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R. C. WAREHAM
METHOD OF FORMING A HEAT SHRINKABLE TUBULAR SLEEVE
AND BONDING SAME TO A TUBULAR MEMBER
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FIG. 1

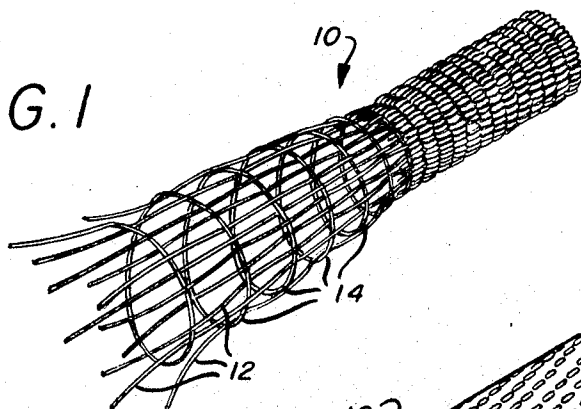


FIG. 2

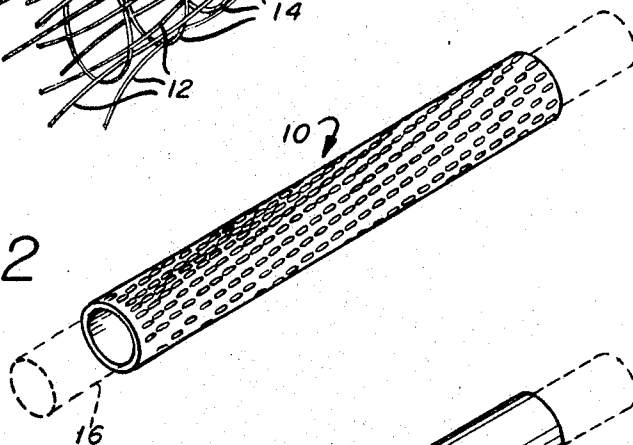


FIG. 3

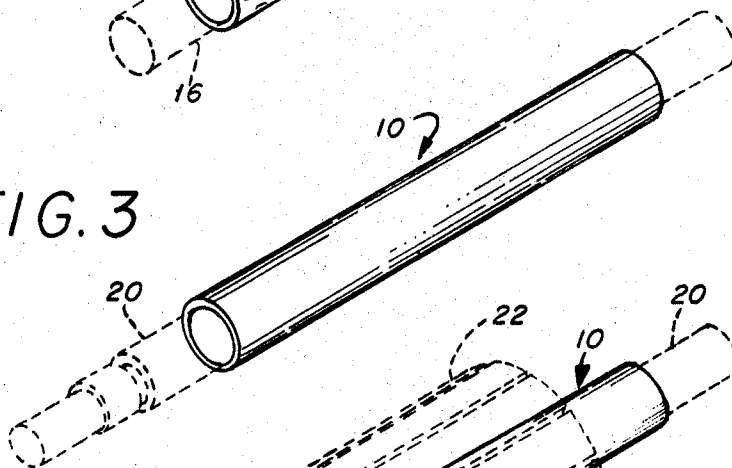
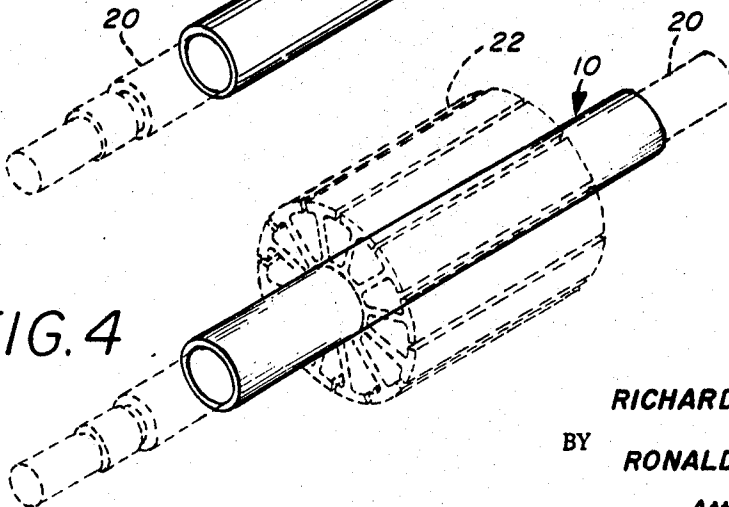


FIG. 4



INVENTOR
RICHARD C. WAREHAM

BY RONALD E. BARRY

Attorney

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Richard C. Wareham, 2371 N. 90th St.,
Wauwatosa, Wis. 53226

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5 Claims

ABSTRACT OF THE DISCLOSURE

The method of forming a protective sleeve from fibrous material having dielectric, chemical or mechanical characteristics including the steps of interweaving a fibrous material and a heat shrinkable fibrous material with the heat shrinkable material aligned in the direction of required shrinkage, coating the sleeve with a resin and heating the resin coated sleeve while on the member to be protected to shrink into tight engagement with the member and to cure the resin.

This invention relates to a protective type preformed tubular sleeve and to the method of manufacturing this type of sleeve. It is particularly concerned with a preformed tubular sleeve which can be used to electrically, chemically or mechanically protect the device on which it is mounted.

It is well known that many devices are electrically, chemically or mechanically protected by applying coatings of protective material on their outer surface. Where the protective material includes a fibrous material, difficulties are often encountered in holding the fibrous material in position while resinous materials are applied to the fibrous material to bond it to the particular device to which it is to be attached.

One of the principal objects of the present invention is to provide a preformed fibrous tubular member which can be easily mounted on and secured to a device to protect it either electrically, chemically or mechanically.

Another object of the present invention is to provide a preformed tubular member having predetermined electrical, chemical or mechanical characteristics which can be mounted on a member and shrunk into tight engagement with the member.

Another object of the present invention is to provide a preformed tubular member that can be heat shrunk and adhesively secured in position on a device having a predetermined outer configuration.

A further object of the present invention is to provide a tubular member which is preformed to a rigid predetermined configuration either in cross-section or longitudinal section.

A still further object of the present invention is to provide a fibrous protective sleeve which can be shrunk to a snug fit on a device and will maintain its homogeneous relationship without raveling.

A still further object is to provide a protective device having a cross-section or longitudinal-section of predetermined shape which can be readily secured to a device having a corresponding shape by the application of heat.

A still further object is to provide a method for preparing a tubular member for use as a protective member on an article having a substantially similar shape.

Another object is to provide a method for forming a tubular member which can be shrunk into tight engagement with an article of substantially similar shape and adhesively secured thereto.

These objects are accomplished by using a woven or

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braided sleeve which has a heat shrinkable fiber interlaced in the sleeve in the direction of required shrinkage. The sleeve is placed on a mandrel having the ultimately desired configuration, but is of slightly smaller dimensions than the sleeve, but larger dimensions than the part that is to be protected. The sleeve is coated, dipped or sprayed with a liquid binder such as resin, ceramics, etc. which will wet out and penetrate the fiber. The binder will bond the interwoven fabric together at their points of intersection on initial curing and the heat shrinkable fiber will shrink the sleeve to a snug fit on the mandrel. After the sleeve has been cured (completely or partially) and is removed from the mandrel, it will be sufficiently rigid to retain the shape of the mandrel. If it is considered unnecessary to heat shrink or secure the sleeve to the member to be protected, it is treated at this stage so that it becomes permanently fixed in the preformed shape.

If the sleeve is not to be permanently shrunk it is then coated a second time with a resin either by repeatedly dipping and air drying and/or baking the resin or by spraying and air drying and/or baking until a coating of resin of the desired thickness has been deposited on the sleeve to provide the desired electrical, chemical or physical properties. A preformed sleeve is thus formed which has a partially cured or B-staged resin on its surfaces. When the coated sleeve is to be mounted on another member of similar shape, it is cut to the desired length and placed on the member to be protected. The sleeve and member are baked at a temperature sufficient to heat shrink the shrinkable material to draw the sleeve into tight engagement with the member as well as curing the partially cured or B-staged resin to secure the sleeve to the member.

These and other features and objects of the invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of a woven sleeve with one end expanded to show the relationship of the fibrous materials used to make up the sleeve.

FIG. 2 is a perspective view of the sleeve in FIG. 1 after curing the resin coated on the preformed sleeve.

FIG. 3 is a perspective view of the sleeve placed on a shaft preparatory to heat curing it into tight engagement with the shaft.

FIG. 4 is a view of the sleeve located on the shaft of an armature for an electric motor.

Referring to FIG. 1 of the drawing, a sleeve 10 is shown having a fibrous material in the warp 12 and a heat shrinkable material in the woof 14. The material is shown woven in a straight weave but it could be woven in a twill or satin weave or braided if desired. The fibrous material can consist of any fibrous material that will provide dielectric, chemical or mechanical characteristics suitable for the desired use. Glass, asbestos, cotton, or any other fibrous material which can be woven or braided may be used. The heat shrinkable material can consist of any material that will shrink under heat such as a polyester, vinyl, rubber, acetate, or any combination or modification thereof.

The sleeve as shown is woven with the heat shrinkable material 14 in the woof to provide shrinkage in a radial direction. If the heat shrinkable material is woven in the warp, the sleeve will shrink longitudinally. It should be apparent that the heat shrinkable material could also be used in both the woof and warp to provide shrinkage in both directions.

The sleeve is placed on a mandrel 16 which has an outer configuration corresponding to the outer configuration of the article onto which the sleeve is to be finally mounted.

The mandrel is provided with an outer dimension slightly larger than the outer dimension of the article to be protected. The sleeve is woven or braided with an inner dimension slightly larger than the outer dimension of the mandrel.

The sleeve is then coated with a resin or varnish of a type to provide the characteristics required for the sleeve. For example, if a high bond strength is required a phenolic, epoxy or any other high bond strength thermosetting resin is used. If chemical resistance is required, an epoxy or any other resin which resists chemical action is used.

As pointed out above, it may be important to have complete "wet out" of the fibers in the initial coating of resin, i.e., where dielectric strength is important. In other instances, it may only be necessary to saturate or coat the fiber. The initial cost of resin is used for two functions. The first is to assure that the fibers are bonded together at their intersections when the resin is treated to thereby prevent raveling of the heat shrinkable fiber from the other fiber. The second is to provide rigidity in the tube after the resin has been treated and the tube has assumed the configuration of the mandrel.

"Treated" as used through the specification and claims refers to the treatment of the resin or binder after coating the sleeve. This may be a heating or air drying step to either cure, partially cure, B-stage or air dry the resin. The treatment will depend on the final use which is to be made of the sleeve.

The mandrel may be coated with a release agent if the resin has a tendency to bond the sleeve to the mandrel. Any well-known release agent can be used such as silicone, Teflon (tetrafluoroethylene), wax, etc., as long as it will prevent adherence of the sleeve to the mandrel, and will not contaminate the resin used.

The resin coated sleeve while still on the mandrel is then treated by heating at a sufficient temperature to partially or completely cure or B-stage the resin. At this temperature, the heat shrinkable material will also shrink causing the sleeve to be drawn into tight engagement with the mandrel. The resin bonds the fibrous material and heat shrinkable fiber together at their intersections so that on shrinking of the heat shrinkable fiber, it will draw the fibrous material tightly against the mandrel.

The sleeve will then take on the shape of the mandrel as well as its dimensions. The mandrel can have any shape such as round as seen in the drawing, oval, square, triangular, rectangular, etc. so long as the tube can be removed from the mandrel after curing. If the mandrel has been made approximately of the same dimension as the product onto which the sleeve is to be mounted, the sleeve will easily slip onto the product after removal from the mandrel.

If the sleeve has to have increased strength, all the pores of the sleeve should be filled with the resin. A second coat of resin may be applied to the sleeve before it is removed from the mandrel and the sleeve and mandrel subjected to a second treatment.

The above coating steps can be accomplished by spraying, painting or dipping methods using a low viscosity resin. It is possible to use higher viscosity resins if a vacuum process is used to impregnate the fiber with the resin or if only a coating is required.

When the sleeve is removed from the mandrel, it will retain the shape of the mandrel as shown in FIG. 2. The sleeve is then coated with a resin by spraying or painting, or by dipping. After each coating, the resin is treated by either air drying or heating to partially cure the resin or B-stage it. The temperature must be kept low enough so that the heat shrinkable fibers do not shrink since the sleeve has been removed from the mandrel. As many coats of resin varnish of this type may be applied to the sleeve as are required to develop a sufficient build up of material on the sleeve.

The sleeve now has all of the materials necessary to provide the particular characteristic required when the

sleeve is mounted on the particular apparatus for which it is designed. The sleeve can then be cut to the desired length and placed on the article. In FIG. 3, the sleeve 10 is shown mounted on a shaft 20 which is a shaft for an electric motor. The shaft and sleeve are baked at a predetermined temperature for a period of time sufficient to shrink the heat shrinkable fiber and to cure the partially cured resin. Shrinking of the heat shrinkable material will draw the other fiber into tight engagement with the shaft and will also cause the resin to form a bond with the shaft so that the sleeve is firmly secured to the shaft. Referring to FIG. 4, an armature stack 22 is shown placed over the insulated tube after it has been shrunk onto the shaft. The sleeve thus forms an electrical barrier between the armature winding and the shaft. The resin and fibers used in the sleeve for this application are chosen to provide a high bond strength and high thermal resistance. As previously stated, any fiber or resin could be used depending on the final use of the sleeve.

A tubular sleeve is shown in the application, but the sleeve could be made of any configuration such as oval, square, rectangular, etc., depending on the shape of the mandrel. The woven sleeve can be placed on any shape mandrel and when heated will shrink into tight engagement with the mandrel. A "protective" sleeve as used in this application refers a preformed sleeve having electrical, chemical or mechanical characteristics depending on the type resin and yarn used in forming the sleeve.

The following example is a typical method for making an insulating sleeve for use in an electric motor.

A fiber glass-polyester fiber combination is woven or braided to form the sleeve with the polyester fiber in the woof. It should be understood that the fibrous material in the sleeve must have sufficient thickness to provide the electrical characteristic required for the sleeve. The sleeve is cut to a length of approximately 30 to 36 inches and placed on a mandrel which has been coated with a Teflon (tetrafluoroethylene). Since high dielectric strength is required in the sleeve, a low viscosity resin, 15 seconds Demmler Cup No. 1, was used to coat the sleeve to assure complete penetration of the fiber by the resin. An alkyd modified phenolic resin known in the industry as a polyester varnish (Westinghouse resin No. B142-1) was used. This varnish thinned to a 10 to 37½% solids content provides good wet-out and penetrating qualities. The resin coated sleeve while still on the mandrel is heated at 300° F. for 30 minutes which temperature is also sufficient to shrink the polyester fiber in the sleeve. The sleeve will shrink against the mandrel and assume the round shape of the outer surface of the mandrel as shown in the drawing. If it is desired to again coat the sleeve, a second coat of varnish may be applied to the sleeve while it is still on the mandrel. The sleeve and mandrel are again baked at 300° F. for 30 minutes.

The sleeve is removed from the mandrel as a substantially rigid tubular structure, and is then coated with a varnish having a 40 to 60% solids content. The sleeve is air dried after each coating and is also baked at a temperature of 200° F. The coating and baking steps are repeated a number of times until sufficient resin coating has been built up on the surface of the sleeve to meet the desired result. A maximum temperature of 200° F. is recommended for this step since it is important that the temperature is not raised to a level that would cause excess shrinking of the polyester fiber.

The preformed resin coated insulating sleeve is then slipped onto the armature shaft. If the mandrel has been properly sized the sleeve will just fit on the shaft. The shaft and sleeve are then baked for one hour at 300° F. and then four hours at 350° F. The polyester fibers in the sleeve will shrink again at this temperature drawing the other fibers in the sleeve into tight engagement with the shaft. The partially cured resin in the sleeve will cure at this temperature and securely bond the sleeve to the shaft.

If a tube is to be made to chemically protect an item, a fiber glass polyester fiber sleeve is formed as above. The sleeve is placed on a mandrel of the desired dimensions and an epoxy resin is used to coat the sleeve. The sleeve, while still on the mandrel, is heated to approximately 300° F. for 30 minutes to shrink the polyester fiber in the sleeve into tight engagement with the mandrel.

When the sleeve is removed from the mandrel, it will have a substantially rigid tubular configuration conforming exactly to the configuration of the mandrel. A coating of epoxy resin is then applied to the tubular structure and is treated by heating or air drying. This step is repeated until a sufficient resin coating has been built up on the surface of the sleeve to make the desired result. As indicated above, it is important that the temperature of the sleeve is not raised above 200° F. or the polyester fiber will shrink and the sleeve will lose its predetermined dimension.

Once the above steps have been completed, the sleeve is then ready for use on the device for which it has been designed. It can be cut to the desired length and slipped onto the device and treated to produce the final tight fit on the device.

If a sleeve is to be made for mechanical strength only, polyester resin is used in place of the epoxy resin or the phenolic resins indicated above. Once the initial steps have been completed, the preformed tubular member can then be placed on an article and heat shrunk into tight engagement and adhesively secured to the article.

If the final application of the sleeve is to be a preformed tubular member without any shrink characteristics, the temperature applied to the sleeve after it has been coated and while still on the mandrel, should be raised sufficiently to permanently set the heat shrinkable material. Temperatures in the range of 400-450° are normally considered sufficient to accomplish this result. At this elevated temperature, the shrink characteristic of the polyester fiber will be completely eliminated and the resin will assume a substantially complete set providing a strong tubular member that can be slipped onto a device having the same shape as the tubular member or used as a tube by itself. It is possible to make a tube of very rigid characteristics with this process and also of shapes other than those shown in the drawings. For example, the sleeve could be placed on items having oval, square, rectangular or any other shape and when heated will shrink into tight engagement with the shape of the mandrel. By raising the temperature sufficiently high, a permanent set will be induced in the heat shrinkable fiber producing a permanent tubular member which can be used on an article having substantially the same shape.

Tubular members have been described which either have been partially treated so that they still have heat shrinkable characteristics or are treated to have a permanent set for particular applications. It is also possible to process the tubes so that they can be bent to conform to different shapes for particular applications regardless of whether the heat shrinkable fiber has been shrunk only to the mandrel size or has been permanently set at elevated temperatures. The tubular members can be bent by applying coatings of resin and treating the resin to either partially cure it or B-stage it. The tube can then be bent into any desired shape.

I claim:

1. The method of making a preformed protective sleeve which can be shrunk on and bonded to an article having a predetermined outer configuration comprising the steps of:

weaving a fibrous material to form a sleeve, weaving a heat shrinkable fibrous material into said sleeve in the direction of required shrinkage, sliding said woven sleeve onto a member having an

outer contour conforming to the outer contour of the article to be protected, applying a coating of resinous material to said woven sleeve while on the member, curing the resin coating on said sleeve while said sleeve is on the mandrel by heating at a temperature sufficient to shrink the heat shrinkable fibrous material into engagement with the mandrel and to cure the resin coating and bond the fibrous material together, and

removing the now rigid sleeve from the member.

2. The method of claim 1, including the additional steps of applying to the sleeve additional coatings of resinous material, and curing each additional coating of resinous material at a temperature sufficient to cure the resin without shrinking the heat shrinkable fiber.

3. The method of making a preformed insulated sleeve for an electric motor shaft, comprising the steps of:

weaving fibrous materials having a dielectric characteristic to form a sleeve, weaving a heat shrinkable fibrous material into said sleeve in the direction of required shrinkage,

placing said sleeve on a member having an outer dimension slightly larger than the outer dimension of the electric motor shaft,

coating said sleeve with a resin to saturate the fibrous material in the sleeve,

heating the saturated sleeve at a temperature sufficient to shrink the heat shrinkable material into tight engagement with the outer surface of the mandrel,

removing the sleeve from the mandrel and coating the sleeve with additional resin, heating the additional resin coating to B-stage the resin, placing the sleeve on the shaft of the armature, and

heating the sleeve to a temperature sufficient to shrink the sleeve into tight engagement with the shaft and to cure the B-staged resin coating.

4. The method of making a permanently set tubular protective sleeve, comprising the steps of:

weaving a fibrous material to form a sleeve, interweaving a heat shrinkable material into the sleeve in the direction of required shrinkage,

placing the sleeve on a member having a predetermined outer configuration,

coating the sleeve with a resinous material while still on the member,

heating the resin coated sleeve while on the member to shrink the heat shrinkable fiber into tight engagement with the member and to cure the resin, and removing the now permanently set sleeve from the member.

5. The method according to claim 4 including the steps of coating the sleeve with a second coat of resin after removal from the member,

heating the sleeve to B-stage the resin, and repeating the last coating and heating steps until the required characteristic is achieved.

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HAROLD ANSHER, Primary Examiner

P. DIER, Assistant Examiner

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