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APPARATUS FOR COATING GLASS FIBER STRAND

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FIG. 1

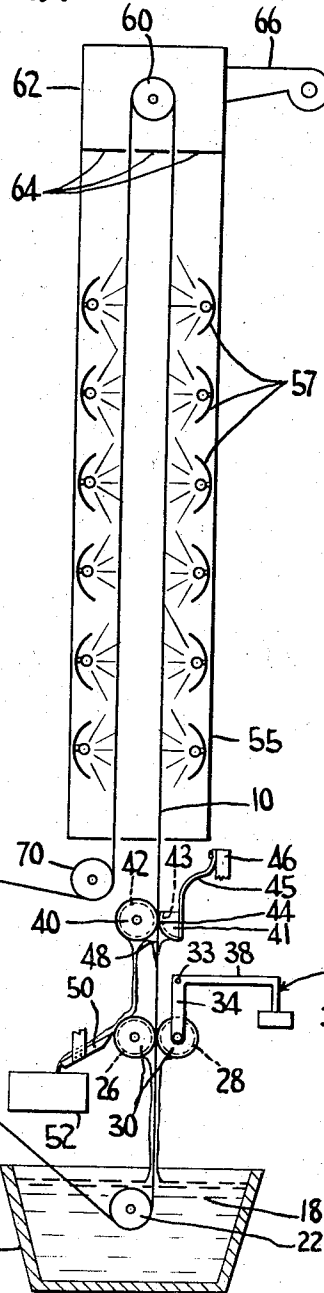


FIG. 2

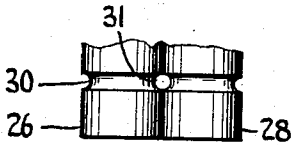
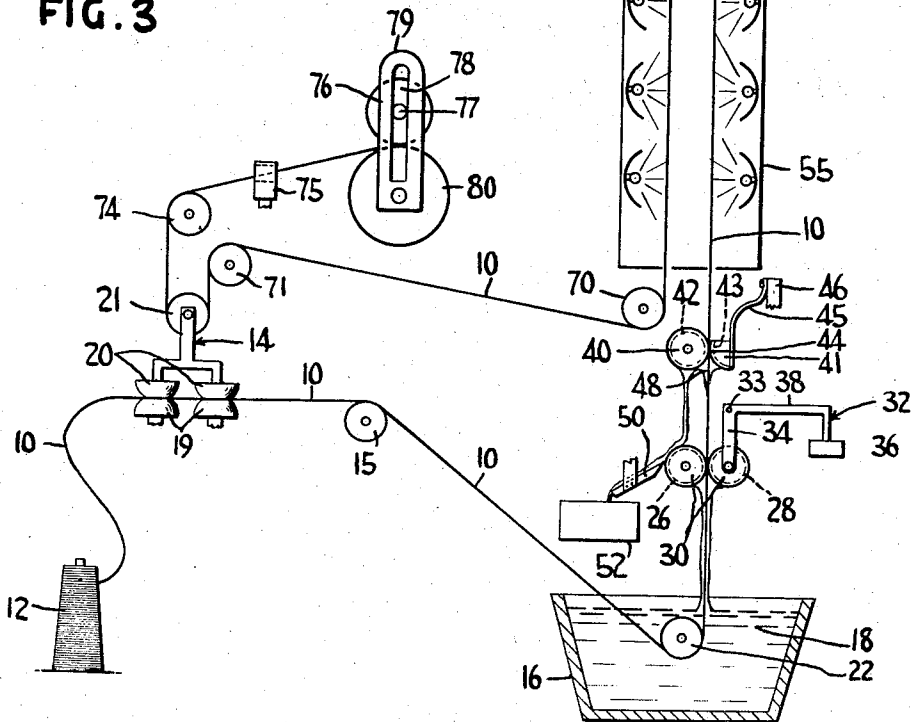
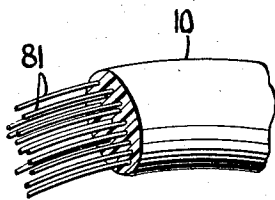


FIG. 3



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APPARATUS FOR COATING GLASS FIBER STRAND

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1 Claim. (Cl. 118—33)

The present invention relates to a method of and an apparatus for applying a material to a strand made up of a number of filaments or fibers and it has particular relation to a method of and an apparatus for applying a liquid to a strand of glass fibers so that each individual fiber making up the strand is coated with the liquid.

For many purposes, it is desired to apply a coating of a flowable material to a strand made up of a number of individual fibers or filaments so that each individual fiber is coated with the material in addition to the strand itself having an overall coating. For example, it is desired to apply a lubricating material to coat each individual fiber of a strand to prevent breakage of the individual fibers caused by abrading of the fibers on each other.

One method which has been employed to apply a lubricating material to a strand of fibers involves applying the material to each individual fiber before the fibers are combined into the strand. However, such method is available only during the manufacture of the fibers. It is desired to have a suitable method of applying a material to each of the individual fibers after they have been combined into a strand.

Other methods which have been employed in the prior art to apply flowable material to the individual fibers of a strand entail passing the strand into a reservoir containing the coating medium, the viscosity of which is so adjusted as to give a uniform pick-up of desired thickness, and then passing the strand through a die orifice. This method is applicable only to flowable materials having a low viscosity. A series of passes through several dies is frequently required to produce thick coatings. Further, the flowable material flows only around the outer filaments of the strand without any marked penetration into the strand.

A superior method of coating individual fibers in a strand of fibers has been provided in which the strand is first contacted or wetted with the flowable material. Then a rolling pressure is applied to the strand evenly at all points on the circumference of the strand at some point or area along the length of the strand so as to force the flowable material into the interior of the strand. This pressure is applied evenly and simultaneously so that the coating material does not have an opportunity to flow around the strand rather than into the interior or central portion of the strand. This pressure may be applied in a number of ways, for example, it may be applied by passing the strand through a groove formed by two coating grooved rollers. The grooves in the coating rollers are aligned so as to form a passage for the strand having a shape or diameter conforming to that of the strand or slightly larger.

Such method of coating and impregnating strands of fibers is satisfactory when the diameter of the strand remains relatively constant, however, when variations in strand diameter occur, for example, increases in diameter caused by splicing, an undue number of breakages are likely to occur. These breakages occur when the por-

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tion of the fiber of increased diameter attempts to pass through the groove or opening. It is unable to do so and the strand is thus broken.

In accordance with the present invention, this breakage caused by the use for example of spliced yarn, can be prevented by increasing the size of the opening of the groove through which the strand passes, however, still maintaining the same amount of pressure on the strand and then removing the excess of the flowable material from the strand. The opening of the groove is increased to a diameter conforming to the largest diameter of the strand or slightly larger than the largest diameter of the strand passing through the groove. This allows an excess of the coating material to be applied to the strand as it passes through the coating and impregnating operation which excess can be wiped off by means of suitable wiper means.

The above embodiment of the invention has been chosen for purposes of illustration and description and it is shown in the accompanying drawing in which like figures refer to like parts throughout and in which:

Fig. 1 is a diagrammatic view schematically illustrating an apparatus embodying the present invention;

Fig. 2 is a plan view of a pair of coating rollers suitable for practice of the invention; and

Fig. 3 is a perspective view of a portion of a strand coated in accordance with the present invention and having a portion of the coating removed therefrom.

The invention is described in conjunction with the drawings with respect to the application of a plastisol to the individual filaments making up the strands of a glass fiber yarn, but it is not intended to be limited to such a coating material or to a strand of glass fibers. The invention is equally applicable to the coating of numerous other inorganic and organic strands made up of a number of filaments.

In the drawing, Fig. 1 illustrates a suitable apparatus for practice of the invention. Glass yarn 10 from a suitable package 12 passes through a twin disc tension compensator 14 over an idler pulley 15 into a reservoir 16 containing a liquid dispersion 18 such as a vinyl plastisol. Compensator 14 is made up of two smooth stationary discs 19 and two smooth movable discs 20 resting on the discs 19. The discs 20 are weighted and attached to a floating pulley 21 which reacts to changes in tension applied to the yarn 10. The performance of the compensator is described below.

The yarn 10 passes around an idler pulley 22 within the liquid dispersion 18 and emerges vertically from the reservoir 16. An amount of the liquid dispersion in excess of that required to impregnate and coat the yarn is picked up by the yarn and carried to a pair of grooved rollers 26 and 28. The grooved rollers are mounted for rotation about horizontal axis and are in coating relationship so that their meeting surfaces are moving in the direction of movement of the yarn 10 passing therethrough.

The grooves 30 in the coating rollers 26 and 28 are in line with each other so that as the rollers are rotating, an opening 31 conforming to the shape of the yarn 10, usually circular or oval, is maintained between the rollers at all times. The diameter of this opening is equal to or slightly larger than the largest diameter of the yarn which is to be coated and impregnated. This allows spliced portions of the yarn to be coated and impregnated and pass freely through the openings. It also results in coating most of the length of the yarn with an excess amount of coating. The grooves 30 in each roller are usually in the form of a semi-circle having a diameter equal to about twice the average diameter of the strand.

As the strand 10 coated with the dispersion 18 passes through the grooves in the roller, it can be seen that there

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is one point in its passage where there is pressure applied to the circumference of the strand equally at all points around the circumference. At this point the liquid dispersion is forced into the strand around each of the individual filaments making up the strand.

Rollers 26 and 28 are mounted so as to exert a pressure against each other and against the yarn 10 during rotation. The amount of this pressure may be adjusted. This is accomplished by having roller 26 rotate in fixed bearings while roller 28 is mounted for rotation on hinge lever 32. The lever 32 is pivotally supported at 33 and roller 28 is supported on one arm 34 while a suitable weight 36 is supported on the other arm 38 to apply the proper amount of pressure to roller 26. Usually this pressure will be in the neighborhood of about 3 pounds per square inch. When the yarn has passed through this set of grooved rollers, it is thoroughly impregnated with the liquid dispersion and also has an excess coating on the exterior of the strand proper.

The coated and impregnated strand next passes to suitable wiping means which serve to wipe off the excess coating on the exterior of the strand. The wiping means is somewhat similar to and may be the same as the coating and impregnating means, however, the diameter of the opening in the wiping means is equal to or slightly larger than the average diameter of the yarn rather than equal to the largest diameter of the yarn as is the case with the coating and impregnating opening. As shown in the drawing, the wiping means is made up of a grooved rotating roller 40 rotating in the direction of movement of the strand 10 and against a grooved, spring loaded wiper die 41. The grooves 42 and 43 in the roller and die respectively are in line with each other so as to form an opening 44 conforming to the average diameter of the yarn 10.

The grooved wiper die 41 is mounted on a flexible strip 45 which in turn is attached to fixed mounting 46. The die 41 and flexible strip 45 are fixed in relationship to the grooved roller 40 so that a very slight pressure, enough to exert a wiping effect is exerted on the coated strand 10 as it passes through the opening 44. The pressure exerted by die 41 is slight enough so that when any unusually large diameter portions of the strand, such as splices, pass through the opening 44, the die readily gives and permits the spliced portion to pass through the opening. The excess coating material gathers underneath grooved roller 40 at 48 and flows to the lowermost portion of the roller and then drips down to the uppermost portion of grooved roller 26.

A portion of the excess coating material which drops down onto the surface of roller 26 is removed by means of scraper 50 and conveyed to a suitable collecting means 52. The scraper 50 has a flat edge corresponding to the surface of the roller 26. As shown in the drawing, only one scraper 50 is employed. It is contemplated that additional scrapers may be used with each roller employed in the impregnating and wiping process.

The removal of this excess has been found to be desirable because it is contaminated to a certain extent with short glass fibers. These fibers are broken ends which are sheared from the yarn as they enter the liquid dispersion 18 and pass through the coating and wiping means. If these broken ends of fibers are allowed to continuously build up in the liquid dispersion, they soon tend to collect in the openings 31 and 44 and narrow the effective diameter thereof.

This is undesirable for several reasons. As the diameter of the openings becomes smaller, the final diameter of the coated yarn becomes smaller. A principal use of the coated yarn is in screening and differences in diameter of the yarn employed to weave the screening show up glaringly as changes in density and light transmittance from one section of the screen to another. Further, it can be seen that reduction of the size of the openings causes choking thereof and breakage of the yarn. Thus it has been found that the removal of this contaminated

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coating material as indicated with a corresponding replenishment in reservoir 16 with new material enables the coating operation to proceed uniformly for a long length of time free from any breakages.

Following the application of the coating, the coated yarn 10 is passed through a curing tower 55 equipped with suitable heating means such as radiant heaters 57 placed along the inside of the tower. The yarn 10 passes up through the tower 55 and over an idler pulley 60 located in the top of the tower and then back down through the tower and out the bottom thereof.

The idler pulley 60 is mounted in a cooling chamber 62 at the top of the curing tower 55. This cooling chamber is separated from the remainder of the tower 55 by baffle plates 64. Cool air is directed onto the yarn 10 just before passing over the idler pulley 60 by means of a conventional air blower 66. The purpose of this air cooling is to reduce the temperature of the partially cured plastisol and thus prevent the coating yarn from being flattened as it passes over pulley 60.

After the coated strand leaves the tower, it passes over idler pulleys 70 and 71 to floating pulley 21 which is mechanically linked with the tension discs 19 and 20 of tension compensator 14. The mechanical linkage of the floating pulley 21 with the twin tension discs affords automatic tension compensation. It can be seen that whenever too much tension is created in yarn 10 as it passes through the twin tension discs 19 and 20, floating pulley 21 is pulled upwardly so as to pull the tension discs 20 away from discs 19 and lower the friction applied to the yarn 10. The correct amount of tension which is desired may be determined by weights which are applied to the tension compensator 14. It has been found that it is necessary to maintain a certain amount of tension on the yarn, for example $\frac{1}{3}$ pound, during the coating operation.

It can be seen that the reverse procedure would occur whenever less tension than desired is present on the strand. In such case, the floating pulley 21 and tension compensator discs 20 move downwardly thereby increasing the pressure of the compensator discs 20 and 19 on the yarn 10 to provide the correct amount of tension throughout the operation.

The yarn 10, after passing over floating pulley 21, next passes over idler pulley 74 and through a suitable traversing mechanism 75 to a cylindrical tube 76 upon which it is wound. The tube 76 is mounted on a weighted spindle 77 which moves vertically in slots 78 of guide 79. The tube 76 and yarn 10 wound thereon rests on rubber roller 80 which is driven at a constant speed by means of a suitable driving means (not shown). The roller 80 in turn drives tube 76 which is resting on it. This method of indirect package drive insures a constant linear yarn speed throughout the coating operation irrespective of the increasing diameter of the yarn package collected on tube 76. A constant linear speed of yarn travel as well as the constant tension has been found necessary to insure uniformity of application of the flowable material to the strand.

In a typical operation of the apparatus described above, a glass fiber yarn commonly known to the trade as a 150-2 continuous filament yarn is employed. Such a yarn is made up of two continuous filament strands twisted and plied together, each strand being made up of 204 individual glass filaments having an average diameter in the neighborhood of 0.00038 inch. Each of the two individual strands of yarn having such designation contain approximately 15,000 yards to the pound. The yarn itself has an approximate diameter of about 0.0097 inch. It can be seen therefore that such a yarn is composed of 408 individual glass filaments and that it is extremely difficult to force a flowable material into the yarn so as to coat each individual fiber or filament.

The yarn 10 is passed into the reservoir 16 containing a vinyl plastisol 18. It is to be understood that nu-

merous flowable materials may be applied to a multi-filament strand in accordance with the present invention. Included among these are numerous textile sizings, binders and lubricants as well as numerous resins and plastics which may be applied for a number of reasons, for example coatings which are designed to make the fibers hydrophobic or compatible with various resins and plastics for lamination therewith.

The temperature of the material 18 in the reservoir may be regulated to produce the desired viscosity for application depending upon the particular material to be employed. It has been found, for example, that with viscosities in the region of 40,000 to 50,000 centipoises per second at 22° C., a 150-½ strand can be coated at speeds of 90 to 95 feet per minute. It has further been found that with viscosities in the region of 4,000 to 10,000 centipoises per second at 22° C., a 150-½ strand can be suitably coated at speeds of 100 to 300 feet per minute. Usually at such speeds, the amount of flowable material or plastisol picked up by the strand will be about equal to its own weight. It is further proposed as an aid to wetting the strand with sufficient plastisol, to apply a supply of the plastisol to the grooves 30 themselves so that a portion of the contacting of the yarn with the plastisol and impregnation thereof occurs simultaneously or nearly so.

After the yarn has been contacted with the plastisol, it then passes through the grooved rollers 26 and 28. These grooves are generally semi-circular or semi-oval in shape and for the conditions above, the dimensions of the grooves 30 in each roller are approximately 0.03 inch in diameter. This is a sufficient opening to allow splices to pass through. It has been found that the majority of splices made for such yarn have a diameter of about 0.028 inch and smaller. It is understood, of course, that the dimensions of the groove 31 set forth above are merely exemplary of the particular yarn employed and that for other applications the opening should be at least sufficient to permit the largest diameter of any portion of the yarn to pass therethrough.

The circumferential speed of the rollers 26 and 28 is adjusted so that it is much less than the linear speed of the yarn, for example ¼ the speed of the yarn. Such differential in the circumferential speed of the rollers and linear speed of the yarn has been found to be necessary to prevent the formation of irregular globules of coating on the surface of the yarn. As the coated yarn 10 passes through the grooves in the roating rollers, pressure is applied to the coating equally at all points around the circumference of the yarn at the point of contact with the rollers and the coating is driven into the strands of the yarn and around each of the individual filaments making up the yarn.

The impregnated yarn 10 having an excess coating of the plastisol thereon is then passed through the opening 44 formed by grooved roller 40 and wiper die 41 to remove the excess coating. The opening 44 formed by grooved roller 40 and die 41 is about 0.016 inch in diameter. The wiper die 41 is mounted on spring 45 so that it exerts a very slight pressure, about 2 ounces per square inch, against grooved roller 40. Such a small amount of pressure allows the die to give and permits splices to pass through the opening, however, it is sufficient pressure to insure adequate wiping performance by the die and roller.

The circumferential speed of the roller 40 is much less than the linear speed of the yarn, for example about ¼ the speed of the yarn. Maintenance of such differential of the circumferential speed of the roller 40 and linear speed of the yarn 10 has been found necessary to prevent formation of irregular globules of coating on the surface of the yarn.

It is also contemplated that the wiper die 41 may be replaced by a grooved roller similar to roller 40. The

rollers would then function similarly to rollers 26 and 28 with the main difference being that rollers 26 and 28 are forced together under about 3 pounds per square inch pressure whereas the rollers performing the wiping process are forced together under much less pressure, for example about 2 ounces per square inch.

It is to be noted that an excess of the coating material gathers at 48 immediately below the opening 44 and flows to roller 26. The excess material is taken off by scraper 50 and flows to a suitable collecting means 52. To make up for the amount of excess contaminated material removed, a slight amount of new coating material is continuously added to reservoir 16.

The coated and impregnated yarn 10 is next passed through the heating tower 55 wherein a suitable amount of heat is applied to the coating to cause it to set or polymerize or harden depending upon the particular coating employed. It is usually preferable to heat the plastisol sufficiently to allow it to flow smoothly along the individual fiber before finally applying sufficient heat to cure. In some instances, it may be desired to apply only sufficient heat to partially polymerize or set the coating on the yarn. The height of the tower and the speed of the yarn passing through the tower will determine the amount of heat which is to be supplied at the various points in the tower to properly condition the coating. The coated yarn is then wound on a conventional textile package.

The coated yarn is shown diagrammatically in Fig. 3 with a portion of the plastisol 18 cut away. It can be seen that each individual glass filament 81 is coated and the strand is thoroughly impregnated with the coating. For purposes of illustration only, the strand is magnified many times and it is shown as comprising only a relatively few fibers.

The apparatus as shown above can be employed to coat more than one strand at a time. For example, a pair of rollers such as 26 and 28 having ten grooves therein suitable for coating ten strands at one time have been employed with one reservoir 16 and one curing tower 55. Such a set up has been found to be highly satisfactory when the apparatus is constructed in the form of a circle with the arm being stationed at ten points on a circle and the reservoir 16, coating rollers 26 and 28, and tower 45 being positioned at the eleventh and twelfth positions on the circle.

The yarn leaves its package at a position on the circle and passes through the reservoir, rollers, and heating tower and returns to be wound on another suitable package at the same position on the circle. Such a circular set up for multiple coating operation has the advantages of ease of operation and conservation of space. Also, such a circular set up constitutes a complete multi-end manufacturing unit as compared with conventional textile equipment used for similar applications.

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

I claim:

An apparatus for applying a viscous, flowable plastisol to a glass fiber strand having variations in diameter along its length which comprises a reservoir containing the plastisol, a guide means mounted in the reservoir and submerged in the plastisol, coating means having an opening therein adapted to force the plastisol into the strand as it passes therethrough and leave a coating on the strand in excess of the diameter than that finally desired on the strand, said coating means being mounted above the guide means in vertical alignment therewith, resilient means mounted above the coating means in vertical alignment therewith for removing the excess of

the plastisol which resilient means will give to permit passage therethrough of the strand at points of its largest diameter and produce a coated strand of substantially uniform diameter, means to remove the excess plastisol from the resilient means and prevent the excess plastisol from returning to the coating system, heating means mounted above and in vertical alignment with the resilient means for heating the plastisol coating on the strand and means for passing the strand at a constant linear speed and under constant tension through the plastisol in the reservoir and then vertically through the coating means, resilient means and heating means.

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