Jan. 1, 1974 R. D. TERRY 3,783,069

METHOD AND APPARATUS PRODUCING FIBROUS TUBULALR ARTICLES

Original Filed May 27, 1970 3 Sheets-Sheet 1

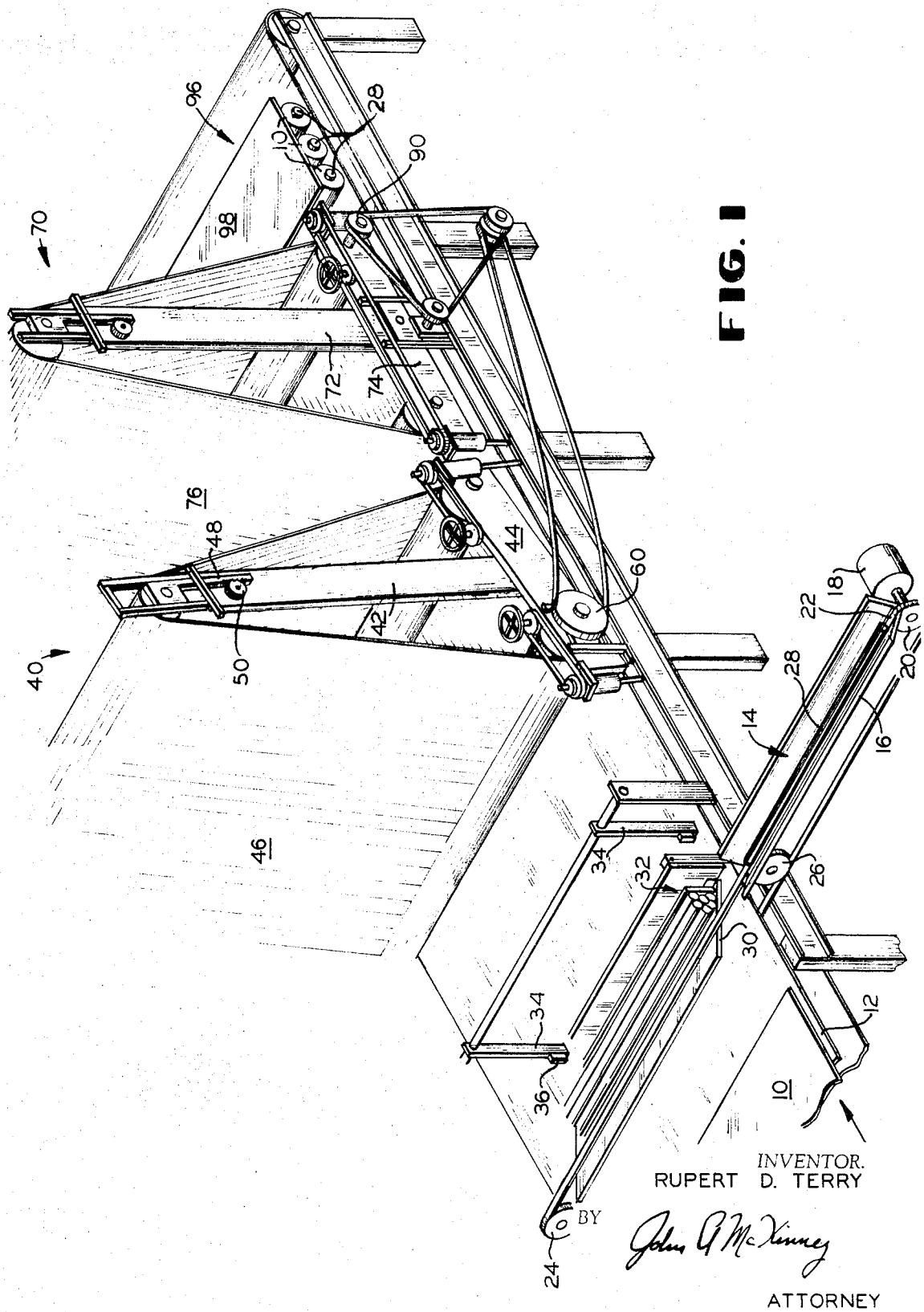


FIG. 1

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METHOD AND APPARATUS PRODUCING FIBROUS TUBULALR ARTICLES

Original Filed May 27, 1970 3 Sheets-Sheet 2

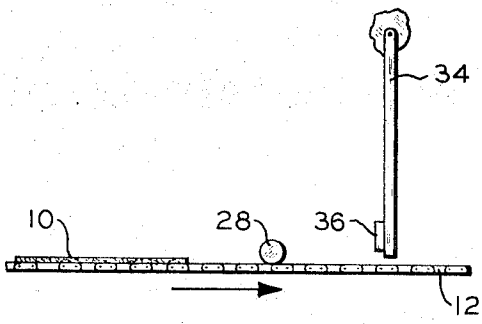


FIG. 2

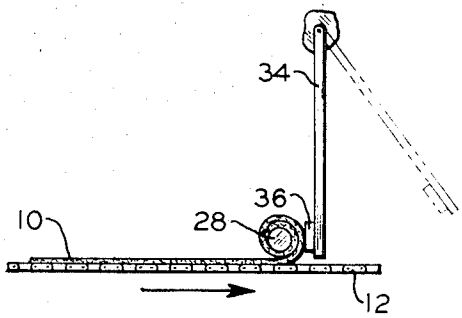


FIG. 3

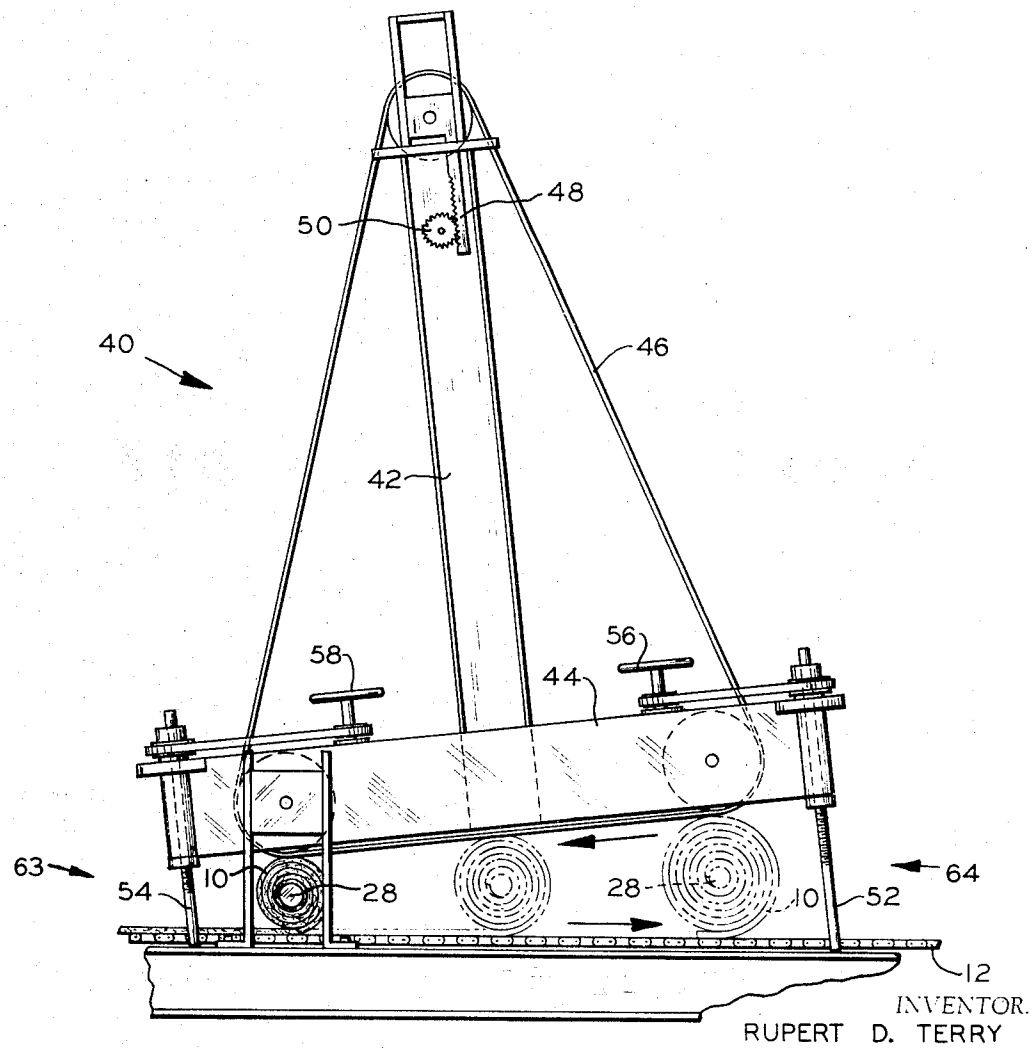


FIG. 4

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METHOD AND APPARATUS PRODUCING FIBROUS TUBULALR ARTICLES

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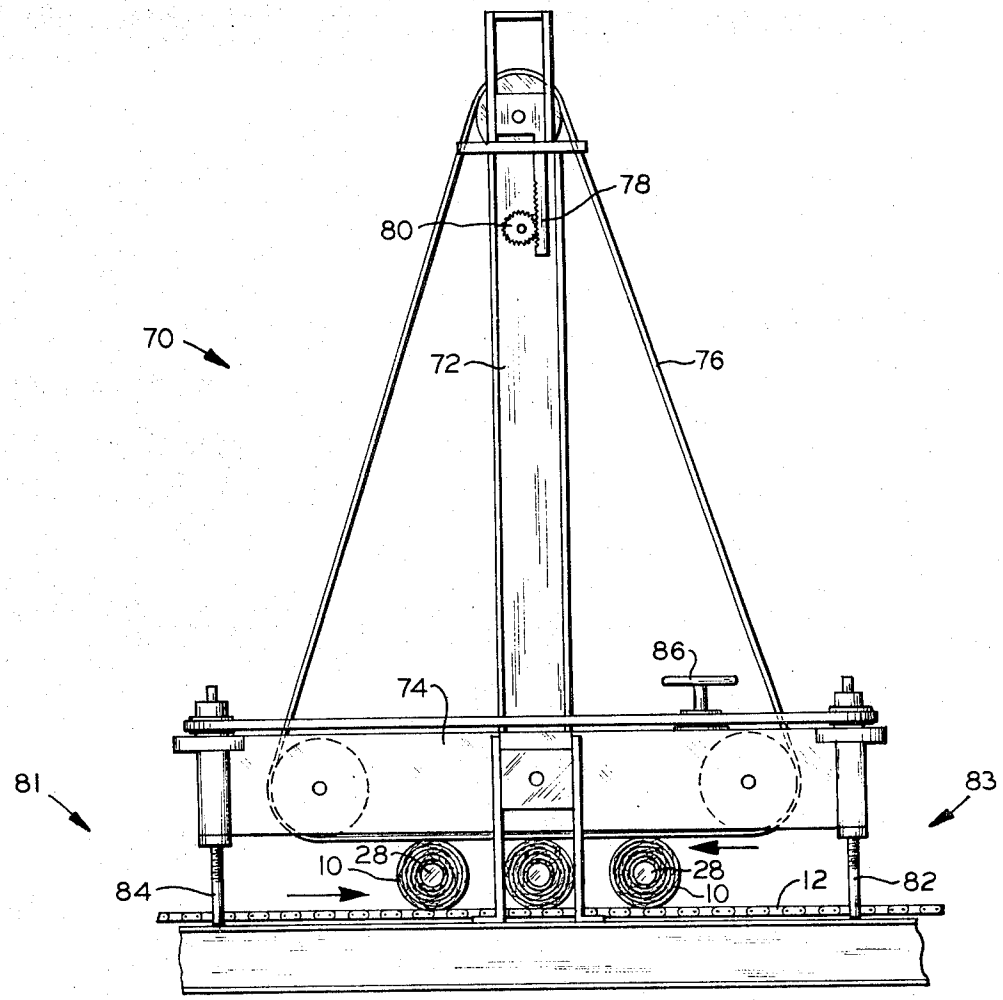


FIG. 5

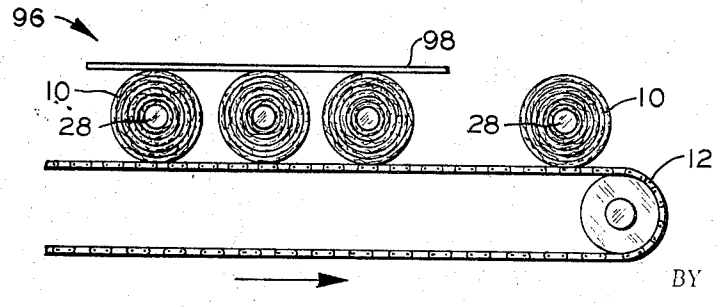


FIG. 6

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3,783,069

METHOD AND APPARATUS FOR PRODUCING FIBROUS TUBULAR ARTICLES

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Continuation of abandoned application Ser. No. 41,018, May 27, 1970. This application Mar. 3, 1972, Ser. No. 231,759

Int. Cl. B65h 81/02

U.S. Cl. 156—184 24 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for producing tubular articles formed of fibrous material wherein a moving mat of fibrous material is wrapped about a mandrel rotating about an axis moving along the path of the mat. The mat is then wrapped around the mandrel until a desired quantity of fibrous material is achieved. Thereafter, the mat and mandrel are conveyed to a sizing station where the outer diameter and configuration of the tubular article are finally set.

This is a continuation of application Ser. No. 41,018, filed May 27, 1970, now abandoned.

BACKGROUND OF THE INVENTION

It has heretofore been proposed to form a tubular article of fibrous material by wrapping a mat of resin impregnated fibrous material on a mandrel and thereafter curing the resin binder by moving a series of mandrels from a wrapping station to a heating station, or by removing the tubular articles from the mandrel after wrapping, and then placing the articles in an oven. Also, it has been proposed to effect the binder curing operation at the same station as the wrapping wherein the fibrous material remained on the mandrel upon which it was initially wrapped.

In the prior art methods and apparatus for forming tubular articles of mats of fibrous material, the mandrels about which the fibrous mat is wrapped are positively driven, and adapted to rotate about fixed axes.

In each of the prior art apparatus, the operating procedures involved means for indexing the mandrels which necessarily required the braking, clutching, and driving techniques.

The present method and apparatus involves the production of tubular articles of fibrous material wherein the mandrels employed are not positively rotated, but rather the fibrous material is driven, causing the same to form around the mandrel which, in turn, is moved longitudinally along the path of travel of fibrous material.

Illustrations of the prior art are found in United States Letters Patent: No. 2,331,146, Slayter; No. 2,674,557, Boggs; No. 3,446,684, Pall.

SUMMARY

The present invention relates to a method of and apparatus for the continuous production of tubular articles formed of fibrous material.

Among the objectives of the invention is to produce tubular articles formed of fibrous material wherein the articles are produced in a continuous fashion, eliminating any necessity of handling the articles during the intermediate production steps and thereby eliminating any of the discontinuous intermediate operations.

Another object of the invention is to produce tubular articles formed of fibrous material wherein the method and apparatus arranged in accordance with the invention provide for increased production of such articles than has been practical heretofore.

A further object of the invention is to provide a method and apparatus for the production of tubular articles of fibrous materials of a wide variety of sizes, both in respect of inside diameter, as well as to the thickness of the tubular wall, and the density of the media.

In one of its broader aspects, the invention contemplates the production of tubular articles from a mat of mineral fibers which comprises the steps of: advancing a mat of mineral fibers along a path; rolling the mat on a mandrel rotatable about an axis traveling along the path of the mat, normal to the direction of advancement of the mat and at a speed less than the speed of advancement of the mat; conveying the rolled mat and mandrel between a pair of oppositely rotating members to roll an additional length of mat on the mandrel to produce a tubular article having the desired quantity of mineral fibers; and, passing the tubular article to a sizing station to produce a final outer dimension thereto.

Another feature of the invention involves the use of divergently spaced conveying surfaces moving in opposite directions at slightly different speeds selected to cause the mandrel to advance in the direction of the divergence in coordination with the build-up of the wall thickness and the outer diameter.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become readily apparent to those skilled in the art from reading the following detailed description of an embodiment of the invention when considered in the light of the accompanying drawings, in which:

FIG. 1 is a perspective view of apparatus containing the structural concepts of the invention for continuously producing tubular articles from a mat of fibrous material;

FIG. 2 is an enlarged fragmentary side view of the leading end portion of a mat of fibrous material spaced from the mandrel upon which it is to be wrapped;

FIG. 3 is an enlarged fragmentary side view similar to FIG. 2 showing the leading end portion of the fibrous mat wrapped around the mandrel;

FIG. 4 is an enlarged fragmentary side view of the secondary rolling station of the apparatus illustrated in FIG. 1;

FIG. 5 is an enlarged fragmentary side view of the sizing station of the apparatus illustrated in FIG. 1; and

FIG. 6 is an enlarged fragmentary side view of the final heating station of the apparatus illustrated in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With general reference to the drawings, there is illustrated an apparatus particularly adaptable for producing tubular articles of fibrous material, which articles are useful as pipe insulation, for example. Referring to FIG. 1 of the drawings, there is illustrated a system for continuously producing tubular articles made from fibrous material, typically resin bonded glass fiber mat **10**. The mat **10** is formed in any of the conventional manners wherein the fibers of glass are formed, coated or impregnated with a suitable resin, such as phenol formaldehyde, for example, and blown onto a moving conveyor, such as the endless conveyor **12** formed of a woven wire and driven in the direction indicated by the arrow. The mat **10** is typically formed of fibers of glass which are disposed in random fashion in a plane substantially parallel to the plane of the conveyor **12**. The mat **10** is further typically cut into discrete lengths determined by the diameter, wall thickness, or desired density of the finished product, as will become clearly manifest hereinafter.

At the entry of the apparatus illustrated in FIG. 1, there is disposed a conveyor **14**, which is arranged gen-

erally normally to the path of travel of the conveyor **12**. The conveyor **14** includes a main frame **16** on the outer end of which is located a drive motor **18** that drives a sprocket **20**. The sprocket **20**, in turn, drives a chain member **22**, which is guided about a pair of spaced apart idler sprockets **24** and **26**.

Discrete lengths of mandrels **28** are disposed on the chain member **22**, which moves the mandrels transversely over the conveyor **12** and thence automatically discharges the same when the mandrel **28** is in the desired position over the conveyor **12**. At the discharge point, the mandrels **28** are caused to roll over an inclined heated surface **30**, which effectively heats at least the outer peripheral surface of the mandrels **28**, and thence come to rest in a supply zone **32**. The supply zone **32** is equipped with a gating mechanism which effectively meters the discharge of the heated mandrels **28** onto the conveyor **12**. The heated mandrels **28** are mounted to be discharged onto the conveyor **12** so as to be positioned immediately in front of the leading edge of the mat **10** of the resin bonded fiber glass material, as illustrated in FIG. 2.

The gate mechanism for releasing the heated mandrels **28** on to the conveyor **12** is typically energized by a photocell sensing circuit which photoelectrically senses the presence of the leading edge of a length of mat **10** and thereupon effectively releases a single one of the mandrels **28** from the supply zone **32** to fall onto the surface of the conveyor **12**.

It must be understood that the mandrels **28** are heated to effectively cause the binder material in the mat **10** to adhere to the outer peripheral surface of the mandrels **28**. Alternate techniques could be employed to effect the desired adherence, such as to coat the mandrels **28** with an adhesive substance which could be rendered tacky upon the application of heat or be sprayed with a catalyst, for example, to bring about the desired chemical reaction.

The conveyor **12** thereafter moves both the mat **10** and the heated mandrel **28** until the mandrel **28** contacts the gate arms **34**, at least a pair of which is disposed in spaced relation across the conveyor **12** (FIGS. 2 and 3). The gate arms **34** effectively bring about an alignment of the mandrel **28**, causing the same to assume a position which is perpendicular or normal to the path of travel of the mat **10** and the conveyor **12**. Manifestly, only the outer ends of the heated mandrels **28** are contacted by the gate arms **34**, which temporarily impede the forward movement of the mandrels **28** on the conveyor **12**. However, since the conveyor **12** continues to advance, such advancing movement will simultaneously cause the mandrels **28** to rotate about its axis and properly align with the mat and conveyor.

With the forward movement of the mandrel **28** being impeded, the leading edge of the mat **10** continues to move forward and contacts the rotating heated mandrel **28**. At this point, the leading edge of the mat **10** adheres to the mandrel **28** and is caused to be rolled or wrapped upon the mandrel **28**, as illustrated in FIG. 3. Due to the fact that the mat **10** is typically comprised of fibers of glass containing an uncured binder substance, the heat of the mandrel **28** initiates the curing of the binder, causing the same to become tacky and thereby readily adhere to the outer peripheral surface of the mandrel **28**.

It will be noted that on the terminal end of each of the arms **34**, there is disposed a microswitch **36**. The microswitch **36** may be connected in a series circuit which is energized only upon physical contact of both switches, indicating that the mandrel **28** is properly aligned. Upon energization of the switches **36**, a timing circuit is energized, which is set to time out in a desired time interval necessary to build up the desired thickness of the mat **10** on the mandrel **28**. It has been found that satisfactory results are achieved by effecting two wraps or thicknesses of the mat **10** on the mandrel **28**, at which time the gate arms **34** are raised or swung out of contact with the ends of the mandrel **28**, permitting the already rolled mat and mandrel to advance to the next winding or roll-up station, generally indicated by reference numeral **40**, and specifically illustrated in FIG. 4.

The roll-up station **40** consists of a pair of spaced apart, upstanding, substantially vertically extending columns **42**, supported at their lower ends by a transversely extending base member **44**. Since the structure on each of the sides is identical, only a single side structure will be described in detail. At each of the base member **44**, and at the upper end of the upright member **42**, there are disposed roller members about which a continuous woven wire belt or chain **46** is supportingly mounted. To enable the tautness of the belt **46** to be varied, the roller disposed at the upper end of the upstanding column **42** is mounted in an adjusting mechanism consisting of a rack **48** and an associated pinion **50**.

The ends of the base member **44** of the above assembly may be raised and lowered together, or relative to one another, by the provision of adjusting screws **52** and **54**. A control wheel **56** is adapted to move the screw **52** up and down relative to the member **44**, while a control wheel **58** is adapted to move the screw **54**. It will be appreciated that similar screw members located on the other side of the conveyor **14** may be suitable coupled to the above referred to screws by drive chains, so that actuation can be simultaneously effected by actuation of the respective control wheels **56** and **58**.

The woven wire belt or chain **46** is typically driven through a drive sprocket **60** which, in turn, drives one of the rollers which support the chain **46**. The chain **46** is driven in a direction opposite to that of the conveyor **12**, and thereby effects a complete roll-up of the mat **10** onto the mandrel **28**. It will be noted that the lowermost run of the chain **46** is disposed such that the exit end **62** is spaced further from the surface of the conveyor **12** than the spacing at the inlet end **64**, to produce a divergence of the conveying surfaces from the inlet end to the exit end. Such relative disposition permits the complete roll-up of the mat **10** onto the mandrel **28** and effectively applies substantially the same compressing forces on the tubular elements being formed.

It will be appreciated that the speed of travel of the mat **10** and the mandrel **28** through the roll-up station **40** is determined by the relative speed of the chain **46** and the conveyor **12**. Further, it will be appreciated that the relative spacing between the chain **46** and the conveyor **12** is determined by the thickness of the mat, outside diameter of the mandrel **28**, and the number of wraps of the mat **10** on the mandrel **28**.

Upon exit from the roll-up station **40**, the completely wrapped or wound assembly of the mat **10** and mandrel **28** is caused to be conveyed to a sizing station **70**, illustrated in particularity in FIG. 5. The function of the sizing station **70** is typically to compare the wound assembly to the desired outside diameter. The structure of the sizing station **70** is similar to the roll-up station **40**, and, more particularly, consists of a pair of spaced apart, upstanding, substantially vertically extending columns **72**, supported at their lower ends by a transversely extending base member **74**. Since the structure of each of the sides of the sizing station **70** is substantially identical, only a single one will be described in detail. At each end of the base member **74**, and at the upper end of the upright member **72**, there are disposed roller members about which a continuous woven wire belt or chain **76** is supportingly mounted. To enable the tautness of the belt or chain **76** to be varied, the roller disposed at the upper end of the upstanding column **72** is mounted in an adjusting mechanism consisting of a rack **78** and an associated pinion **80**.

The inlet end **81** and the exit end **83** of each side of the above described sizing station assembly **70** may be raised and lowered together by the provision of adjusting screws **82** and **84**. A control wheel **86** is adapated to move the adjusting screws **82** and **84** up and down

relative to the member 74. It will be noted that the single control wheel 86 is coupled through a typical chain drive to the adjusting screw 82, which, in turn, is coupled through another chain drive to the adjusting screw 84, to effect the desired simultaneous movement. It will be appreciated that the similar screw members located on the other side of the conveyor 12 are likewise suitably coupled to the chain actuated by the control wheel 88 so that actuation can be simultaneously effected to raise and lower the entire assembly relative to the conveyor 12.

The woven wire belt or chain 76 is driven through a drive sprocket 90 which, in turn, drives one of the rollers which drivingly support the chain 76. The chain 76 is driven in a direction opposite to that of the conveyor 12. Assuming that the chain 76 is driven at a speed equal to one half of the speed of the conveyor 12, the articles comprised of the rolled mat 10 and the mandrel 28 will rotate in a counter-clockwise direction, as viewed in FIG. 5, and will travel in the direction of the movement of the conveyor 12 at a speed equal to one quarter of the speed of the conveyor 12.

The distance or spacing between the conveyor 12 and the lower surface or run of the chain 76 determines the outside diameter of the tubular articles being formed. As mentioned before, the mat is, in the preferred embodiment, comprised of glass fibers impregnated with a binder material such as phenol formaldehyde resin, which is in its uncured stage. Since the resin is uncured, the sizing station 70 can, in addition to determining the outside diameter of the tubular articles being formed, determine the density of the fibrous medium constituting the tubular walls.

Upon exit from the sizing station 70, the sized tubular assembly is caused to be conveyed to a curing station 96, illustrated in particularity in FIG. 6. The function of the curing station 96 is to cure the resin, at least in the regions of the outer peripheral surface of the formed articles, to effectively set and maintain the outer dimension thereof. This objective is achieved by a heated plate 98 spaced vertically from the conveyor 12 a distance substantially equal to the predetermined outside diameter of the tubular articles being formed. The heated plate 98 may be heated by various means and, in the preferred embodiment, the use of an electric resistant heating element is preferred. It will be appreciated that the vertical spacing between the lower surface of the plate 98 and the conveyor 12 may be varied by adjusting means of the type illustrated in respect of the apparatus shown in FIGS. 4 and 5, or other adjusting means.

While the curing station 96 has been mentioned as being employed only to cure the binder content in the outer region of the tubular articles being formed, which typically can be achieved by only a single revolution of the article, it will be appreciated that the curing station 96 could be varied to allow for the curing o fthe entire binder content of the article.

In the preferred embodiment, as the tubular article leaves the curing station 96, only the outer skin of the article and the inner skin, adjacent the mandrel 28 are cured. The remaining portion of the binder is cured by manually transporting the formed articles to another station which would include suitable heating means. As a general rule, before entering this final heating means, the mandrels 28 are removed from the tubular articles. It has been found that such procedure is readily accomplished without any deformation or attrition of the inner surface thereof.

In conclusion, the apparatus illustrated and described above provides a method for continuously forming tubular articles of fibrous material without the need for any discontinuous intermediate steps. Also, the apparatus may be utilized for producing tubular articles of different dimensions regarding inside diameter, outside diameter, wall thickness, and density. The length of the tubular articles is determined by the width of the mat 10 being used. The wall thickness is determined by the thickness of mat 10; the length of the discrete lengths of mat 10; or the degree of compression achieved between the lower runs of the chains 46 and 76 and the conveyor 12; or combinations of the above.

In accordance with the provisions of the patent statutes, I have explained the principle and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desired to have it understood that the invention may be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope

I claim:

1. Apparatus for producing tubular articles from mats of fibrous material comprising:
   (a) a conveyor for advancing a mat of fibrous material along a path;
   (b) means for disposing a mandrel across said conveyor and normal to the direction of advancement of the mat;
   (c) means for causing a leading portion of the mat to adhere to the mandrel;
   (d) means at a first winding station for rolling at least one turn of the leading end portion of said mat onto said mandrel; and
   (e) a diverging conveying surface at a second winding station farther along the path, said diverging conveying surface being disposed in spaced relation above said conveyor and moving in a direction opposite to said conveyor at a speed less than the speed of said conveyor to effectively roll said mat on said mandrel to form a tubular article as the mat and mandrel are advanced in the direction of divergence.

2. Apparatus as defined in claim 1 wherein said means for causing a leading portion of the mat to adhere to the mandrel is a means for heating the mandrel prior to the disposition of the mandrel across the conveyor and wherein said means for disposing a mandrel on said conveyor includes a second conveyor disposed substantially normal to the direction of travel of said first mentioned conveyor.

3. Apparatus as defined in claim 1 wherein said means for causing a leading portion of the mat to adhere to the mandrel includes an inclined heated surface on which said mandrel is caused to travel before being disposed on said conveyor.

4. Apparatus as defined in claim 1 wherein said means for disposing a mandrel on said conveyor includes a gating mechanism for selectively delivering a single mandrel to said conveyor.

5. Apparatus as defined in claim 1 wherein said means for rolling the leading end portion of said mat on said mandrel includes a gating mechanism for selectively impeding the advancement of said mandrel on said conveyor.

6. Apparatus as defined in claim 5 wherein said gating mechanism includes a pair of laterally spaced arms positioned to contact opposite end portions of said mandrels.

7. Apparatus as defined in claim 6 including means for selectively moving said arms out of contact with said mandrel.

8. Apparatus as defined in claim 1 including a conveying surface disposed in spaced relation above said conveyor moving in a direction opposite to said conveyor at a speed less than the speed of said conveyor to effectively determine the outside diameter of the tubular article formed by cooperative relation of said conveyor and said diverging conveying surface as the tubular article is advanced between the conveying surface and the conveyor.

9. Apparatus as defined in claim 8 including a heated zone through which said tubular article is passed.

10. Apparatus as defined in claim 9 wherein said heated zone includes a heated plate disposed in spaced relation above said conveyor.

11. A method of producing tubular articles from a mat of fibrous material comprising:
(a) advancing a length of mat of fibrous material along a path;
(b) locating a mandrel across the path and normal to the direction of advancement of the mat;
(c) adhering a leading end portion of the mat to the mandrel;
(d) rolling at least one turn of the leading end portion of the mat onto the mandrel at a first winding station by rotating the mandrel about an axis normal to the direction of advancement of the mat;
(e) conveying the mat and mandrel with the mat partially rolled onto the mandrel farther along the path to a second winding station;
(f) locating the leading end portion of the mat and the mandrel between a pair of diverging conveying surfaces with the mat in contact with the diverging conveying surfaces; and
(g) rolling a remainder of the mat onto the mandrel while advancing the mat and mandrel along the path by moving the diverging conveying surfaces in opposite directions at slightly different speeds selected to cause the mat and mandrel to advance in the direction of divergence in coordination with the build-up of the wall thickness and the outer diameter of the tubular article as the remainder of the mat is rolled thereon.

12. The method as defined in claim 11 wherein said fibrous material is comprised of mineral fibers.

13. The method as defined in claim 12 wherein said mineral fibers are glass.

14. The method as defined in claim 13 wherein the fibrous material is impregnated with an uncured binder.

15. The method as defined in claim 14 wherein said binder is a thermosetting compound.

16. The method as defined in claim 14 including the step of heating the mandrel before the mat is rolled thereon whereby heat from the mandrel causes the binder in the leading portion of the mat to become tacky and the mat is adhered to the mandrel.

17. The method as defined in claim 14 including the final step of curing the binder.

18. A method of producing tubular articles from a mat of fibrous material, comprising:
(a) advancing the mat of fibrous material along a path;
(b) locating a mandrel across the path and normal to the direction of advancement of the mat;
(c) rolling at least one turn of the leading end portion of the mat onto the mandrel at a first station by rotating the mandrel about an axis normal to the direction of advancement of the mat;

(d) conveying the mat and mandrel, with the mat partially rolled onto the mandrel, farther along the path to a second winding station;
(e) locating the leading end portion of the mat and the mandrel between a pair of diverging conveying surfaces with the mat in contact with the diverging conveying surfaces;
(f) rolling a remainder of the mat onto the mandrel while advancing the mat and mandrel along the path by moving the diverging conveying surfaces in opposite directions at slightly different speeds selected to cause the mat and mandrel to advance in the direction of divergence as the mat is rolled on the mandrel to produce a tubular article having the desired quantity of fibrous material; and
(g) advancing the tubular article farther along the path to a sizing station to produce a final outer dimension thereto.

19. The method as defined in claim 18 wherein the fibrous material is impregnated with an uncured binder.

20. The method as defined in claim 19 wherein said binder is a thermosetting compound.

21. The method as defined in claim 19 including the step of heating the mandrel prior to rolling the mat thereon whereby heat from the mandrel causes the binder in the leading portion of the mat to become tacky and the mat is adhered to the mandrel.

22. The method as defined in claim 19 including the final step of curing at least the binder in the outer peripheral zone of the tubular article being formed.

23. The method as defined in claim 18 wherein the fibrous material is mineral fibers.

24. The method as defined in claim 23 wherein said mineral fibers are glass.

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U.S. Cl. X.R.

93—81 R; 156—446, 447, 448, 449, 450, 455