Sept. 2, 1952 E. A. FARRELL 2,609,312

METHOD AND APPARATUS FOR MAKING FLEXIBLE TUBULAR COVERINGS

Filed June 28, 1947 2 SHEETS—SHEET 1

Fig. 1.

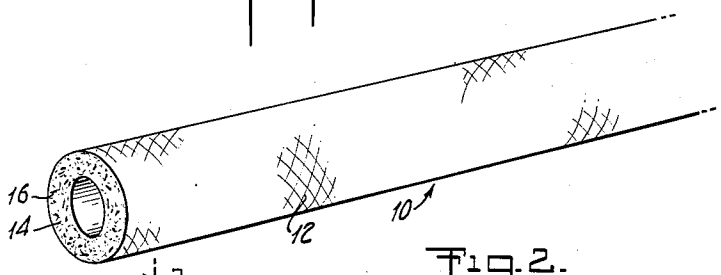



Fig. 2.

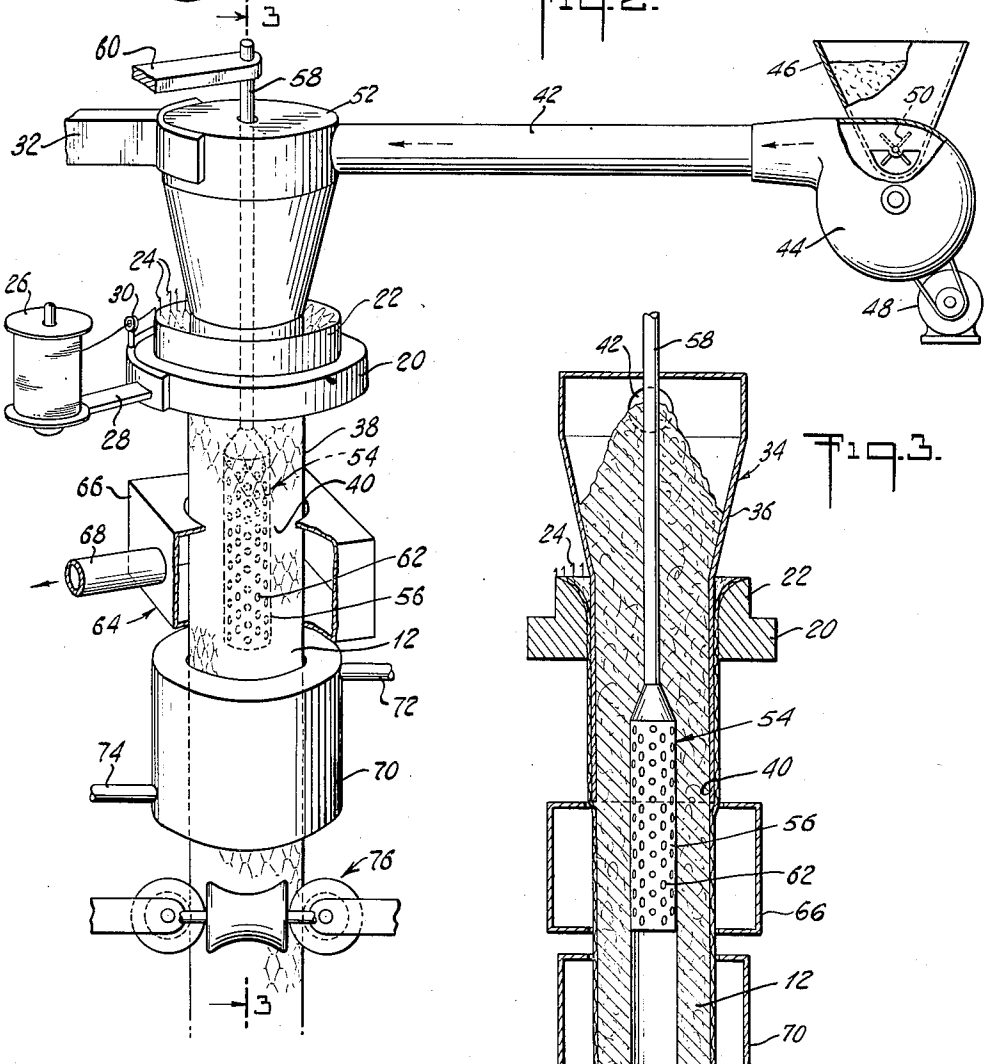



Fig. 3.




INVENTOR
EDWARD A. FARRELL.
BY Virgil C. Kline
ATTORNEY

Sept. 2, 1952 E. A. FARRELL 2,609,312

METHOD AND APPARATUS FOR MAKING FLEXIBLE TUBULAR COVERINGS

Filed June 28, 1947 2 SHEETS—SHEET 2

Fig. 4.

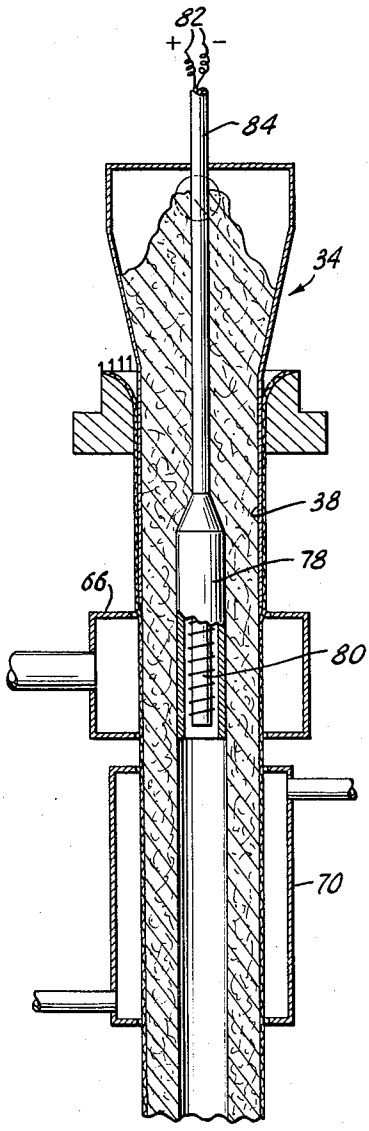
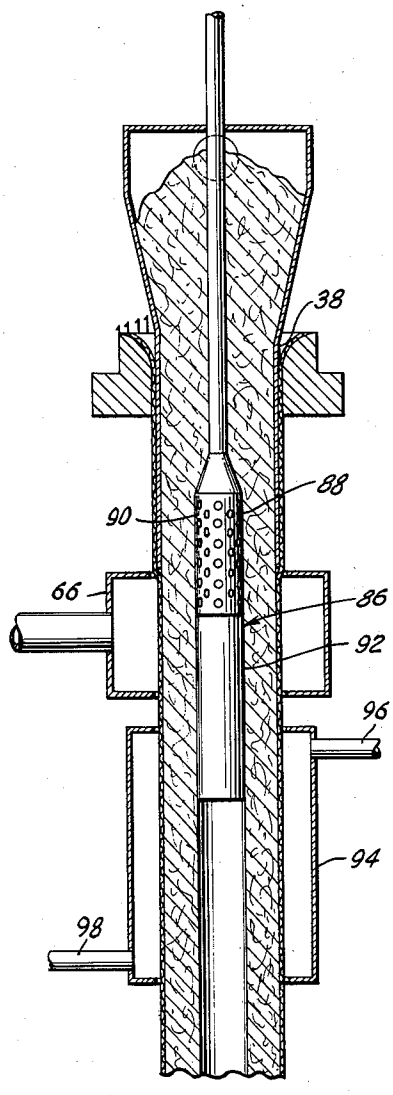



Fig. 5.




INVENTOR
EDWARD A. FARRELL.
BY Virgil C. Kline
ATTORNEY

Patented Sept. 2, 1952

2,609,312

# UNITED STATES PATENT OFFICE

2,609,312

## METHOD AND APPARATUS FOR MAKING FLEXIBLE TUBULAR COVERINGS

Edward A. Farrell, North Plainfield, N. J., assignor to Johns-Manville Corporation, New York, N. Y., a corporation of New York

Application June 28, 1947, Serial No. 757,820

8 Claims. (Cl. 154—27)

1

The present invention relates to flexible, tubular coverings particularly adapted for use as insulating coverings for pipes, tubes and the like. The invention also relates to a method and apparatus for the manufacture of such coverings.

The principal object of the invention is the provision of an improved flexible covering and method and apparatus for making the same, the covering comprising a seamless sleeve surrounding and containing a bonded tubular insulating body.

Another object of the invention is the provision of a tubular covering comprising an outer, seamless sleeve fabricated preferably of knitted metal strands and a tubular insulating body of fibrous material such as asbestos, mineral wool, glass fiber or other fibrous material within the sleeve, the body containing a distributed, hardened binder.

Another object of the invention is the provision of a method and apparatus for fabricating a product of the type described above, the steps of the method being carried out in sequence whereby the covering is completed in a single series of operations and continuous production is obtained.

A further object of the invention is the provision of a method and apparatus for knitting or otherwise fabricating a tubular sleeve around a forming member, introducing a fibrous insulating filling containing a distributed binder into the sleeve as it is drawn off the forming member, and setting or curing the binder. In the operation the insulating material is confined between the forming member and a centrally located mandrel whereby it is shaped to tubular form.

A still further object of the invention is the provision of a method and apparatus as described above in which the mandrel is of a character to impart heat to the body of fibers. The application of heat sets the binder in the event a thermo-setting binder is used, or serves to soften the binder where the binder is a thermoplastic, the body thereafter being cooled. The mandrel may serve as a heat-imparting medium in several ways; for example, it may be electrically heated to provide a relatively localized heating effect adjacent the inner circumference of the tubular body or it may serve as means for circulating hot air, steam or the like through the tubular body. Additional heating means may be used to apply heat to the exterior of the covering as it is formed.

My invention will be more fully understood and further objects and advantages will become apparent when reference is made to the more detailed description of a preferred embodiment of the invention which is to follow and to the accompanying drawings in which:

2

Fig. 1 is a perspective view of a tubular covering in accordance with the instant invention;

Fig. 2 is a diagrammatic, perspective view of an apparatus embodying the invention and for carrying out the method thereof;

Fig. 3 is a sectional view, taken on the line 3—3 of Fig. 2;

Fig. 4 is a view similar to Fig. 3 illustrating a modification of the invention; and

Fig. 5 is a view similar to Fig. 3 illustrating a further modification.

Referring now to the drawings and particularly to Fig. 1, the product of the invention comprises a tubular covering 10 adapted particularly for use as insulation for pipes, tubes and similar equipment. However, as will be appreciated, the product may have uses other than for insulating purposes and may be employed to cover other elements than those stated. The covering includes an outer sleeve 12 surrounding and containing a fibrous, tubular body 14.

Sleeve 12 is of a stretchable, distortable character and is suitably fabricated by knitting flexible strands of a character to impart to the product any desired properties or characteristics. Preferably for this purpose metallic strands are employed. If resistance to high temperatures is a factor, metals such as chrome alloys, nickel steel alloys, nickel copper alloys and nickel chrome alloys of conventional types may be used. If heat resistance is not a factor, softer metals, asbestos or even organic materials may be employed. Where metal is employed, as is preferred, relatively fine strands are selected, say, for example, those having a diameter of about 0.006", and the fabric is preferably knitted to have relatively small mesh openings; for example, about $\frac{1}{16}$". However, the gauge of the strands and the size of the stitches may vary considerably from those given above, depending upon the particular application of the product, the character of the filling material, and the like. Also, the strands may be in the form of round wires or flat cut strands, as desired.

Particularly for high temperature applications, the tubular body 14 has as its major constituent, a fibrous material such as asbestos fiber, although glass fibers, mineral wool fibers and the like may be used. For low temperature applications, fibrous materials of either an organic or inorganic character are suitable and may be selected

from the many known materials for similar uses, such as wood fibers, cotton fibers, and the like.

The arrangement of the fibers in the form of the tubular body 14 is maintained by a binder 16 distributed in minor proportions throughout the body, say in proportions of about 2 to 8%. The selection of the particular binders is not critical to the invention, binders of either a thermo-setting or thermo-plastic type being satisfactory, although thermo-setting resins are preferred. Examples are phenol-formaldehyde and accroides resins. Typical thermo-plastic binders which may be used are crude polystyrene resins, a natural resin such as batu gum in powdered form, pinewood pitch from which rosin and petroleum solvent soluble components have been extracted, and paracoumarone resins consisting of mixtures of polymerized coumarone and polymerized indene obtained from solvent-naphtha fractions of coal tar. Also, combinations of thermo-plastic and thermo-setting binders can be used in any desired proportions.

The tubular covering disclosed in Fig. 1 and described above may be readily applied to extending lengths of tubes, pipes and the like, by drawing or pushing the covering over the same, the readily stretchable, distortable character of the covering permitting it to conform to irregularities, changes in the dimensions, and the like.

Referring now particularly to Figs. 2–5 inclusive, the apparatus for the manufacture of the product described above and for carrying out the method of the instant invention includes a device 20 for fabricating the tubular sleeve 12. Device 20 is preferably, as illustrated, a circular knitting machine of known type include a stationary cylinder 22 supporting a series of knitting needles 24. One or more spools 26 of the strand material from which the sleeve is to be fabricated are supported from the machine, as indicated at 28, to be rotated around cylinder 22, the strand extending from the supply through guide 30 to the knitting point. The drive for the knitting machine, supporting members and other conventional operating parts, such as the needle cam structure, and the like, have not been shown, and the knitting machine elements referred to above have been shown only diagrammatically as such features may be of any conventional or known type and, per se, form no part of the invention.

Supported above the knitting machine 20 as by bracket 32 is a delivery tube 34 having an upper section 36 and a lower, substantially cylindrical forming member 38 extending through the knitting machine cylinder and projecting some distance therebelow to terminate in an open mouth 40. Forming member 38 is of substantially the diameter of the knitted sleeve to be made on the machine 20. Upper section 36 is connected through a conduit or tube 42 to the out-put side of a blower or fan 44. A hopper or the like 46 for the introduction of the fibrous material making up the insulating body 14 is in communication with the in-put side of the blower or fan. The latter is driven by any suitable means, such as motor 48. A metering device 50 of any known type may be employed to control the quantity of the fibrous material fed to the forming member through fan 44 and duct 42. The upper end of upper section 36 is closed by a cover 52. Extending axially of the delivery tube is a mandrel 54 including a head 56 partially within the forming member but projecting therefrom. The mandrel also includes a stem 58 extending upwardly through the cover 52 of upper section 36 and supported exteriorly of the delivery tube by bracket 60.

In the form of the invention shown in Figs. 2 and 3, mandrel head 56 and stem 58 are of hollow construction and the head is provided with a plurality of perforations 62. Stem 58 is in communication exteriorly of the delivery tube with a suitable source (not shown) of heated fluid under pressure, such as heated, compressed air or steam, whereby the fluid may be led through the stem into head 56 and delivery through perforations 62.

Immediately below the mouth of forming member 38 is a suction box 64 comprising a housing 66 surrounding the sleeve and tubular body, the housing being connected to a suction line 68 leading to a suction fan or the like (not shown) to obtain continuous withdrawal of air or other fluid from the body.

A chamber 70 is mounted below the suction box to surround the sleeve and tubular body. The chamber in the embodiment of Figs. 2 and 3 has outlet ports 72 and 74, respectively, through which a heated fluid such as steam, hot air, or the like may be circulated from any suitable source of supply (not shown). The product comprising the knitted sheath and the tubular body is withdrawn downwardly through the several operating portions of the apparatus by suitable take-off means which may comprise, for example, pairs of opposed, concave, knurled rolls 76, driven in any suitable manner in timed relationship to the knitting operation.

In the operation of the apparatus described above and in carrying out the method of the instant invention, strand material of the kind selected for the sleeve 12 is supplied from spool 26 and is fabricated into a seamless, tubular fabric around forming member 38 by knitting machine 20. Coincident with this operation blower 44 is operated and the selected fibrous material, such as asbestos fiber, mineral wool fiber, glass fiber or the like, is supplied from the hopper 46 through measuring device 50 to the blower or fan and is carried with the airstream set up in conduit 42 into hopper section 36. The introduction of the fibrous material through the fan insures that it will be opened and fluffed and well dispersed before it reaches the delivery tube. The airstream, in addition to serving as a conveyor for the fiber, serves as an impacting medium to pack the fiber between mandrel head 56 and the forming member to snugly fill the space therebetween. It will be understood that the density to which the fibers is packed will depend upon the quantity of fibers supplied and the force of the airstream, both of which are subject to control and may be varied to meet particular requirements.

The selected binder, a thermo-setting binder in the operation now being described, preferably in powdered form, is introduced with the fiber through hopper 46 and blower 44 and, due to the turbulence in the airstream and the opening and fluffing of the fibrous material thereon, is distributed throughout the fibrous material.

Simultaneously with the operations described above, a heated fluid, suitably hot air or steam, at such a temperature that when mixed with the conveying air the temperature within the body will be sufficient to liquefy and then set the thermo-setting binder, is supplied through the mandrel. The heated fluid and the conveying

air pass through the insulating body built up within the sleeve and are exhausted through suction device 66.

As the knitted sleeve with the tubular body therein passes downwardly from the suction box 66, it is preferably subjected to an additional heat treatment in chamber 70. A heated fluid, suitably air or steam, at the required temperature to set the selected binder, is introduced into the chamber and circulate throughout, to insure that the binder adjacent the exterior surface of the body will be completely cured. No special cooling steps are necessary though they may be employed, if desired. As the product leaves the take-off rolls it may be cut into sections of the desired length and is then ready for use.

In the event that it is preferred to concentrate the bonded areas of the tubular body adjacent the inner and outer peripheries to leave a relatively unbonded, extremely flexible interior, the heated fluid supplied through the mandrel may be in sufficient quantity or at such temperature that it will effectively liquefy and cure only the binder adjacent the inner periphery of the body. The binder adjacent the exterior of the body is cured solely by the passage of the product through the chamber 70.

A similar result may be obtained by using other means for the localized heating of the inner peripheral portion of the body. For example, as illustrated in Fig. 4, the mandrel may consist of a head 78 containing an electrical heating element 80, such as a conventional resistance heater, the electrical leads 82 for the element extending through the stem 84 and being connected into a suitable source of current supply (not shown). The heat supplied by the mandrel primarily is applied directly to those portions of the body adjacent the inner periphery whereby the binder in such portions is cured and set, and the remainder is relatively unaffected. Suction device 66, in this instance, serves only to remove the conveying air and to prevent the emission of dust into the room. The heating of the body adjacent the outer periphery to cure the binder is accomplished entirely by the heating chamber 70.

The methods and apparatus described above may be used equally well where the binder is a combination of thermo-setting and thermo-plastic materials with the thermo-setting ingredient in reasonable proportions, say in proportions of 10% to 20% of the total binder. The thermo-setting material will be cured at the same time that the other binder ingredient is liquefied or softened and when used in such proportion will effectively maintain the shape of the body until the thermo-plastic material cools and hardens.

In cases where it is desired to employ a thermo-plastic alone or with a very small proportion of a thermo-setting material, the minor modifications of the apparatus illustrated in Fig. 5 are found desirable. In this case mandrel 86 has a head 88 including a perforate hollow section 90 lying partially within forming member 38, and partially projecting therefrom, and a solid, or at least imperforate section 92 extending from the perforate section through the suction device 66 and into a cooling chamber 94. The cooling chamber may be similar to heating chamber 70, except that its inlet and outlet ports 96 and 98, respectively, are in communication with a source of cold or refrigerated fluid.



In the operation of the apparatus disclosed in Fig. 5, a relatively high melt point thermo-plastic binder, such as the powdered batu gum, previously referred to, is introduced with the fiber as before and a heated fluid is supplied to the tubular body through the hollow, perforate section 90 of mandrel 86, the temperatures set up within the body being controlled to soften the thermo-plastic binder sufficiently to soften it, but preferably not to completely liquefy it, whereby it very quickly solidifies and exerts its binding function after the tubular body passes from the heating zone. Inasmuch as the mandrel extends beyond the heating zone, the body is maintained in its required tubular shape until the binder takes a sufficient set to prevent collapsing of the body. The solidification of the binder is accelerated as the product passes through the cooling zone set up in chamber 94.

In each of the several forms of the invention described above, the tubular shape of the body is maintained until the binder has set to a sufficient extent to insure retention of the tubular shape without outside support. The density of the body may be easily controlled by controlling the rate of delivery of the fibrous material and the velocity of the airstream which carries the fibers into the forming member and serves as the packing medium. The bore of the tubular body may be changed to meet particular requirements by merely substituting mandrels of the desired diameter. The product is of particular advantage for insulating lengths of tubing and the like which have numerous bends and turns as it may be easily forced onto the tubing from one end thereof, its flexible character permitting it to conform to the curvatures and other irregularities in the line.

Having thus described my invention in rather full detail, it will be understood that these details need not be strictly adhered to but that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. In the method of making a tubular covering, the steps comprising, fabricating a seamless, tubular sheath and substantially simultaneously therewith conveying a loose insulating material containing a thermo-plastic binder into the sheath and forming said loose insulating material into a tubular body within said sheath, heating the body to soften the binder and holding the tubular body against collapsing while cooling the binder.

2. The method defined by claim 1 in which the body is heated by the circulation of hot air therethrough.

3. In an apparatus for the manufacture of a flexible tubular covering, a hollow forming member having an open mouth, means for fabricating a tubular sleeve around the forming member, a hollow mandrel extending axially of said forming member, said hollow mandrel being in communication with a source of heated fluid and having openings for the emission of the heated fluid therefrom, means for conveying a filling material containing a binder into said forming member to form a tubular body between said forming member and mandrel, and means for moving said sleeve forwardly as it is knitted to draw the sleeve from the forming member with the tubular body therein.

4. In an apparatus as defined by claim 3, means for applying heat to the exterior of said body.

5. In the method of making a tubular covering, the steps comprising, fabricating a seamless tubular sheath and simultaneously therewith conveying a loose insulating material containing a distributed unset thermo-setting binder into the sheath, forming said loose insulating material into a tubular body within said sheath, setting the binder by the circulation of a hot fluid through the tubular body, and holding the tubular body against collapsing during the binder-setting operation.

6. In an apparatus for the manufacture of a flexible tubular covering, a hollow forming member, means for fabricating a tubular sleeve around the forming member, a mandrel extending axially of said forming member, means for conveying a filling material containing a binder into the forming member to form a tubular body between the forming member and the mandrel, means for supplying a fluid medium to the body from the mandrel, suction means surrounding the body to assist in the circulation of the fluid medium through the body, and means for moving the sleeve forwardly as it is fabricated to draw the sleeve from the forming member with the tubular body therein.

7. In an apparatus as defined by claim 3, suction means supported around the tubular body to assist the circulation of the heated fluid through the body.



8. In an apparatus for the manufacture of a flexible tubular covering, a hollow forming member having an open mouth, means for fabricating a tubular sleeve around the forming member, a mandrel extending axially of said forming member, said mandrel including a perforate hollow section and an imperforate section, means connecting the hollow section with a source of a fluid medium, means for conveying a loose filling material containing a binder into said forming member to form a tubular body between said forming member and mandrel, and means for moving said sleeve forwardly as it is fabricated to draw the sleeve from the forming member with the tubular body therein.

EDWARD A. FARRELL.


## REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 411,384 | Lee | Sept. 17, 1889 |
| 775,540 | McConnell | Nov. 22, 1904 |
| 1,159,895 | Canda | Nov. 9, 1915 |
| 1,771,216 | Gossler | July 22, 1930 |
| 2,257,112 | Forster | Sept. 30, 1941 |
| 2,445,231 | McDermott | July 13, 1948 |