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[54] JACKETED FIBROUS DUCT AND METHOD AND APPARATUS FOR APPLYING THE JACKET TO THE DUCT
8 Claims, 8 Drawing Figs.

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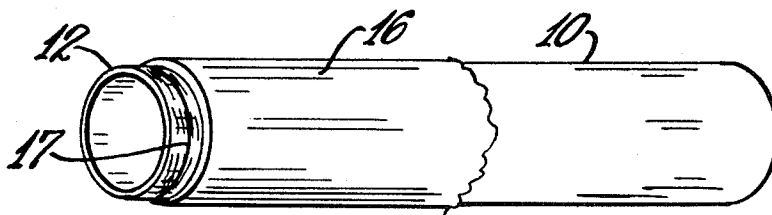
[50] **Field of Search**..... 156/85, 86

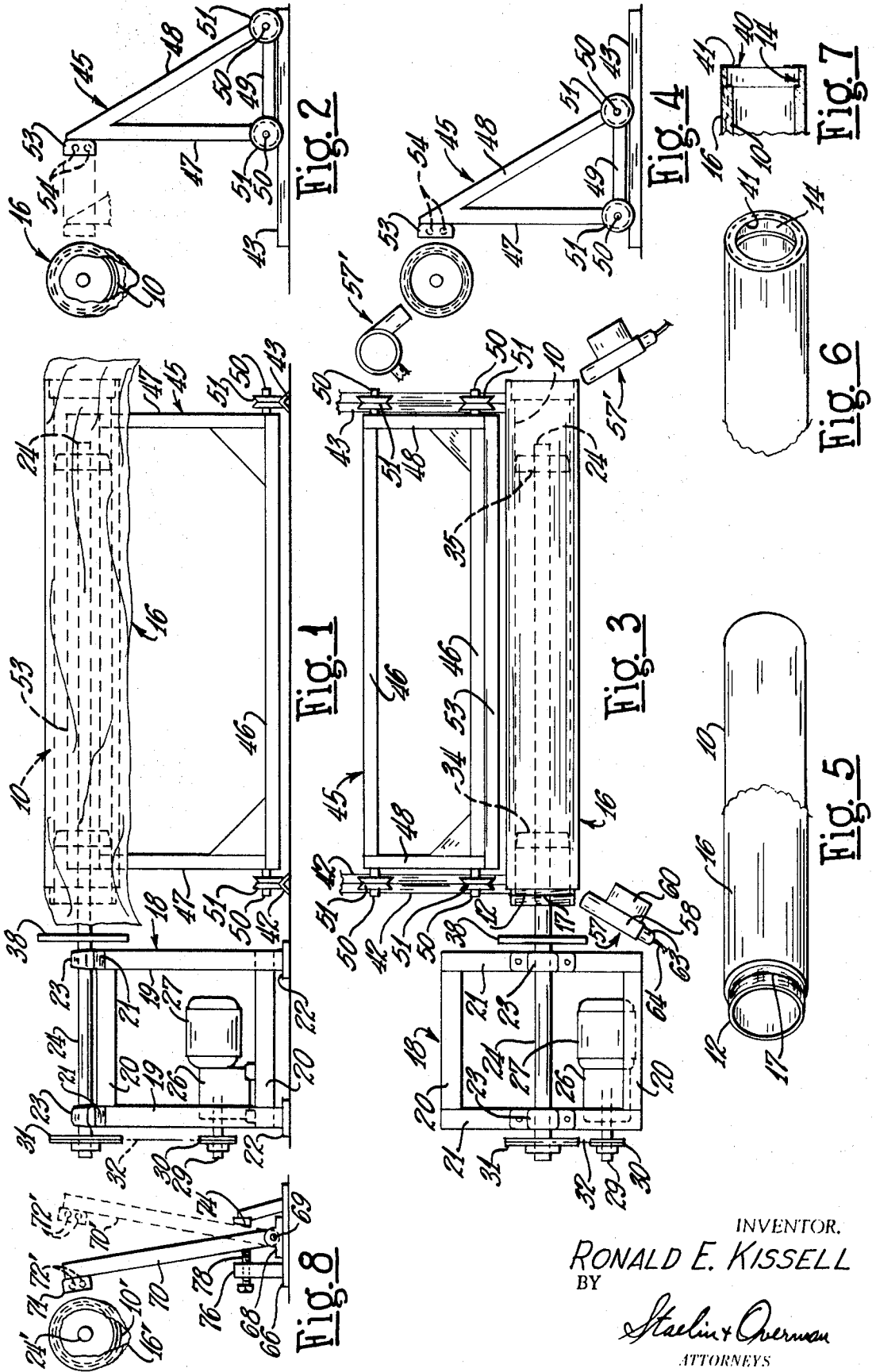
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ABSTRACT: The disclosure embraces a rigid duct of bonded fibers sheathed or encased in a heat-shrunk jacket and involves a method of and apparatus for applying a tubular jacket of a suitable heat-shrinkable organic film onto the fibrous duct and applying heat to the end regions of the jacket and throughout the length of the jacket whereby the same is heat-shrunk or contracted to snugly engage and enclose the exterior surfaces of the fibrous duct.





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JACKETED FIBROUS DUCT AND METHOD AND APPARATUS FOR APPLYING THE JACKET TO THE DUCT

The invention relates to cylindrical tubular bodies of fibrous material utilized as rigid duct sections in air duct systems utilized for conveying air in both air-heating and air-cooling systems and relates more especially to a rigid fibrous duct encased in a jacket and to a method and apparatus for applying the jacket to a duct section whereby the jacket provides a permanent sheath or enclosure on the duct section.

Heretofore rigid fibrous ducts have been fashioned by inserting a mass of binder impregnated fibers in a mold to cure the binder and a covering of cloth wrapped around the duct primarily as a protection for the fibers. Such cloth coverings are of porous character and do not effectively function as moisture barriers for preventing condensation resulting from substantial temperature variations. Furthermore substantial heat losses may be encountered in cloth covered duct sections by reason of the porosity of the cloth and the temperature differentials between the ambient air and the air interiorly of the duct.

The present invention embraces a rigid fibrous duct construction having a snugly fitting tubular jacket encasing the fibrous duct wherein the jacket comprises a heat-shrunk organic film or surfacing material.

Another object of the invention resides in a method of applying a tubular film of organic material including thermally shrinking or contracting the film onto rigid fibrous duct section providing a permanent jacket or casing for the duct.

Another object of the invention resides in a method of shrinking a tubular film of heat-shrinkable resinous material onto a rigid tubular duct of bonded mineral fibers, such as glass fibers, by applying heat to the end regions of the tubular film on the duct to shrink the end regions in snug engagement with the ends of the duct section and applying heat exteriorly and lengthwise of the duct section to shrink the film into intimate stressed contact or engagement with the cylindrical duct throughout its periphery to provide a permanent enclosure, casing or jacket for the duct section without the use of fastening or securing means.

Another object of the invention resides in an arrangement for rotating an elongated rigid fibrous body provided with a tubular shrinkable film and means for applying heat to the end regions of the tubular film on the body and for applying heat to the intermediate region of the film on the body while rotating the same for shrinking the tubular film into snug engagement with the body throughout its length.

Another object of the invention resides in a method of encasing a tubular fibrous duct section in a tubular heat-shrinkable jacket involving the steps of telescoping a loosely fitting tubular jacket of a heat-shrinkable organic film onto a duct section, effecting relative movement of the duct section and jacket, applying heat to the portions of the film adjacent the ends of the duct to shrink the end portions of the film into snug engagement with the end regions of the duct section and subjecting the moving jacket to radiant heat throughout substantially the length of the duct section to shrink or contract the jacket into intimate contact with the rigid duct throughout its length.

Further objects and advantages are within the scope of this invention such as relate to the arrangement operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

FIG. 1 is a front elevational view of an arrangement for performing steps in the method of the invention;

FIG. 2 is an end view of a portion of the apparatus illustrated in FIG. 1;

FIG. 3 is a top plan view of the apparatus shown in FIG. 1;

FIG. 4 is a view similar to FIG. 2 illustrating the method of applying heat to the jacket on a duct section;

FIG. 5 is an isometric view of the male end of a jacketed duct section, part of the jacket being broken away;

FIG. 6 is an isometric view of the female end of the fibrous duct with the covering jacket;

FIG. 7 is a fragmentary sectional view of the female end of the duct illustrating an end region of the jacket, and

FIG. 8 illustrates a modified arrangement for applying heat for shrinking a jacket on a duct section.

While the method of the invention is illustrated in applying a tubular heat-shrinkable organic film onto a rigid tubular fibrous duct of a character particularly usable in air conveying systems for heating and cooling, it is to be understood that the method of the invention may be utilized for applying tubular heat-shrinkable jackets to other elongated fibrous bodies.

Referring to the drawings in detail, FIGS. 1 through 3 illustrate an apparatus or arrangement for the performance of method steps in applying heat-shrinkable tubular jackets onto rigid fibrous bodies such as tubular duct sections. The method is particularly usable for applying a jacket of heat-shrinkable organic film onto tubular duct section 10 of fibrous material having ship lap ends, the male end 12 being shown in FIGS. 3 and 5 and the female end 14 being particularly illustrated in FIGS. 3, 6 and 7.

The duct section is cylindrical and is fashioned of mineral fibers, for example, glass fibers compressed to a density in a range of 2 to 16 pounds or more per cubic foot providing a tubular duct of a rigid character and the fibers bonded together by a suitable resin. The arrangement or apparatus includes means for supporting and rotating a duct section provided with a loosely fitting tubular film or jacket 16, shown in FIGS. 1 and 2, of heat-shrinkable material. The apparatus includes a frame or support means 18 comprising vertical struts 19, horizontal members 20 connecting the struts 19 and transversely extending bars or members 21.

The lower ends of the struts 19 are provided with base plates 22 adapted to rest upon a floor or other supporting surface. The bars 21 are equipped with journal bearing means 23 of conventional construction which support a shaft or mandrel 24 for rotation. Mounted upon the frame 18 is a housing 26 enclosing variable speed reducing mechanism or gearing of conventional character. Secured to the housing 26 is a motor 27 for driving the speed reducing mechanism. The output shaft 29 of the speed reducing mechanism contained in the housing 26 is equipped with a sheave 30. The shaft or mandrel 24 is equipped with a sheave 31, the sheaves 30 and 31 being connected by an endless belt 32 whereby the mandrel or shaft 24 is driven at a comparatively slow speed through the variable speed reducing mechanism in the housing 26. As shown in FIGS. 1 and 2, the mandrel or shaft extends outwardly from the frame 18 a substantial distance. Removably secured on the shaft 24 in lengthwise spaced relation are disclike members or collars 34 and 35, the collar 35 being disposed adjacent the distal end of the shaft 24.

The collars 34 and 35 are of a diameter slightly less than the interior diameter of a duct section 10 whereby the duct may be slidably received on the collars or supports 34 and 35. The collars are removably secured to the shaft 24 so that pairs of collars of different sizes may be employed to accommodate rigid fibrous ducts of different interior diameters. A circular disc or abutment plate 38 is fixedly secured on the shaft 24 adjacent the frame 18 to limit the lengthwise movement of the duct when the same is telescoped onto the supporting collars 34 and 35.

FIG. 1 illustrates a tubular film, cover or jacket 16 of a size to be loosely drawn over the duct 10 mounted on the collars 34 and 35, the material of the film or jacket being of a character to be heat-shrunk onto the tubular fibrous duct 10 as hereinafter described.

Means is provided for applying heat to the tubular cover or jacket to shrink the same into intimate engagement with the fibrous duct. Mounted on a floor or other suitable support surface and spaced lengthwise of the shaft 24 are transversely disposed parallel tracks or ways 42 and 43. Mounted for movement on the tracks is a frame structure or carriage 45

comprising lengthwise members 46, upwardly extending struts 47 and diagonally or angularly arranged struts 48. The lower ends of the horizontal frame members 46 are connected by members 49.

The end regions of the horizontal frame members 46 are provided with stub shafts 50 which journally support grooved wheels 51, the grooved wheels 51 being engaged with the tracks 42 and 43 to facilitate movement or adjustment of the carriage 45 toward and away from a duct or duct section supported on the shaft or mandrel 24.

The arrangement includes heating means preferably of a character providing radiant heat for shrinking the tubular cover or jacket 16 onto a duct section. In the embodiment illustrated, an elongated member 53 is mounted parallel to the shaft 24 and is secured to the upper ends of the struts 47 of the carriage 45. The member 53 is of generally U-shaped cross section to provide a reflecting means for heat producing means 54 mounted within the member 53. In the embodiment illustrated the heat producing means 54 are in the form of infrared, resistance or calrod heaters which develop radiant heat reflected by member 53.

When the carriage 45 is moved to the position shown in FIG. 4, the heating means 54 is in effective heat-transferring relation with the cover or jacket 16 on the duct section supported by the collars 34 and 35 on the shaft 24. The member 53 and the heating means 54 are of a length to apply radiant heat to the jacket 16 throughout substantially the length of the duct 10.

The method includes an arrangement for applying heat to the heat-shrinkable jacket 16 adjacent the end regions of the duct 10 in order to shrink the end regions of the jacket into snug engagement with the end regions of the duct. It has been found desirable to utilize a comparatively small heating means or unit 57, preferably a portable unit, that may be held in the hand of the operator for directing heat onto the ends of the jacket 16. The heating device 57 comprises a body 58 in which is disposed an air blower rotated by an electrically energizable motor 60.

The heater body 58 is fashioned with a cylindrical tubular extension 62 containing an electrically energizable heater of the resistance type for heating the air which is delivered by the blower onto the end regions of the jacket supported on the duct on the mandrel. Secured to the heater body 58 is a suitable handle 63 which is tubular to accommodate an electric supply conductor 64 adapted to be connected with any suitable conventional current supply outlet.

The portable heater 57, embodying a resistance heating unit, provides heat for shrinking the end regions of the jacket 16 by convection through the heated moving air and by the radiant energy from the resistance heating unit in the unit. While two portable heating units 57 and 57' are illustrated in FIG. 3, one heating unit may be employed to first shrink the jacket on one end of the duct and, subsequently, the same heating unit may be employed to shrink the jacket on the opposite end region of the duct.

The tubular film, cover or jacket 16 is a heat-shrinkable organic film which is preexpanded or stretched so as to be effectively contracted or shrunk under the influence of heat. This characteristic is imparted to the organic film by the film manufacturer at the time the tubular film is formed. A suitable material having this characteristic is polyvinylidene chloride (Saran). Other suitable heat-shrinkable organic films may be employed as a heat-shrinkable tubular jacket, such as rubber hydrochloride (Pliofilm), fluorocarbon resin (Teflon), polyester resin (Mylar) or other heat-shrinkable resinous material.

The heat-shrinkable film is preferably of a thickness of about 0.02 of an inch but the film may be as thin as 0.001 of an inch up to a thickness of 0.030 of an inch depending upon the characteristics desired for the jacket enclosing a duct.

The method of applying the tubular jacket, casing or sheath 16 to a rigid tubular fibrous duct 10 is as follows: The heat-shrinkable tubular film is cut to a length a few inches longer

than the length of the rigid fibrous duct to be covered. The ducts are usually 6 feet in length but may be of lesser or greater length if desired. The motor 27 is energized and the variable speed mechanism in the housing 26 adjusted to rotate the shaft or mandrel 24 at a comparatively low speed for the heat-shrinking operation.

For example, in heat-shrinking a jacket 16 on a fibrous duct of an exterior diameter of 8 inches, the shaft 24 and the duct mounted on the collars 34 and 35 are rotated at a speed in a range of about 9 to 12 revolutions per minute. If fibrous ducts of smaller diameters are being equipped with heat-shrinkable jackets, the shaft 24 and the duct are rotated at a proportionately increased speed and, for a duct of larger diameter, the speed of the shaft 24 is proportionately reduced so as to maintain substantially the same peripheral linear travel of the jacket past the radiant heating means.

The rate of peripheral linear travel of the rotating duct is dependent in a measure on the amount of radiant heat energy provided by the heating means 54. After the desired speed of rotation of the shaft 24 is attained through adjustment of the speed reducer 26, the operator telescopes a rigid fibrous duct or duct section 10 onto the supporting collars 34 and 35 to the position shown in FIGS. 1 and 2. The operator then telescopes or draws a length of the tubular unshrunk organic film onto the duct 10 to the position shown in FIG. 1 with the ends of the tubular jacket extending beyond the ends of the duct.

The operator then energizes the heater 57 and disposes the heater in the position shown in FIGS. 3 and 4 to shrink the end region of the film providing the jacket 16 adjacent the male end 12 of the duct 10. The same or similar heating unit 57 is then disposed in the position shown at 57' in FIG. 3 at the right end of the duct 10 to shrink the material of the jacket around the female end 14 of the duct to the position illustrated in FIGS. 6 and 7. The action of shrinking the material of the jacket around the male end of the duct draws the left end region of the jacket so that the end 17 is in the position shown in FIGS. 3 and 5 in snug engagement with the tenon 12.

The operator then energizes the radiant heating means 54 and moves the carriage 45 in a left-hand direction, as viewed in FIG. 2, to the position shown in FIG. 4, with the heating means spaced from but in close proximity to the jacket 16 on the duct. The heating means 54, extending throughout the length of the duct, shrinks the film or jacket into intimate tensioned engagement with duct as the duct and jacket are slowly rotated by the motor 27. The radiant energy of the heating means is reflected by the U-shaped support member 53 so that the radiant heat energy is efficiently employed in shrinking the film or jacket 16.

It is found that a temperature of about 270° F. at the peripheral region of the jacket adjacent the heating means 54 is effective to shrink a film of polyvinylidene but other heat-shrinkable films may require different temperatures. The temperature at the periphery of the jacket should be in a range between 225° F. and 300° F. It is found that the radiant heating means 54 in heat-applying position, shown in FIG. 4, may be in a range of about 1 inch to 3 inches from the periphery of the jacket on the duct.

After the jacket 16 is thus shrunk and stressed in tension into intimate unbonded contact or engagement with the duct throughout its periphery, the carriage 45 is retracted to the position shown in FIG. 2. The operator then trims the overhanging inwardly extending portion 40 of the film at the female end of the duct to form a circular opening defined by the inner circular terminus 41 of the jacket end, shown in FIGS. 6 and 7. When the female end of the sheathed duct is telescoped with a male end 12 of an adjacent duct section, the overhanging portion 40 is sufficient to be folded along the male portion 12 during assembly of the ship lap ends of the duct sections. The trimming of the inwardly extending jacket portion 40 may be accomplished by use of a sharp instrument or an electrically heated tool of conventional construction. The operator then withdraws the completed sheathed duct section lengthwise from the collars 34 and 35 on the shaft 24.

In assembling a duct section with an adjacent duct section in installing an air duct system, the male end is engaged with a female end in ship lap fashion, and the overhanging portion 40 of the jacket at the female end is folded along the tenon 12 providing overlapping engagement of end portions of the films or jackets 16 at the juncture of adjacent duct sections.

Collars or support means 34 and 35 for the duct sections are provided of various diameters to accommodate duct sections having interior diameters in a range of 4 to 20 inches or more. For processing duct sections of different interior diameters, the variable speed mechanism contained in the housing 26 is adjusted to maintain the linear peripheral movement of a duct section at substantially a uniform rate so that the jacket is subjected to a substantially uniform heat treatment from the radiant heating means 54 irrespective of the diameter of the duct section. The method steps are then repeated upon a succeeding fibrous duct section fitted onto the support collars 34 and 35. Through the method above described, a rigid duct section of glass fibers or other mineral fibers is provided with a permanent sheath or jacket without the use of adhesive or other fastening means.

FIG. 8 illustrates a modified arrangement for applying infrared or radiant heat to an organic film jacket on a fibrous duct section to shrink the jacket on the section. Mounted upon a base plate 66 are lengthwise spaced journal members 68 in which a shaft 69 is journally supported in substantial parallelism with the mandrel or shaft 24', the latter supporting a duct section 10' on which is loosely disposed a heat-shrinkable organic film or jacket 16'.

Mounted upon the shaft 69 is an upwardly extending frame or carriage 70 supporting a bar or member 71 of U-shaped cross section within which is supported radiant heating means 72. The heating means 72 may be of the calrod or resistance type. The position of the carriage 70 and heating means 72, when not in film-shrinking position, is illustrated in broken lines at 70'. An abutment member 74 mounted on the base 66 defines the retracted position of the frame 70.

The base 66 is fashioned with a projection 76 having a threaded bore to accommodate an adjustable abutment means or threaded member 78 which, as shown in FIG. 8, determines the position of the frame 70 and heating means 72 when the latter is in a position providing radiant heat in jacket shrinking position. The abutment means or screw 78 may be adjusted to secure the desired operative position for the radiant heating means 72. When different size ducts are supported by collars on the mandrel 24', the abutment screw 78 may be adjusted to change the operative position of the heating means 72.

In the use of the arrangement shown in FIG. 8 in carrying out the method, the mandrel 24' is rotated at a slow speed through speed-reducing mechanism contained in the housing 26 shown in FIG. 1. The operator telescopes a fibrous duct section 10' onto supporting collars carried by the shaft 24' and a length of tubular heat-shrinkable organic film providing the jacket is drawn or telescoped onto the rotating duct section 10'.

The ends of the film or jacket 16' are shrunk into snug or intimate engagement with the end regions of the duct section by portable heating means of the character illustrated at 57 in FIGS. 3 and 4. The operator then swings the frame of carriage 70 in a counterclockwise direction about the axis of the 69 from the position 70', shown in broken lines to the full line position with the carriage engaging the abutment 78. In this position the heating means 72 is in close proximity to the film or jacket on the duct and the radiant heat shrinks the film or jacket 16' into intimate unbonded surface engagement with the exterior of the duct 10'. After the shrinking operation is completed, the carriage 70 is moved by the operator to its out-of-use position indicated at 70'. The portion of the jacket extending over the female end of the duct section is severed or trimmed as hereinbefore described to provide an opening such as the opening defined by the trimmed edge 41 shown in FIG. 6, thus completing the assembly of the jacket in intimate stressed condition on the duct section.

While portable heating units illustrated are of the type embodying electric resistance heating means and blower means for delivering heated air onto the ends of the jacket for shrinking the ends, it is to be understood that radiant-heating units may be employed for the purpose.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1 The method of encasing a substantially rigid tubular fibrous body with a shrinkable tubular film including disposing the fibrous body in a substantially horizontal position upon a support, telescoping the tubular film lengthwise onto the fibrous body, directing heat from a heat source substantially the length of the tubular body toward the tubular film in heat-transferring relation therewith, and effecting relative rotational movement between the heat source and the film on the fibrous body to shrink the film into intimate contact with the body throughout its periphery.

2. The method according to claim 1 wherein the directed heat from the heat source is radiant heat.

3. The method of encasing a substantially rigid tubular body of glass fibers in a heat-shrinkable tubular jacket including disposing the tubular body in a substantially horizontal position on a support, telescoping the tubular body and the jacket thereon about the axis of the tubular body, and subjecting the rotating jacket to heat from a heat source substantially the length of the tubular body to shrink the jacket into intimate engagement with the body.

4. The method of encasing a substantially rigid tubular fibrous body in a tubular jacket of heat-shrinkable film including disposing the tubular body in a substantially horizontal position upon a support, telescoping the tubular film lengthwise onto the fibrous body with end regions of the tubular film extending beyond the ends of the fibrous body, applying heat by convection to the end regions of the tubular film to shrink said end regions in stressed engagement with the end regions of the body, and applying radiant heat to the portion of the film intermediate its end regions to shrink said portion in stressed engagement with the body.

5. The method according to claim 4 including rotating the fibrous body and the film thereon about the axis of the body during the application of heat to the film.

6. The method of encasing a substantially rigid tubular fibrous body having male and female end configurations in a tubular jacket of heat-shrinkable organic film including disposing the tubular body in a substantially horizontal position upon a support, telescoping a preformed tubular film lengthwise onto the fibrous body with the ends of the film extending beyond the ends of the fibrous body, applying heat by convection to the film at the male end region of the body to shrink the film at said region in engagement with the male end, applying heat by convection to the film adjacent the female end of the body to shrink the film radially inwardly embracing the female end, and applying radiant heat to the portion of the film intermediate its end regions to shrink said portion in engagement with the body throughout its periphery.

7. The method according to claim 6 including the step of trimming the inwardly extending portion of the film adjacent the female end of the body.

8. The method of encasing a substantially rigid tubular body of glass fibers in a jacket of heat-shrinkable material including disposing the tubular body in a substantially horizontal position upon a support, fitting the jacket onto the fibrous body with the end regions of the jacket extending beyond the ends of the body, rotating the body and jacket about the longitudinal axis of the body, applying heat to the end regions of the rotating jacket to shrink the said regions in stressed engagement with the end regions of the body, and applying radiant heat to the rotating jacket exteriorly of the jacket and substantially throughout its length to shrink the portion of the jacket intermediate its end regions in stressed engagement with the tubular fibrous body throughout its periphery.