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COATING FIBROUS GLASS YARNS

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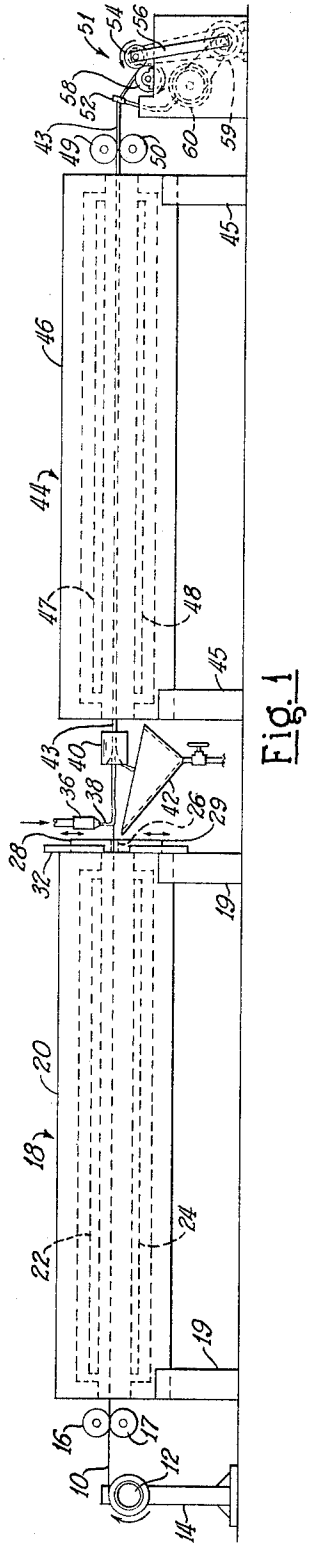


Fig. 1

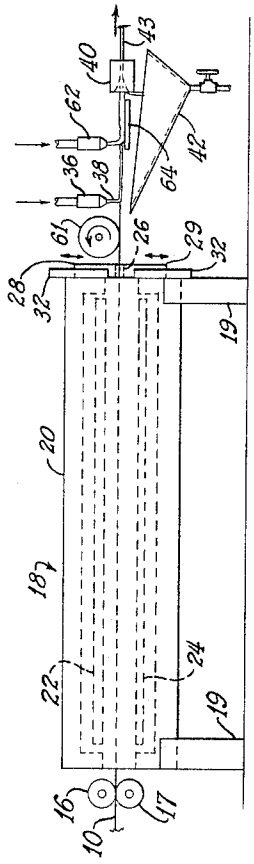


Fig. 3

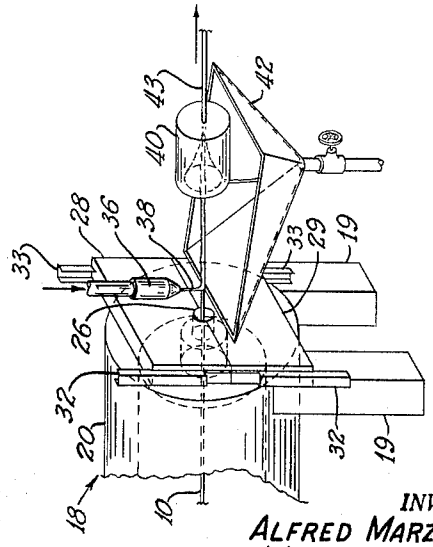


Fig. 2

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COATING FIBROUS GLASS YARNS

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This invention relates primarily to heating and coating fibrous glass yarns and supplementally to attenuating the yarns while they are heated. The invention may also be advantageously practiced in treating rovings, strands, twine, and cordage of fibrous glass, as well as such articles composed of other natural or synthetic fibers. Certain aspects of the invention are also adapted for utilization in connection with monofilament strands, such as solid metallic wire.

In order to simplify the explanation, the description of the invention will be directed to the use of the invention in connection with fibrous glass yarns, with only occasional reference to its practice with other elongated bodies.

Fibrous glass yarns coated in the manner of this invention have their greatest field of utility in insect screening. Uniformity in size and roundness of the coated yarn is important in this product from the standpoint of appearance and also to leave maximum openings for the passage of air. Such coated yarn is further employed in weaving seat covers, curtains, fabrics and in various other objects.

Among the procedures previously followed in coating yarns of fibrous glass have been directing the yarn over a pad saturated with the coating material, in contact with a material carrying roller or belt; through a dip tank, spraying coating material upon a moving yarn; and passing a yarn through a wiping die after applying material to the yarn.

Of these methods, passing the yarn 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.

Plastisols, combinations of a resin and a plasticizer, are the most common finishing materials for coating yarns with a wiping die. They are not only durable, and attractive in appearance, but set rapidly due to the absence of any substantial amount of a volatile constituent.

There has been, however, a problem in bringing these resinous coating materials to a suitable viscosity. The plastisol should be sufficiently fluid to penetrate the yarn, but yet should not flow freely enough to form beads or undulations in the coating.

Another difficulty encountered with plastisols is the migration of the plasticizer component to the surface of the yarn. This concentration, which occurs during the fusing or curing treatment, weakens the adhesion of the coating to the yarn.

A principal object of the invention is to provide a method curbing the inclination of the plasticizer component to collect on the surface of the yarn and thus to improve the bonding of the plastisol and the yarn.

A further object is to secure adequate penetration of the plastisol into the yarn.

Another object is to produce a uniform, cylindrical coating on the yarn.

These objects are attained mainly by heating the yarn immediately before the plastisol is placed thereon. It has been found that this procedure not only encourages penetration, but by applying heat, interiorly, minimizes plasticizer migration. It also enables a heavier and a more evenly distributed coating of plastisol to be deposited.

Another discovery of the invention is that if the yarn is heated to a softening stage and is attenuated under tension, a considerable increase in strength is secured. This is evidently due to equalization of tension stresses between the filaments, while the strength of the individual filaments is not heightened.

A supplemental object of the invention is accordingly to provide a method of producing a stronger yarn.

The attenuation has the further benefit of improving the roundness of the yarn and, if of sufficient extent produces a yarn with much finger filaments and consequently one of improved flexibility.

Another advantage of the attenuation of the yarn and the filaments of which it is composed is that fresh surfaces are developed on the filaments which are more receptive to adhering association with the plastisol.

These and other objects and advantages of the invention will be brought out more completely in the following specification with reference to the accompanying drawings in which:

FIGURE 1 is a side elevation of a production line, shown somewhat diagrammatically, designed to carry out the method of this invention;

FIGURE 2 is an enlarged perspective view of the discharge end of the furnace of the production line of FIGURE 1, and of the plastisol applying equipment positioned in close following relation to the furnace; and

FIGURE 3 is a side elevation of the furnace of FIGURE 1 with a tensioning capstan and a different form of plastisol applying apparatus adjacent the discharge end of the furnace.

Referring to the drawings in more detail, and first to FIGURE 1 thereof, the yarn **10** is pictured as being payed off from a spool **12** mounted on the creel stand **14**. For employment in weaving insect screening, this yarn may be a single twisted strand about .010 of an inch in diameter composed of 204 filaments with an average diameter of .0005 of an inch. Such a yarn is designated in the trade as 75 1/0 with a nominal length of 7500 feet per pound.

The yarn **10** is drawn from spool **12** at a predetermined rate, generally between one and six hundred feet per minute and passes between the mated pulling or guide wheels **16** and **17**.

The yarn **10** is then led through furnace **18** mounted on legs **19**. Within the main casing **20** of the furnace are upper and lower heating elements **22** and **24**, which may be electric or radiant gas burners. In one manner of practicing this invention the temperature to which the glass yarn is raised in furnace **18** is below its softening point temperature, which generally is between 600° F. and 700° F. Accordingly, the yarn may be heated, for example, to a temperature of 560° F. Because of the rapid traverse of the yarn through the furnace the temperature thereof must be well above that desired to be developed in the yarn.

To minimize loss of heat by the yarn **10** at the exit of the furnace, the yarn is delivered therefrom through a restricted outlet **26** formed between the edges of two vertically slidable doors **28** and **29**, as best seen in FIGURE 2. The doors are movable in a pair of vertical runways **32** and **33**.

Immediately adjacent the outlet **26** an applicator nozzle **36** directs a narrow stream of plastisol against the travelling yarn. The plastisol may be one of numerous different compositions, but is preferably composed of 100 parts of a polyvinyl chloride resin to 60 parts of a plasticizer.

Other suitable resin bases include other polyvinyls and copolymers thereof, polyethylenes, polystyrenes, polypropylenes, acrylic polymers, cellulose derivatives, vinylidene chloride, polyesters, polyamides, phenolics, epoxides, silicanes, alkylds, and allyl esters.

The possible plasticizers include esters such as dioctyl phthalate, dioctyl sebacate, and dioctyl adipate as well as phosphates and sulfonamides.

The plastisol **38** projected from the nozzle **36** is restricted to the least amount that will provide the desired coating. Upon striking the yarn it is further fluidized by the heat of the yarn and is thus enabled to better penetrate between the filaments of the yarn. At the same time the heat is sufficient to initiate fusing of the portion of the plastisol in direct contact with the surface of the yarn. This tends to preclude migration of the plasticizer to this area.

The final plastisol coating is desirably sufficiently heavy to be equivalent in weight to the glass yarn. This may be as much as one and one-half times in volume.

Accordingly, the amount of the plastisol applied to the yarn from nozzle **36**, being in excess of the amount that remains thereon as a final coating, will rapidly reduce the temperature of the glass yarn, but still will absorb only enough heat to raise the temperature of the main portion of the plastisol a moderate extent, to probably not more than 80° F. This is a good fluidizing temperature facilitating the forming of a smooth uniform sheath of plastisol on the yarn as it passes through the wiping die **40**. At the same time, due to the partial fusing of a thin skin of plastisol over the surface of the yarn, a larger body of plastisol will maintain itself in proper shaped form on the yarn as the latter proceeds from the die **40**.

Below the nozzle **36** and the die **40** is a drain pan **42** to catch any drippings of plastisol. If in sufficient volume, this excess material may be filtered and recirculated back to the nozzle **36**. The plastisol delivered to the nozzle may be preheated slightly, but any such heating should be balanced with the heat absorbed from the hot yarn to limit the temperature of the main body of plastisol to less than 110° F.

The coated yarn **43** advances from the die **40** into the fusing oven **44**. As illustrated, this is mounted on legs **45**, with a main casing **46** and upper and lower heating elements **47** and **48**. The temperature for fusing the polyvinyl chloride resin is between 300° F. and 400° F. with the exact temperature depending upon the length of the oven, the rate of travel, and the thickness of the coating. The coated yarn **43** is pulled through the oven **44** by a pair of tension rolls **49** and **40**, and then reaches the winding mechanism **51**. A transversing member **52** guides the yarn back and forth upon the collection tube **58**. The latter is rotated by driving contact with the rubber roller **54** which is pivotably mounted on arm **56** to bear against the tube.

A motor indicated at **59** through belts or chains drives a cam **60** which reciprocates the transversing member **52** and also drives the rubber roller **54**.

In the preceding description of the operation of the production line of FIGURE 1, the method of the invention has been presented in which the fibrous glass yarn has been heated, but has not been attenuated. Certain worthwhile benefits are realized with such functioning of the system, as has been pointed out.

However, additional advantages of special importance are secured by raising the temperature of the furnace **18** to a point where the yarn is heated to a drawable state and applying tension to the yarn by driving the mated pulling wheels **16** and **17** at a fixed speed and operating

the tension rolls **49** and **50** at a higher speed. For example, the wheels **16** and **17** may positively feed the yarn at a rate of 450 feet per minute and the tension rolls **49** and **50** may draw the yarn at the rate of 675 feet per minute.

The constant tension rolls **49** and **50** are driven through a fluid clutch by which the speed is maintained only against a predetermined tension, and the rolls will slow down proportionately under any increase in tensile force.

To be suitably softened for attenuation the yarn **10** must be heated in the furnace **18** to at least 800° to 900° F. In order to do this, because of the speed of travel of the yarn through the furnace, the furnace temperature must be raised to a much higher temperature, possibly to as much as 2000° F. The length of the furnace and the velocity of the yarn, as well as the yarn size, are factors in the exact furnace temperature required.

Under the prescribed difference in speeds between the pull wheels **16** and **17** and the tension rolls **49** and **50**, the yarn is attenuated fifty percent in length while passing through the furnace. This develops a uniform load on all two hundred and four of the filaments of the yarn and therethrough increases the strength of the yarn an estimated thirty percent above that of the usual glass yarn of the same gauge. The filament diameters are reduced one-third to a greater fineness and flexibility. Loose filaments are drawn in by the attenuation, reducing fuzziness, and the yarn is compacted and made more round. Twist per inch is naturally reduced proportionately to the increase in length.

The fresh nascent surfaces of the filaments thus developed are more active chemically and cohere more readily with the plastisol projected upon the yarn by the nozzle **36**. In this arrangement the yarn carries more heat and the advantages of the transfer of heat to the yarn are thereby enhanced.

Instead of a fifty percent elongation the attenuation may be confined to a nominal amount to simply equalize the stresses on the filaments and thus strengthen the yarn without materially affecting the length of the yarn, the surface character, or the size of the filaments. However, even this reduced heat application appears to have a tempering effect, enhancing the chemical stability of the glass.

In FIGURE 3 certain refinements in the practice of the invention are illustrated. For more accurate pulling tension a capstan **61** is placed immediately following the furnace **18**. This is fluid driven to maintain a constant tension on the yarn. It is also heated to keep the yarn at the desired temperature.

The modification of equipment presented in the showing of FIGURE 3 also includes a second plastisol applicator nozzle **62**. With this arrangement a limited amount of plastisol may be emitted from the first nozzle **36** which will be appreciably set by the heat of the yarn. Then a surplus of plastisol is directed upon the yarn by the second nozzle **62**. This creates a pool of plastisol upon the platform **64** through which the yarn travels. With the under layer at least partially set an overall greater quantity of plastisol may be applied to the yarn and a final heavier coating secured.

In case a thermosetting resin composition is applied to the yarn instead of a thermoplastic, such as polyvinyl chloride, the heat carried by the yarn may initiate the thermosetting action with exothermic consequences progressively continuing the setting from the yarn surface outwardly. This not only expedites the curing procedure, but also eliminates the interior trapping of plasticizer.

Illustrative of a supplemental benefit of this invention is the attenuation of a lower cost 75 1/2 yarn by one hundred percent to create the more expensive, finer 150 1/2 yarn.

The heating and resin impregnating method of the invention is obviously adapted to strands of most any composition, whether of monofilament or multifilament type.

The supplemental extension or attenuation step is quite restricted in employment to strand-like bodies of thermoplastic character. However, low melting metals fit into this category and, as an example, aluminum wire for screening could be attenuated under the heat of furnace 18 and the fresh surface thus developed thereon would have improved coherence properties for the subsequently applied plastisol. Alternately, the wire could be first elongated by being drawn through a die and then be heated prior to the coating step.

While a plastisol is the preferred coating material because of its lack of volatile constituents, a resin in an evaporative vehicle may of course be utilized in the subject process. With such a coating material considerably more time is required in the setting of the coating as the vehicle must be quite entirely released therefrom.

In review, it may be seen that adequate means for attaining the recited objects of the invention have been provided. The features of the invention include the heating of the yarn immediately preceding the application of the plastisol and the prompt curing of the plastisol coating; the attenuation of the yarn during the heating step; and restricting the temperature of and the amount of the plastisol deposited upon the traveling yarn.

While specific yarns have been identified herein, the term "yarn" has been used generally in a broad sense to indicate multifilament strands whether untwisted, or with numerous twists and plies such as found in heavy yarns and cordage. "Strands" is intended as a broad term encompassing both multifilament and monofilament elongated bodies. "Plastisol" as used in this specification should be taken as representing various coating substances, except where the context indicates a more restricted meaning.

In some respects mineral as well as organic fibers should be considered quite analogous to "fibrous glass." Accordingly, the scope of the appended claims should not be construed as necessarily limited by the aforementioned specific terms.

We claim:

1. The method of applying a coating material, of a type made more fluid by heat, to a yarn which comprises directing the yarn along a linear path, continuously applying heat to the yarn in a first section of such path to uniformly heat the yarn, in a second section of the path following immediately thereafter continuously depositing coating material upon the yarn, said material being fluidized by the heat of the yarn, and then in a final section of the path setting the coating material on the yarn.

2. The method of coating a yarn with a material made more fluid by heat within a low temperature range, which comprises directing the yarn in a linear path, heating the yarn at a temperature well above said low temperature range, and immediately thereafter applying the coating material to the yarn only in an amount which absorbs enough heat from the yarn to bring the temperature of the yarn and that of the coating material within the low temperature range, then passing the yarn through a wiping die, and thereafter finally setting the coating material.

3. The method of coating a fibrous glass yarn with a heat settable, synthetic resin plastisol made more fluid by heat at a temperature below 110° F. which comprises directing the yarn along a linear path, uniformly heating the yarn to a temperature substantially above 110° F., applying the plastisol to the yarn in a measured amount which by heat absorption reduces the temperature of the yarn to below 110° F., the plastisol being made more fluid by the heat absorbed for better penetration of the yarn, removing excess plastisol from the yarn, and then setting the plastisol on the yarn by heating at a temperature substantially above 110° F.

4. The method of coating a strand with a heat settable, resin and plasticizer coating composition which comprises directing the strand along a linear path, in a first section of the path uniformly heating the strand above the temperature at which the composition is settable, in a following section of the path, depositing a quantity of the composition on the strand to be partially set by the heat thereof, and applying an additional quantity of the composition to the strand immediately after the deposit and partial setting of the limited quantity.

5. The method of coating an elongatable, multifilament glass strand with a heat settable, resinous material which comprises directing the strand along a linear path, elongating and compacting the strand by applying tensile forces thereto, while the strand is elongated and compacted depositing the heat settable material upon the strand, and finally applying heat to set the material.

6. The method of coating a fibrous glass multifilament yarn which comprises directing the yarn along a linear path, heating the yarn above the softening point of the fibrous glass and attenuating the yarn while it is so heated, immediately thereafter applying a coating material to the yarn, and then setting the coating material.

7. A method according to claim 6 in which the coating material is a synthetic resin plastisol, initially made more fluid by the heat of the yarn and thus enabled to better penetrate the yarn.

8. A method according to claim 6 in which the attenuation is very limited in extent.

9. The method of strengthening a twisted, multifilament, normally non-stretchable, glass yarn in which some of the filaments are more loosely disposed than are other filaments which comprises extending the yarn in a linear path, heating the yarn to a glass softened state and while the yarn glass is so softened applying tensile forces thereto to thus equalize the tautness of the filaments.

10. The method of improving the roundness of a twisted, multifilament yarn of fibrous glass in which some of the filaments are loosely disposed which comprises heating the yarn above the softening point of the fibrous glass and attenuating the yarn while so heated to draw the filaments into more compact relationship.

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