United States Patent [19]

Benson et al.

[11] **3,924,028**

[45] **Dec. 2, 1975**

[54] **METHOD FOR IMPREGNATING AND COATING FIBROUS STRANDS**

[75] Inventors: **Gustav E. Benson**, Edgewood; **Paul D. Yakuboff**, Woonsocket, both of R.I.

[73] Assignee: **Owens-Corning Fiberglas Corporation**, Toledo, Ohio

[22] Filed: **Apr. 20, 1973**

[21] Appl. No.: **353,150**

Related U.S. Application Data

[62] Division of Ser. No. 171,252, Aug. 12, 1971, Pat. No. 3,779,207.

[52] **U.S. Cl.** **427/175;** 118/33; 118/109; 118/264

[51] **Int. Cl.²** **B65G 49/04**

[58] **Field of Search** 117/7; 118/33, 56, 109, 118/204, 264, 265, 270, 414, 423, 68; 273/738

[56] **References Cited**

UNITED STATES PATENTS

2,740,373	4/1956	Wagner et al.	118/68
2,749,266	6/1956	Eldred	273/73 F
2,779,388	1/1957	Quoss	273/73 F
2,826,167	3/1958	Cohn et al.	117/7

FOREIGN PATENTS OR APPLICATIONS

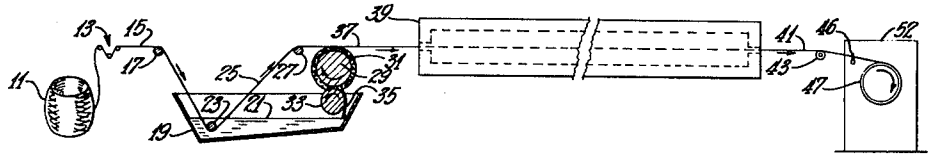
320,869	10/1929	United Kingdom	117/7

Primary Examiner—Caleb Weston
Attorney, Agent, or Firm—Carl G. Staelin; John W. Overman; Kenneth H. Wetmore

[57] **ABSTRACT**

Strands of textile filaments are impregnated and coated with a liquid material by passing each strand through an immersion bath and in contact with a resiliently compressible and absorptive material which wipes off excess impregnant and coating from the strand. The path and tension of the strand is adjustable to vary the depth at which the strand is embedded into the absorptive material. The absorptive material is in the form of an endless surface constantly rotating to continuously present an unsaturated portion to the strand.

4 Claims, 9 Drawing Figures



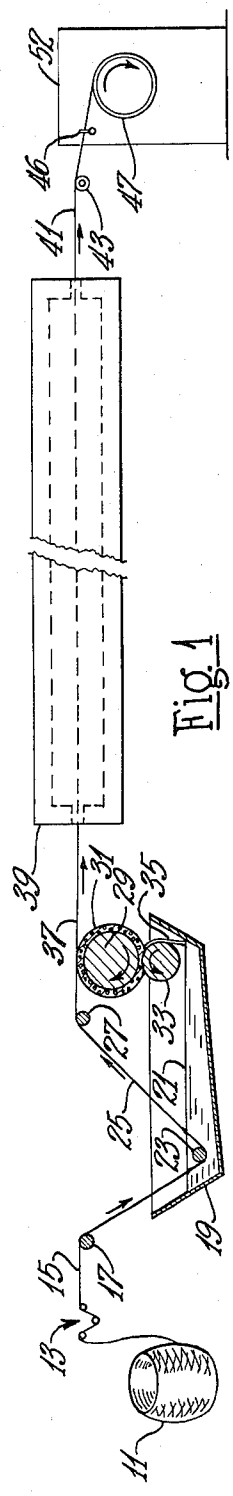


Fig. 1

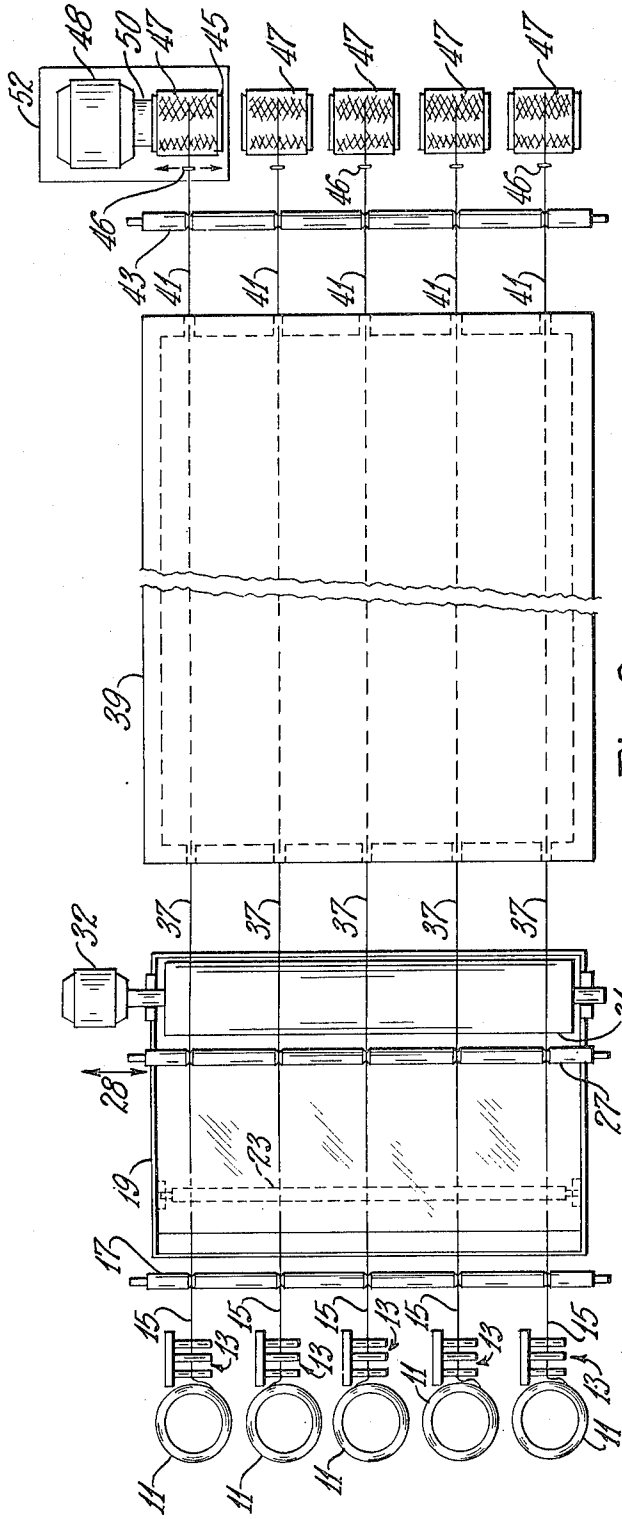


Fig. 2

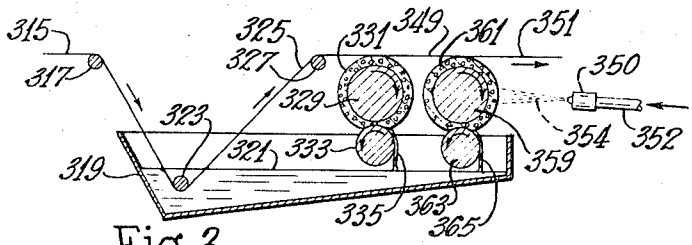


Fig. 3

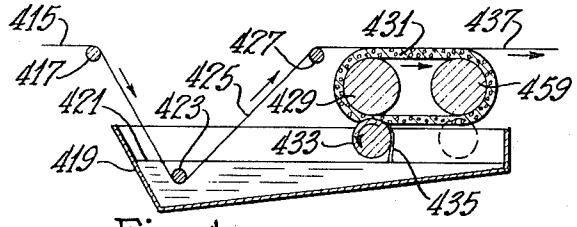


Fig. 4

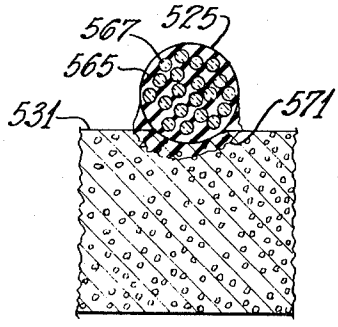


Fig. 5

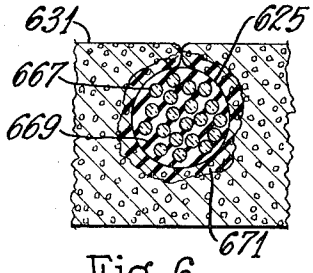


Fig. 6

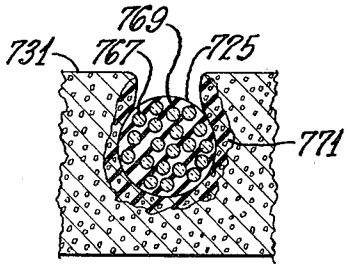


Fig. 7

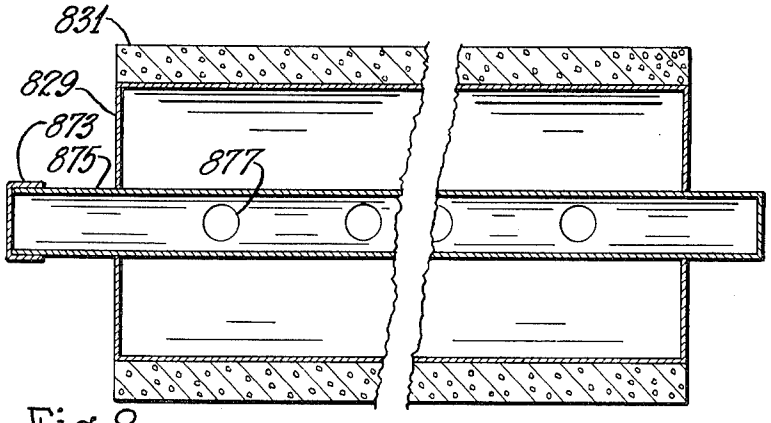


Fig. 8

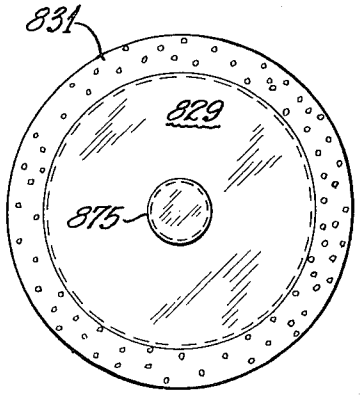


Fig. 9

METHOD FOR IMPREGNATING AND COATING FIBROUS STRANDS

This is a division of application Ser. No. 171,252, filed Aug. 12, 1971, now U.S. Pat. No. 3,779,207.

BACKGROUND OF THE INVENTION

The present invention relates generally to the controlled application of a coating or impregnant to strands of textile filaments or other finely elongated materials. For economical and technical reasons, producers of treated fibrous strands have constantly sought to maintain a high degree of impregnation uniformity while simultaneously achieving complete permeation. Conventional fixed dies consisting of a smaller circular orifice in a hard metallic structure and employed to strip excess impregnant from moving fibrous strands have provided reasonably accurate and uniform control over the process, but from a manufacturing viewpoint the standard die system has several disadvantages. The most significant disadvantage stems from the inability of the system to function for long periods of operation without clogging. For example, the throat of the die orifice tends to accumulate a residue of dried impregnant as well as trap other solid particles such as strand fuzz and the like. These trash deposits constrict orifice diameter and account for a high incidence of strand breakage and poor impregnation quality.

Furthermore, present high production speeds coupled with the natural abrasiveness of fibrous materials, glass fibers in particular, have drastically reduced the life span of even the most durable dies. Replacement of worn or defective dies naturally require numerous process interruptions. These interruptions and those necessarily incurred for installation of different die sets for the purpose of changing product specification may be prohibitive in regard to maintaining desirable operating efficiencies.

In view of the limitations and soaring replacement costs of fixed dies, including resultant declines in operating efficiencies, it becomes apparent that this method of controlling fibrous strand coating and impregnation is no longer economically favorable.

SUMMARY OF THE INVENTION

According to the present invention, it has been discovered that a resiliently compressible material may be utilized to eliminate many objectionable features of strand wiping system employing fixed dies without destroying desirable attributes. The resiliently compressible material is provided by an absorptive sponge in a design having an endless surface, such as a cylinder or an endless belt. The impregnated or coated strand is passed across the sponge in a path which at least partially embeds the strand into the sponge. Thus, at one extreme the strand is completely surrounded by the sponge, and at the other extreme, the sponge only contacts one side of the strand.

As the strand passes in contact with the sponge, excess impregnant is wiped from the strand and absorbed by the sponge. The sponge can be rotated to move the impregnant-saturated portion of the sponge away from the strand contact zone. At another location remote from the strand contact zone the impregnant-saturated portion of the sponge is squeezed to remove the absorbed impregnant. This invention includes variations

which are further described in the Description of Exemplary Embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation in partial section of a glass strand impregnation and coating production line which includes the impregnation apparatus of this invention.

FIG. 2 is a plan view of the production line shown in FIG. 1.

FIG. 3 is a side elevation in partial section of this invention shown in FIG. 1 with modifications featuring two sponge rolls mounted in tandem and a nozzle spraying liquid onto the last sponge roll.

FIG. 4 is a side elevation in partial section of this invention shown in FIG. 1 with a further modification featuring an endless sponge covered belt replacing the roll.

FIG. 5 is a section view of an impregnated glass strand passing over the sponge roll of this invention and illustrating one method of removing excess impregnant from the strand.

FIG. 6 is a section view of an impregnated glass strand passing over the sponge roll of this invention and illustrating a second method of removing excess impregnant from the strand.

FIG. 7 is a section view of an impregnated glass strand passing over the sponge roll of this invention and illustrating a third method of removing excess impregnant from the strand.

FIG. 8 is a section view of a modified sponge roll to be used in this invention.

FIG. 9 is an end view of the modified sponge roll shown in FIG. 8.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

Referring now to the drawings, FIG. 1 and FIG. 2 show more specifically a production operation wherein linear materials in the form of fibrous strands **15** are pulled from packages **11** through tension controlling devices **13.** The strands are then guided by grooved surfaces or pulleys **17, 23** and **27** through a reservoir of impregnating medium **21** which is held in a vat **19.** The strands **25,** having an excess of impregnant, are then guided across the sponge surface **31** of a revolving drum **29** where the excess impregnant is removed. Ultimately, the strands **37,** having the desired amount of impregnant on them, are passed through a curing oven **39** and wound into a package **47** by a standard winding device **52.** The initial thread-up of the production line is manually accomplished, but thereafter, strand moving forces are supplied entirely by the winding device.

To more specifically describe the production process, reference is first made to the strands **15** of unimpregnated fibers. By way of example, the impregnation process shall be described for glass fibers, but the same process would apply for any type of textile filaments in a strand. The term strand is used here to means a primary bundle of continuous filaments combined in a single compact unit without twist as well as a bundle of twisted continuous or staple filaments. It also is used here to mean plied bundles of twisted or untwisted filaments. The diameter of the filaments may vary in size, but must be small enough to be flexible. The number of filaments in the strand may also vary. However, a strand having a very small number of filaments becomes impractical to handle. On the other hand, it would be difficult to completely impregnate a strand

having a very large number of filaments. It is not known what maximum number of filaments in one strand can be completely impregnated in the impregnation line of this invention, but it is thought that as many as two thousand filaments in one bundle can be satisfactorily impregnated in the apparatus of this invention. An example of a strand satisfactorily impregnated in the apparatus of this invention is one of continuous fiber glass filaments containing **408** filaments with an average diameter for each filament of **0.00036** inches and the strand having one-half twist per inch.

As may be seen in FIG. **2,** grooved surfaces **17, 23** and **27** are laterally disposed in spaced aligned relationship to thereby separately guide the strands **15** in parallel fashion through the impregnating bath **21.** In passing through the bath, strands are saturated with the impregnant material to generously coat the outer surface of the composite strand as well as each individual filament. To achieve complete penetration and coating, the strands **15** are subjected to the impregnant long enough to accomplish the viscous work necessary in overcoming the influence of variables such as mechanical and chemical cohesiveness of the individual filaments and the impregnant. For the purpose of illustration, the impregnant material **21** is exemplified by an elastomeric dispersion. Other coating materials including an aqueous or non-aqueous solution of a film forming composition or a hot melt or a solvent free material which is liquid at room temperature but which may be hardened by a subsequent chemical or thermal condition may be applied equally as well by using the techniques of this invention. Desirable but optional additives such as pigments, dyes, plasticizers, emulsifiers, lubricants and coupling agents may also be added. The terms impregnant and impregnation are used here to refer also to coating material and coating.

Emerging from the impregnant bath **21,** the strands **25** have more impregnant on them than is desired in the final impregnated strand. The excessively impregnated strand is guided horizontally across the sponge surface **31** of revolving drum **29** where the excess impregnant is removed from the strand and absorbed by the sponge **31.** The wetted sponge is revolved by a hard-surface roll **33** which squeezes out most of the impregnant from the sponge. The impregnant **35** squeezed from the sponge flows back into the vat **19** and again becomes part of the impregnant reservoir **21.**

The sponge covered drum **29** is rotatably mounted above squeeze roll **33.** It has been found advantageous to mount the shaft of the drum **29** loosely in vertical slots. The vertical positioning of the drum **29** is then determined by balancing the weight of the drum **29** with the compression resisting force of the sponge surface **31.** The advantage of this arrangement is that a new drum **29** can be quickly substituted for an old one that has developed a worn sponge surfae. The drum can be made from any hard material, such as steel. The sponge covering the drum is preferably an open cell flexible foam such as polyester of polyurethane. Other material capable of absorbing the impregnant can also be used as long as it is compressible and resilient. An example of a satisfactory sponge is one ⅜ inches thick **263** polyester foam of **2** pound density sold by Rogers Foam, Inc., Sommersville, Mass.

The sponge covered drum **29** is shown by the arrow as rotating in the same direction as the strand movement, but it could be rotated in the opposite direction with satisfactory results. Also, the surface speed of the drum **29** can be varied within a wide range and still obtain good results. However, in order to wipe, there must be some relative movement between the strand and the surface of the sponge covered drum in contact with the strand. The drum must also rotate fast enough to present a fresh surface to the strand and avoid a saturated area in the contact zone. Operating at strand speeds from **400** to **600** FPM, it has been found that drum rotation speeds of **4** to **18** RPM have worked satisfactorily.

The squeeze roll **33** is rotatably mounted about a fixed axis. It is preferably driven by a conventional power source, such as an electric motor **32,** through chains, V-belts, or direct drive. Its surface interaction with the sponge surface **31** of the cylinder **29** accomplishes rotation of the cylinder **29** with the result that the sponge surface **31** is continually squeezed by the roll **33.** The squeeze roll **33** can be made from any of several hard materials. An example of a satisfactory material is stainless steel.

After the excess impregnant is removed from the impregnated strands **25,** the strands **37** having the desired amount of impregnant are advanced through the curing oven **39** where the impregnant is cured to the desired degree. The heat source in the curing oven can be supplied by any conventional form of heat, such as gas combustion, electrically heated elements, micro-wave energy, etc. The length of the oven is dependent upon the rate of impregnant cure and the speed of the strand passing through the oven. Curing of impregnants in this manner is well known in the art. In some cases the impregnant cure is carried out at ambient conditions, and no curing oven is required.

The strand **41** with cured impregnant is advanced from the curing oven **39,** over guide roller **43** and wound into a package **47.** The winding is accomplished by a commercially available standard winding apparatus commonly used in the textile industry. The winder **52** shown schematically consists of an electric motor **48** which rotates a shaft **50** upon which a collet **45** has been placed and reciprocates a traversing guide **46** back and forth along the length of the package to distribute the advancing strand **41** as it is wound into a package **47** on the rotating collet **45.** The winding apparatus also supplies the pulling force to advance the strand through the impregnation line. The winder **52** is shown at one position only for illustrative purposes, but each position in the line would have a similar winder.

Resisting the pull of the winding apparatus is the tension control **13,** along with frictional forces developed where the strand contacts members of the impregnation line. The tension control **13** is shown as a simple three finger configuration which is designed to produce the desired amount of drag on the strand when the strand is being pulled at operating speed. It may be desirable to use an adjustable tension controller, especially if the impregnation line is operated at varying speeds. Such an adjustment can be accomplished by varying the distance between the three fingers in the tension control **13** shown, as well as through use of other well known tension controllers.

FIG. **3** illustrates another feature of this invention. The impregnation line shown in FIG. **3** is the same as that shown in FIGS. **1** and **2,** but it has two sponge covered wiping drums **329** and **359.** Each drum rests upon a squeeze roll **333** and **363** which turns the sponge cov-

ered wiping drum **329** and **359** and squeezes removed excess impregnant **335** and **365** from the sponges **331** and **361.** With the addition of the second wiping drum, it has been found that the strand can be advanced through the impregnation line at a faster speed than with only one wiping drum and still obtain the desired impregnation removal. It is not necessary that both sponge covered drums rotate in the same direction nor at the same speed. In fact, less impregnant will be removed from the strand by the second drum, so it would not be necessary to rotate it as fast as the first drum. It should be noted that this invention also contemplates the use of more than two sponge covered wiping drums. Three or more drums could be used to allow faster line speed operation and better control of the amount of impregnant removed. As with the use of two wiping drums, each drum ina series of three or more drums can be rotated in either direction and at a different speed from the other drums.

FIG. **3** illustrates another feature of this invention. Included in the impregnation line is a spray nozzle **350** for applying a liquid **354** to the sponge **361** on the last drum **359.** The liquid **354** is supplied through a pipe **352** under pressure. It can be pumped, or if water is used, the usual line pressure can be used for the motivating force. The function of the liquid is to prevent the removed impregnant from drying on the sponge **361** and thereby facilitate removal of the impregnant from the sponge by the squeeze roll **363.** FIG. **3** shows the liquid being squeezed out of the sponge along with the removed impregnant. If the liquid is of a type which will contaminate the reservoir of impregnant **321,** the catch area for the removed impregnant **365** must be separated from the reservoir of impregnant **321.**

FIG. **4** illustrates a further feature of this invention. The impregnation line shown in FIG. **4** is the same as shown in FIGS. **1** and **2,** but having an endless sponge belt **431** rather than a sponge covered drum. The sponge belt is mounted on two spaced drums **429** and **459** which are rotatable about parallel axes. One of the drums rests upon a squeeze roll **433** with the sponge belt between. The squeeze roll **433** rotates the belt **431** and squeezes the removed excess impregnant **435** from the belt. FIG. **4** shows the squeeze roll mounted below drum **429,** but it could be just as well mounted below drum **459** in the location shown by the broken line. The belt **431** is shown in FIG. **4** as rotating in the same direction as the strand movement, but it could also be rotated in the oppoiste direction. In fact, rotation against the strand movement might be more desirable because a fresh unsaturated surface of belt would be presented to the strand as it progresses along the belt. On the other hand, better impregnation removal control might be obtained by keeping the strand in contact with a damp belt surface throughout the contact zone, in which case, rotation with the strand movement would be preferred. The nature of the impregnant and speed of strand movement would determine which is preferable.

FIGS. **5, 6** and **7** illustrate three methods of impregnation removal possible with this invention. The method which applies is dependent upon the compressibility and resiliency of the sponge material and the depth to which the strand is embedded into the sponge. FIG. **5** illustrates a strand **525** embedded only slightly into the sponge **531.** This arrangement would result when the sponge is positioned so that it barely interferes with the path of the strand. With this arrangement the sponge **531** wipes impregnant **565** from beneath the strand **525.** An the impregnant is wiped off the strand, it is absorbed into the sponge **571** and carried away by the moving sponge so that a fresh sponge surface is presented to the advancing strands. After impregnant is wiped from the bottom of the strand, the remaining impregnant on and in the strand of filaments **567** distributes to again cover the bottom of the strand, if the impregnant is not too viscous. In this manner, removal of excess impregnant from all parts of the strand can be accomplished by wiping only the bottom of the strand.

As the strand is pulled from the package **11** shown in FIG. **1,** a twist is created in the strand as a result of the strand being pulled from a non-rotating cylindrical package. This created twist caused the strand to rotate as it moves through the impregnation line and especially as it comes in contact with the sponge surface **31.** Thus, a greater portion of the strand periphery is presented to the sponge **31** as the strand passes through the zone of contact with the sponge **31.**

FIG. **6** illustrates a strand **625** deeply embedded into the sponge **631** and completely surrounded by the sponge. This arrangement would result when the sponge is of an easily compressible material which is very resilient and the sponge is in a position which interfers substantially with the path of the strand and the strand is pulled with sufficient tension to overcome the resilient forces of the sponge. With this arrangement, the sponge **631** wipes impregnant **669** from the complete circumference of the strand **625** without appreciably exerting pressure on the strand so that the impregnant surrounding the internal filaments of the strand remain well impregnated. The impregnant wiped from the strand **625** is absorbed in the sponge **671** and carried away by rotation of the drum so that a fresh sponge surface is presented to the strand. The method of removing excess impregnant shown in FIG. **6** allows more removal for the same strand speed than that shown in FIG. **5.** It might be desirable to utilize the FIG. **6** method in the first sponge covered roll **331** of FIG. **3** to remove the bulk of the excess impregnant and the FIG. **5** method in the second sponge covered roll **361** of FIG. **3** to make a final wipe with finer control. In the event the first sponge covered drum **331** is used to remove the bulk of the excess impregnant, it will be necessary to rotate it faster than the second sponge covered drum **361** to remove the larger amount of impregnant removed from the sponge. The use of either wiping method would be determined by the material of the sponge and the height setting of the squeeze roll **333** and **363.** Adjustment can also be made by raising or lowering guide rolls **27** and **43** shown in FIG. **1.** The tension in the strand as it comes in contact with the sponge is also an important factor in determining the degree to which the strand is pulled into the sponge. Even if the strand guides are set to cause the strand path to interfere with the sponge, the strand will only ride on top of the sponge unless there is sufficient tension to pull the strand into the sponge. The tension adjustment is made at the tension controller **13** of FIG. **1.** The tension is adjusted to a greater amount until the desired strand depth in the sponge is obtained.

FIG. **7** illustrates yet another method of excess impregnant removal within the scope of this invention. In this figure, the strand **725** is deeply embedded into the sponge **731** as was the case in FIG. **6,** but here the

sponge does not completely surround the strand as it did in FIG. 6. This arrangement results when the sponge is of an easily compressible material, but not as resilient as the material of FIG. 6 or when the strand path and tension do not pull the strand to the same depth into the sponge as with the method of FIG. 6. In this method, the sponge must also be positioned so that it will interfere substantially with the path of the strand. With this arrangement the sponge wipes excess impregnant from the majority of the circumference of the strand, perhaps 270°. The remaining portion of the excess impregnant on the top of the strand distributes to evenly coat the surface of the strand.

As with the sponge covered drum of FIG. 6, this method of excess impregnant removal can be used in combination with the method shown in FIG. 5 or FIG. 6. In fact, all three methods could be used in combination. For example, the first wipe could be taken by the method of FIG. 6, the second wipe by the method of FIG. 7, and the last wipe by the method of FIG. 5. Other combinations could, of course, also be used.

It should be noted that impregnant removal by the apparatus of this invention can be accomplished in three ways. The first, as already stated, is wiping. The second is sucking action brought about by the cells of the sponge resiliently expanding after passing the strand contact zone. The third method is drawing the impregnant from the strand by capillary action of the sponge cells. The second method requires rotation of the sponge covered drum to perform, and probably, the rotation must be much faster than with the other methods of impregnant removal. The first method requires rotation of the sponge covered drum only to present the strand with a fresh surface, as does the third method.

FIGS. 8 and 9 illustrate yet another feature of this invention. FIG. 8 is a cut-away view of a modified sponge covered drum, and FIG. 9 is an end view of the drum shown in FIG. 8. The drum 829 is a hollow sealed tube with sponge covering 831. On one end of the hollow shaft 875 is a removable cap 873 which can be attached by any conventional method, such as with threads. The hollow shaft 875 is perforated inside of the sealed drum 829. With this arrangement, water can be poured into the end of the shaft after the cap is removed to fill the drum with water to the level desired. Thus, the weight of the sponge covered drum is adjustable. Since the sponge covered drum is preferably mounted loosely above the squeeze roll in vertical slots, the degree of sponge compression at the squeeze roll can be adjusted by adding or subtracting water from the roll. It may be necessary to squeeze the sponge more when operating at fast strand speeds in order to remove the desired amount of absorbed impregnant from the sponge, and with this arrangement the same sponge covered roll can be used at many different speeds by adjusting the level of water in the drum.

Referring back to FIG. 2, a further feature of this invention is illustrated. Strand guide bar 27 can be moved back and forth horizontally a short distance as indicated by two-headed arrow 28 to change the path of the strand 25 across the sponge covered drum 31. In this way the operating life of the sponge will be extended because more surface of the sponge will be exposed to the strand. Movement of the strand guide bar 27 can be accomplished by a number of methods, such as a motor and cam arrangement. It is not necessary that the movement be constant and therefore, the simplest method is periodical manual indexing of the strand guide bar 27 by the operator of the apparatus. It should also be noted that the same effect can be obtained by moving the sponge covered drum 31 back and forth rather than the strand guide bar.

Having described the particular embodiments of this invention, it is to be understood that the invention is not limited to these specific embodiments, but modifications can be made without departing from the true scope and spirit of the invention. For example, this invention is not limited to glass fibers, but applies to many varieties of textile fibers. Also, it can be readily seen that it is not limited to strands in its use. Coating of monofilaments can also be accomplished. It is further pointed out that the impregnation of the strand can also be accomplished by means other than dipping the strand into a bath of impregnant. For example, the impregnant can be sprayed onto the strand prior to the strand contacting the sponge or the impregnant can be applied to the sponge itself whereby the strand will then pick up the impregnant in metered quantities when contacting the strand. Having thus stated a few of the modifications within the scope of this invention.

We claim:

1. The method of combining a coating material with filaments of a strand comprising:
moving said strand through a path at a predetermined tension;
applying coating material to said strand; and
passing said strand into contacting relationship with a member of resiliently compressible and absorptive material so that the member is compressed by the tensioned strand such that the strand passes below the uncompressed surface regions on either side of said strand of the member to remove excess coating material.

2. The method of combining a coating material with filaments of a strand comprising:
moving said strand through a path at a predetermined tension;
applying coating material to said strand;
advancing said coated strand with sufficient tension along a path into contact with a member having an endless surface of resiliently compressible and absorptive material such that said tensioned strand effects compression of said surface in the region of contact so that said surface partially surrounds said strand to remove excess coating material from said strand; and
rotating said strand about its longitudinal axis while said strand contacts said member.

3. The method of combining a coating material with filaments of a strand comprising:
moving said strand through a path at a predetermined tension;
applying coating material to said strand;
advancing said coated strand with sufficient tension along a path into contact with a member having an endless surface of resiliently compressible and absorptive material such that said tensioned strand effects compression of said surface in the region of contact so that said surface partially surrounds said strand to remove excess coating material from said strand;
extracting from said member the excess coating material removed from said strand and absorbed by

said member to maintain the absorptive property of the material; and

applying liquid to said member to prevent said coating material removed from said strand and absorbed by said member from drying before being extracted from said member.

4. The method of combining a coating material with filaments of a strand comprising:

moving said strand through a path at a predetermined tension;

applying coating material to said strand;

passing said tensioned strand into contacting relationship with a first member having an endless surface and being of a resiliently compressible and absorptive material to cause the contacted part of said first member to be compressed by said tensioned strand and to partially surround said strand whereby part of said coating material of said strand is removed from said strand and absorbed by said first member; and

passing said tensioned strand into contacting relationship with a second member having an endless surface and being of a resiliently compressible and absorptive material to cause the contacted part of said second member to be compressed by said tensioned strand and to partially surround said strand whereby part of said coating material of said strand is removed from said strand and absorbed by said second member, said contacted part of said first member is compressed more and partially surrounds said strand to a greater extent than said contracted part of said second member.

* * * * *