts in vertical section, of coating apparatus embodying another form of the invention.

Referring to the drawings in more detail, the equipment included in the production line shown in FIGURE 1 starts with a yarn feeding station in which six spools 8, on which strands of yarn 9 are wound, are mounted on a creel 10. The production line may, of course, be designed to handle strands from a much larger number of spools than six.

The strands 9, for example, will be considered as being single yarns with a diameter of approximately .010 of an inch. Such a single end yarn usually includes either two or four hundred glass filaments twisted together. The strands of yarn 9 may be drawn from the spools 8 at most any speed but which usually ranges from one to five hundred feet per minute. Strands from three of the spools, as here disclosed, are drawn through a guide eye 12 from which each of the three strands is led individually through a guide loop 17. In the same manner, the strands 9 from the lower three spools 8 pass together through the guide eye 14 and are then separated before going through the individual guide loops 17.

The strands are thus initially aligned for proceeding through the coating apparatus 16. The strands are led across in light contact with the upper surface of the horizontal plate 19. Coating material 21 is delivered to the surface of plate 19 from goose-neck spouts 23. This material is deposited upon the plates between the paths of the strands and spreads out to be picked up thereby. The strands of yarn then pass through the rotating dies 25 which distribute the coating material around the strands and control the amount of material left thereon.

The coated strands 28 then proceed through the curing oven 30 where the coating material is set by heat and continue to the windup mechanism 32 where the strands are re-wound on wind-up spools 33.

The coating machine 16 is supported on a frame 34 within which is a coating material supply tank 36. A pump 37 delivers material from the tank through a conduit 39 to a horizontal manifold 42. The material is forced therefrom through flow control valves 44 to the series of goose-neck spouts 23. As shown in FIGURE 2 the material 21 flows over the plate 19 toward the strands of yarn 9 into submerging contact therewith and is carried upon the strands over the edge of the plate 19 into the rotating dies 25. Excess material drops down between the plate and the dies to be received by the drain pipe 47 and returned to the supply tank 36.

The dies 25 are usually rotated at a speed in the range of one to six hundred revolutions per minute, but under some circumstances, the speed may be increased to a considerably higher point. The die rotating mechanism includes a series of spindles 50 journaled in bearings 51 and 52 in a series of vertically slidable channels 53. The spindles project laterally from slots 54 and 55, respectively located in side plates 56 and 57 of a casing 58. The dies 25 are frictionally held within the cylindrical sockets 59 on the rearward ends of the spindles 50.

Around each spindle is secured a rubber bushing 60. A V-belt 61, running between pulleys 62 and 63, is normally in driving contact with the bushing 60. Pulley 62 is rotated by the electric motor and speed reducer assembly 65 through the belt 66. The assembly 65 is mounted on a laterally extending platform 67 as may be seen in FIGURES 1 and 4.

A row of idler pulleys 69 engage the upper course of V-belt 61 to press the belt against the spindle bushing 60. Springs 75 compressed between the channels 53 and the top of the casing 58 incline the spindles 50 carried by the channels downwardly to hold the bushings 60 in engaging contact with the V-belt 61.

The springs 75 are each positioned in encircling relation to a rod 76 secured to the respective channel 53 and projecting upwardly from the casing 58. A lever 77 pivoted to each rod 76 may be used to stop the rotation of the associated die 25 by being turned to a vertical position. This raises the respective channel 53 through the connecting rod 76. The spindle 50 journaled in the channel is thus lifted away from the driving V-belt 61. Slots 54 and 55 in the side plates 56 and 57 of the casing 58 permit this upward movement of the spindle 50.

The coated strands of yarn 28 proceed from the hollow spindles 50 to pass through the oven 30. The heating chamber 80 of the oven is supported upon legs 81. Heating elements 83 are designed to furnish sufficient heat to set the coating material whether by drying, curing, or otherwise hardening the material, depending upon its particular composition.

In the normal travel of the strands through the oven, the strands are not in contact with the conveyor 85, as the latter is only utilized in initially feeding the strands through the oven. The conveyor 85 may be mounted for manual propelling around drums 86 and 87. Across the conveyor are slats 88 which are periodically notched crosswise of the slats. To start a strand through the oven its end is pressed into a notch of a slat in line with the path to be taken by the strand and the conveyor is operated to pull the strand to the outlet of the oven where the strand may be grasped for leading through the subsequent winding mechanism 32.

Upon leaving the oven 30, the strands of yarn pass around the idler rollers 90, 91, and 92 and travel down separately to the pairs of guide rollers 93.

Each strand then turns around a spring-biased tension pulley 94. The vertical movement of the tension pulley, resulting from the pull thereon, controls the variable speed drive 95 operating the wind-up spools 33. Traversing mechanism 96 guides each strand back and forth upon its receiving spool 33.

In FIGURE 5 is shown, schematically, additional equipment in the strand coating line for incorporating dry, particulate material in the fluid coating applied by the rotating die 25.

As there illustrated, the strand 97 with the coating in a sticky, unset condition has applied thereto a particulate material 98 which may be flakes or fibers of glass, other natural or synthetic fibers, or grains or flakes of various compositions. A supply of the selected particles is maintained in a hopper 99 and kept in a loose agitated condition by suitable paddles 101. The dry material adhered to the strand passing through the hopper 99 is smoothly embedded in the prime coating by the passage of the strand through the forming die 103, which, as shown, is stationary but which could be mounted for rotation. In case an electrical conductor wire is being made, or it is desired to apply a finishing coat on some other product, a varnish or enamel is applied by the spray nozzles 105.

An oven 107 may follow in the production line to finally set and consolidate the coating layers of the resultant composite strand 108.

In FIGURES 6 and 7 is shown an alternate method of loading the strands with coating material to replace the spouts 23 and plate 19 of the embodiment of FIGURES 1–3.

As there shown, the coating material is contained in a tank 112. A pump 114 driven by motor 115 through belt 116 delivers the material from tank 112 to a tube 117. There are slots 118 in the tube through which the strands pass to pick up the coating material 119 which is delivered to the tube from the pump by piping 121. Excess material is returned to the tank 112 through the return pipe 122. The valve 123 in this pipe is used to regulate the amount of material which exudes from the slots 118. The coating material is returned to the pump through the piping 125 for recirculation. A filter for removing foreign substances or large particles of the material could be located in this piping.

In the operation of the main embodiment disclosed, dies 25 with wiping apertures have a diameter of .015 of an inch may be selected for applying a vinyl coating to heavy fibrous glass yarns for the fabrication of insect screening. Such screens have a higher burst strength than that of any conventional screen cloth as well as outstanding durability. The yarn diameter after coating with a colored vinyl is .0125 of an inch. The coating operation must be carefully executed in order to hide the underlying white-appearing fibers, and the roundness of the coated yarn should be as consistent as possible to minimize the effect of the yarn in blocking the passage of light and air. The uniform roundness as well as a uniform thickness of the coating throughout the length and periphery of the yarn also facilitates the weaving or other process by which the yarn is assembled in reticulated form.

Such coated yarns are also utilized quite extensively for fabrics for upholstery, shoes, and handbags. For the best wearing performance, these yarns should be thoroughly coated and impregnated. The vinyl is preferably applied in a plastisol composition and as heavy a coating as possible is frequently desired.

The vinyl material picked up by the strands of yarn passing over plate 19 of the coating device of FIGURES 1–3 or in traversing the slots in the tube of FIGURES 6 and 7, collects in the conical cavities of the rotating dies 25. Here the vinyl plastisol is given a swirling action which maintains the pigments in a dispersed state and acts to reduce the viscosity of the coating material. This reduction in viscosity would occur with most thermoplastic materials and also with others fluidized by frictional working, and results in a more polished and thicker coating being deposited upon the strands as they pass out the restricted outlets of the dies. The coating material thus applied to the strand may amount to as much or more than one and one-half times the fibrous glass content.

The vinyl coating material is delivered to each rotating die 25 continuously and at a rate which maintains the body of coating material in the die at a constant volume. As it is difficult to feed the coating material at a rate precisely matching that of consumption, the rate of delivery is slightly above the rate of consumption and a small surplus of material drops down or is thrown off by the rotating die. The rotation of the die together with high linear movement of the yarn causes the material in the die to assume a symmetrical shape surrounding the yarn.

The rotation of the dies also has a very beneficial effect in regard to any loose fibers or fuzz riding into the dies with the strands. These vagrant fibers are either wrapped around the traveling strands to be immersed in the coating material or slowly collect in a harmless ring within the die cavity. The customary clogging experienced with stationary dies is thus avoided.

With material with proper viscosity coupled with a die shaped to retain the material at higher speeds of rotation, the material is given a stronger whirling motion.

It is believed that the centrifugal thrust developed in the rotating material relieves the resistance to the traveling strand along the axis of the die and thus inclines to center the strand on the axis; and also that a rotating annular neck of the material surrounds the strand and lubricates its passage through the tapered outlet of the die.

With the rotational speed of the die high in respect to the forward movement of the strand and with a material of sufficient viscosity, a twist is momentarily effected upon the strand while within the die. If this twist is in the direction of an existing twist in the yarn, the yarn will be momentarily tightened and made rounder. This eases its movement through the die outlet and allows more material to remain thereon. A twisting action tending to straighten an existing twist will open the yarn for better penetration while reducing the amount of material left thereon. Any twist developed may be made permanent through correlating twisting mechanism in the subsequent path of the strand. This would preferably be positioned beyond the oven.

Vanes on the interior of the die will, of course, serve to build up the rotation of the coating material and its twisting influence on the strand. The vanes or grooves on the interior of the die may be angled to develop a forward propelling action upon the coating material and thus positively force the material through the outlet of the die. For high speeds the cavity in the die may be elongated and have an inwardly directed annular flange to keep the material from being thrown out. Also, for better control and simplification the coating material may be projected in a small stream directly into the die cavity.

An elongated and flanged die with material projected in a small stream thereto is illustrated in FIGURE 8. As there shown the goose-neck spout 128 has an upturned outlet 129 adjacent the opening of the enlarged die 130. A jet 131 of coating material from the spout 128 maintains the body 132 of coating material within the die at a constant volume with a slight excess escaping over the retaining flange 134 at the mouth of the die.

There is hardly any limit to the variety of coating substances which may be applied to strands with the apparatus of this invention. Among the materials more likely to be utilized are vinyls, polystyrenes, phenol formaldehydes, polyesters, polyethylenes, polyacrylates, polypropylenes, polyvinyl butyrals, cellulose derivatives, polyamides, oleo-resinous enamels, and (for solid wire strands) blends of polyvinyl formal and cresol formaldehyde resins.

Because of the stirring action provided by the rotating die, pigments are readily held in suspension in the coating material. Colored or metal coated glass flakes when added as pigment to the basic coating substance and applied to conductor wires not only provide attractive colors to the resulting coating, but also greatly improve the weatherability of the product. It has been found that the action of the die tends to orient particulate components, with flakes positioned planarly.

The rotating die has proved very effective for coating texturized yarn. This type of yarn is fluffed up by jets of air or other means and has numerous lateral projections of fibers in loops or curl formations. The loftiness and decorative nature of the yarn is not only maintained, but actually enhanced by the coating action of a rotating die. Prior coating methods have been inclined to normalize this special type of yarn by laying the loops and smoothing out the contour. Also, with stationary wiping dies considerable clogging has been experienced due to the extra amount of fuzz characterizing this product.

Because of the fluidizing effect of the rotary die, coating materials of greater viscosity may be applied. This permits a reduction in the quantity of solvents or other fluid vehicles and a consequential saving in drying time and heat requirements.

The rotating die also effectively handles more highly plasticized materials, which generally improve the final product besides contributing flexibility.

The polishing effect of the rotary die is due not only to the fluidizing of the coating material, but also to the frictional contact between the outlet of the die and the surface of the deposited coating material. The frictional action of the rotating die may be utilized alone in dimensionally-truing and polishing strands previously coated and in smoothly contouring and finishing monfilament strands or rods of metal, other inorganic substances or organic materials. For this purpose, the die outlet should be of suitable length and the speed of rotation selected to prevent spiral marking.

The concept of twisting a strand while in direct contact with a body of coating material is believed novel and a rotating die is considered the simplest means for accomplishing this action. However, conventional twisting mechanism could be placed adjacent to a stationary die coater or to some other coating device for the same purpose.

It will be apparent that various changes and modifications, other than those discussed and disclosed herein, may be made in the apparatus and method of this invention without departing from the spirit of the invention and the scope of the accompanying claims.

We claim:

1. Apparatus for applying a resinous liquid coating material to a continuous strand including means for directing a strand along a linear path, a die with an unobstructed, comparatively large entering mouth and a horizontal passage of substantial capacity tapered in section from the mouth to an outlet of restricted size, said die being positioned in the path of the strand whereby the strand travels axially through the horizontal passage and the outlet of said die, means continuously delivering liquid resinous coating material through the mouth of the die to the horizontal passage, said delivery of coating material being at a rate to maintain a constant volume of the coating material within the horizontal passage, and means rotating the die, the speed of rotation of the die and the speed of linear movement of the strand in combination with the capacity and shape of the die passage being such to cause the coating material collected within the passage to whirl as a symmetrical body around the strand passing therethrough.

2. Apparatus according to claim 1 in which the means continuously delivering resinous coating material includes a spout with an outlet adjacent the mouth of the die.

3. Apparatus according to claim 1 in which the die has an inwardly directed, material retaining flange around the mouth of the die.

4. Apparatus according to claim 1 in which there is a plurality of dies and common belt driving means for rotating the dies.

5. Apparatus according to claim 4, in which there is a mounting device for each die arranged to permit it to be separately disengaged from the common belt driving means.

6. Apparatus according to claim 1 in which the means for continuously delivering resinous coating material to the horizontal passage includes means for maintaining a

continuous flow of coating material and for guiding the strand through the flow.

7. Apparatus for applying a liquid coating material to a continuous strand including means for directing a strand along a linear path, a die with a comparatively large entering mouth and an unobstructed horizontal passage of substantial capacity extending from the mouth to an outlet of restricted size, said die being positioned in the path of the strand whereby the strand travels axially through the horizontal passage and the outlet of said die, means continuously delivering liquid coating material through the mouth of the die to the horizontal passage, said delivery of coating material being at a rate to maintain the horizontal passage in a filled condition, and means rotating the die the speed of rotation of the die and the speed of linear movement of the strand in combination with the capacity and shape of the die passage causing the coating material to collect within and fill the passage and to whirl around the strand passing therethrough.

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