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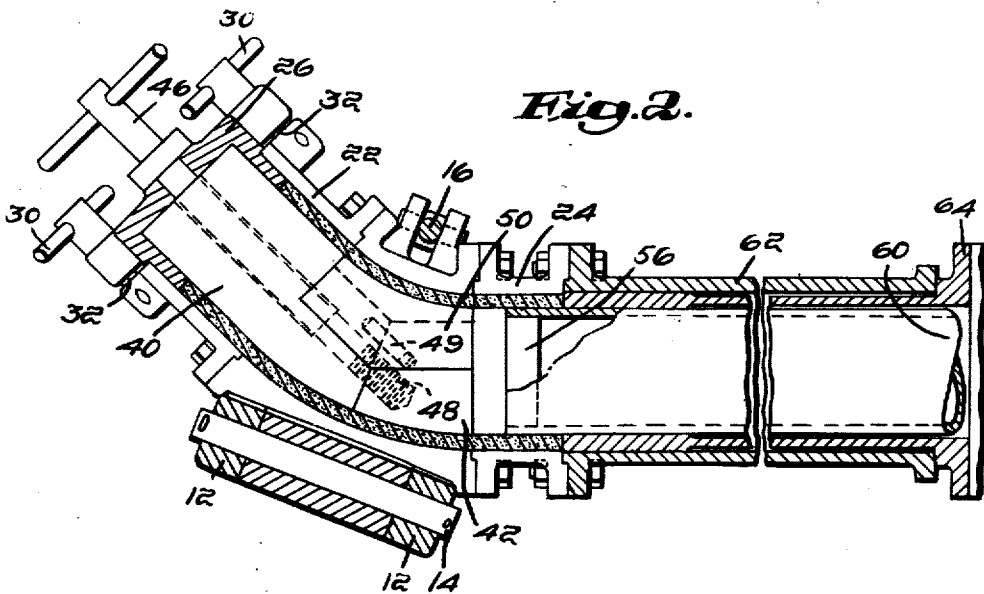
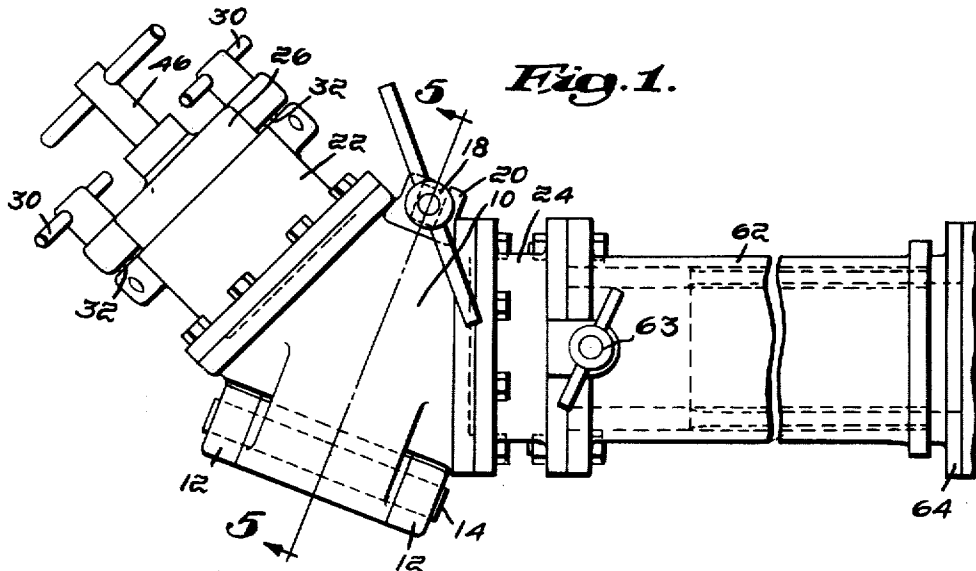
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METHOD AND APPARATUS FOR FABRICATING CURVED FIBER TUBING

Filed April 14, 1953

2 Sheets-Sheet 1



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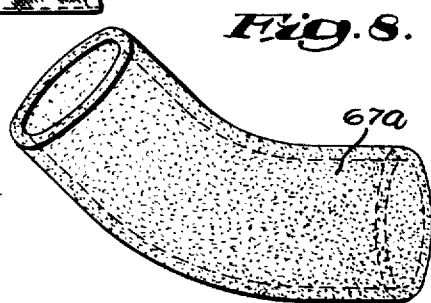
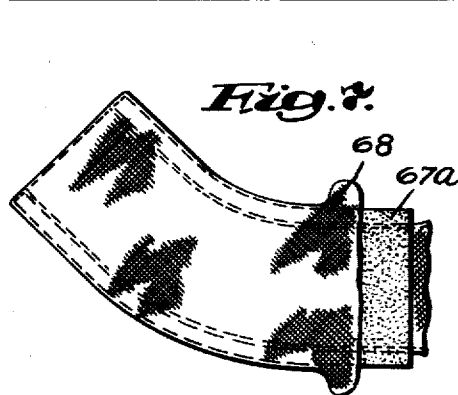
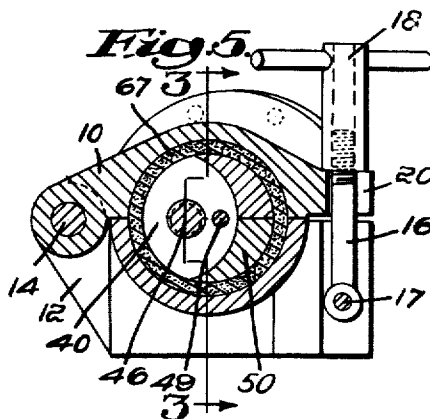
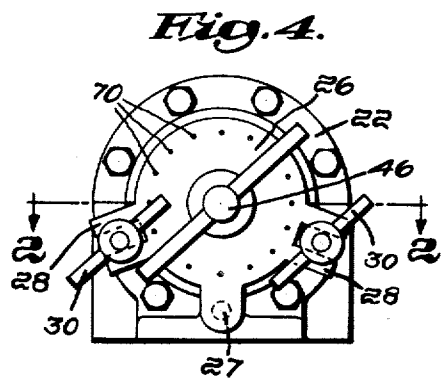
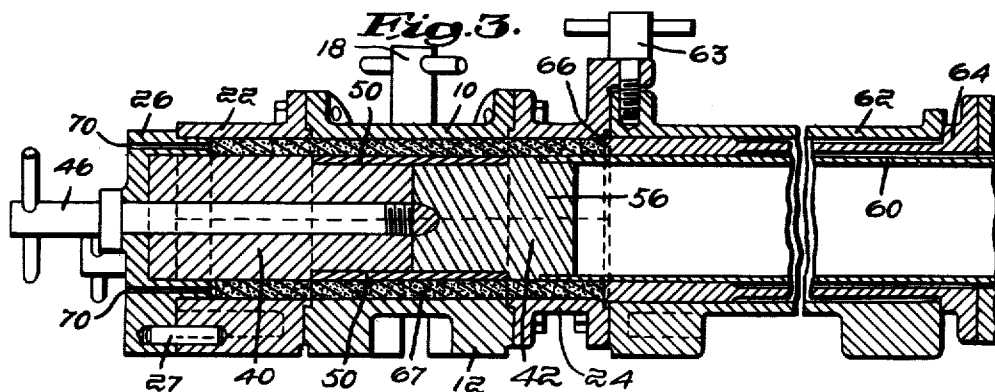
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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR FABRICATING CURVED FIBER TUBING

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6 Claims. (Cl. 92—59)

This invention relates to the production of fiber tubes and, more particularly, to the reforming of straight length fiber tubular stock into elbows or bends, for example, of 45° and conforming to predetermined specifications.

Tubular conduit formed of pulp fiber has found a variety of expanding uses. In straight stock lengths, the material is capable of economic fast production and has good durability in use. Manufacture of shaped components, necessary for all but straight length installations, has, however, been a more difficult proposition. Since the pulp tubes are formed by the deposition of pulp against a form from a water-suspension of the fiber stock, the complication of curved contour leads to non-uniformity of fiber deposition due to the setting up of curved lines of intersecting suspension flow. Also, desired strengths have not been achieved.

Hence, the main object of this invention is to provide a better method for the production of such bends, and to provide apparatus useful in the practice of the method.

The method by which the finished bend or elbow is produced consists in first forming a pulp blank of suitable size and length from wet sheet fibrous materials, this being accomplished by any suitable machine for producing such an article, which machine forms no part of this invention.

After the fiber blank has been prepared, it is preferably, although not necessarily, enclosed in a fabric or other perforate retaining covering, this covering having been previously prepared in tubular or other form, so that it can be quickly placed over the outside and inside of the blank and also over both ends.

The still-wet fiber blank whether or not encased in fabric is then placed on a straight mandrel or arbor, and the mandrel containing the blank is then placed in a cylinder.

The cylinder containing the blank is then assembled with a reshaping die, and a plunger is introduced into the space between the cylinder and mandrel.

The plunger is then advanced over the mandrel and inside the cylinder pushing the pulp blank ahead of it into the reshaping die, preferably with some reduction in its wall thickness concomitant to reduction in moisture content.

A description of the method of this invention may be better understood when taken in connection with a description of an apparatus for performing the method of the invention, which apparatus is illustrated in the accompanying drawings, wherein:

Fig. 1 is a plan view of the apparatus;

Fig. 2 is a horizontal median cross-sectional view of the apparatus of Fig. 1;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 5;

Fig. 4 is an end elevational view of one end of the apparatus;

Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 1; and

Fig. 6 is an elevational view of a jacketed tube prior to bending in accordance with this invention; and

Fig. 7 is an elevational view of the tube after bending with a portion of the jacket removed; and

Fig. 8 is a view of the material after completion of the operation.

The form of apparatus illustrated in the drawings is intended to form 45° tubular bends as illustrated in Fig. 8.

To this end, the apparatus has a main die section formed of upper and lower parts 10 and 12 respectively, hinged along a hinge line 14 and provided with closure means in the form of a bolt 16 pivoted on the lower die section 12 at 17 (Fig. 5), the bolt being screw-threaded at its top for engaging a handled locking nut 18 which is adapted to engage lugs 20 projecting from the upper die part 10. The inner surface contour of these dies conforms to the contemplated outer contour of the completed bend.

Bolted to each end of the main die section are two adapter sections 22 and 24. Parts 22 and 24 are both made in upper and lower halves which are bolted to 10 and 12 respectively, so that the upper halves of 22 and 24 will open with part 10. The left-hand adapter section 22, shown at the left in Figs. 1, 2 and 3, is designed to support from the exterior of the main die assembly a multiple-part core; and includes for this purpose an end cap 26 adapted to telescope within the end of the adapter 22 guided by a pin 27. The end cap 26 also has lugs 28 so that the cap may be locked against the end of adapter 22 by means of handle nuts 30 and bolts 32 pivoted to the adapter 22 to rigidly support the end cap against the adapter 22.

The inside of the end cap 26 is bored to receive a core part 40 which has an outer contour corresponding to the contemplated inner contour of one end of the tube after reforming. The inner end of the core part 40 is relieved or cut away on one side thereof for receiving a throat core part insert hereinafter described. On the side of greater radius, the core part 40 terminates in a flat end surface which abuts a complementary end surface of a core part 42 which extends into the adapter 24 which is bolted to the right-hand end of the main die section. The core part 42, like the core part 40, is relieved or cut away at its inner end in the area of less radius to accommodate the remainder of the throat portion of the core part.

The core part 42 is supported wholly from the left-hand end of the die by providing a handled spindle 46 which extends through the end cap 26 and core part 40 along their axes, and is screw-threadedly received at 48 into the inner end of core part 42. A dowel 49 extending between the core parts 40 and 42 maintains them against relative rotation during the turning of the spindle 46.

The inner longitudinal surfaces of the extensions of core parts 40 and 42 are convexly shaped so that they snugly receive the throat part of the core. The throat core is formed of a two-part member 50, in cross-section, crescent-shaped (Fig. 5), which is split along its median horizontal plane, and the outer ends of composite member 50 are angularly related, as shown, so that the composite shaped member is wedged between the core parts 40 and 42 so that the assembled core, upon tightening of the spindle 46, is rigidly supported from the left end of the apparatus with an annular space separating the outer surfaces thereof from the internal surfaces of the main die sections 10 and 12 and of adapters 22 and 24 and forming an annular curved cavity.

At its outer end, the core part 42 has an extending circular boss 56 of slightly reduced diameter to which is telescopically fixed the end of a cylindrical hollow mandrel 60 so that the outer surface of the mandrel part

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60 of the core registers with the outer surface of core part 42. A barrel 62 is bolted to the lower section of adapter 24, and is engaged by a handled bolt 63 extending through a boss projecting from the upper section of adapter 24. An annular plunger or ram 64 can be moved inwardly and outwardly of the barrel 62 over mandrel part 60. As shown in Fig. 3, the inner diameter of barrel 62 is slightly greater than the inner diameter of the main portion of the die sections and adapters. Thus, a straight section of wet formed fibrous tubing of a wall thickness slightly greater than the thickness of the annular die cavity but slightly less than the annular cavity between mandrel part 60 and barrel 62 may be readily placed into the barrel, and then moved into the die cavity by ram 64. The entering end of adapter 24 may, if desired, be flared on its inner surface slightly at 66 so as to make a registering juncture of the surfaces when the barrel is bolted into place. Similarly, if desired, the outer diameter of mandrel 60 may be slightly less, e. g. $\frac{1}{4}$ ", than the outer diameter of the die core with a corresponding registering flare transition if necessary.

It is helpful to lubricate the inner and outer surfaces of the pulp tubing. Suitable lubricants are liquid soap solution, light machine oil or commercial rubber lubricant, by applying them by spray or brush both to the tube and to the die. Silicon greases applied to the die parts only offer some advantage. Preferably, however, the straight tube wet stock is enclosed in a removable thin pervious jacket before it is fed to the apparatus, the jacket preferably covering all the tube surfaces though it will be understood that the advantages thereof may be partially secured with only the outside or the inside, or portions of either, of the tube surfaces being covered by the jacketing material, which may either be reticular cloth or flexible perforate sheet material.

Thus, a length of tubular knit fabric, for example, of nylon or silk, of slightly more than twice the length of the tube to be reformed, is drawn through the interior of the stock and pulled back over the exterior surface of the stock 67, as indicated in Fig. 6 by the reference 68. For example, one may use material similar to nylon stocking fabric. The stock enclosed in its jacket is then slid onto the mandrel part 60 in the barrel 62.

Where such a knit fabric is used, the lubricants can be applied to the tube after it has been jacketed or the jacket may be dipped into the lubricant before it is applied to the pulp tube. Because the jacket is pervious, it does not hinder the desirable egress of water during the reforming operation.

After the straight section of wet formed jacketed fibrous tube is slid into place between the mandrel part 60 and the inside barrel 62, which, as previously stated, may be, respectively, of slightly greater inside diameter, and slightly less outside diameter, than the wet jacketed tube, so as to facilitate its positioning therebetween, the ram 64 is moved inwardly to force the stock into the annular die space, then along its curved annular space and up against the cap 26. In this motion, the tube moves along a single curved projection of its longitudinal axis at its starting position in barrel 62. As it enters the die cavity which is of less radial width than the radial width of the annular space between mandrel 60 and barrel 62, as hereinbefore explained, the wall thickness of the tube is reduced, the pulp being compressed radially inwardly against the fixed diameter of the die parts 40, 42 and 50. Water is expelled from the stock during this operation, for which reason the end cap 26 is provided with a series of drain outlets 70, and adapter 24 or other of the parts may also have drain outlets. Thereafter, bolt 63 is loosened, the upper section 10 with its attached upper halves of 22 and 24 is opened, the spindle 46 withdrawn, handled nuts 30 loosened and swung out of the way and end cap 26 withdrawn bringing with it core part 40. Similarly, mandrel part 60 and core part 42

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are withdrawn from barrel 62 whereupon reformed tube 67a is lifted out of the bottom half of the die and core part 50 shaken out. The jacket, if used, is then rolled off the outside of the tube and pulled from the inside and can be reused for subsequent tubes. Sufficient moisture removal can be attained during the operation so that the reformed tube will have a self-sustaining set, yet the flow of water present and extruded during the operation facilitates rearrangement of the fiber structure in the new shape without losing the intermeshing and bonding that renders the ultimate product of good strength and rigidity. If the tube were dry, instead of wet, rupture would occur during the operation and no useful product would be produced.

After removal, the bent self-supporting tube may be subjected to additional water removal by drying or other means and pitch application steps conventionally used in the manufacture of straight tubing, and milled to final specification.

The jacketing aids in preventing defects and, hence, minimizing the number of rejects. Also, the method of this invention affords a means of imparting, if desired, decorative or distinctive imprints on the outer surface, depending upon the character and size of the yarn forming the reticulate jacket and its nature.

I claim:

1. The method of fabricating a curved fiber tube comprising pushing a pre-formed substantially straight hollow tube of wet fibrous material along a path surrounding a single curved projection of its axis, while confining the interior surface of said tube against radial contraction and confining the exterior surface of said tube against radial expansion, compressing said tube while moving the same and reducing the wall thickness thereof and expelling moisture therefrom to reform the tube and impart a self-sustaining set to the tube having a curvature conforming to said curved projection.

2. The method of fabricating a curved fiber tube comprising pushing a pre-formed substantially straight hollow cylindrical tube of wet pulp along an annular path concentric with a single curved projection of its axis, while confining the interior surface of said tube against radial contraction and confining the exterior surface of said tube while moving the same and reducing the wall thickness thereof and expelling moisture therefrom to reform the tube and impart a self-sustaining set to the tube having a curvature conforming to said curved projection.

3. The method of fabricating a curved fiber tube comprising enclosing a pre-formed substantially straight hollow tube of wet fibrous material in a pervious thin retaining jacket, pushing said jacket and tube along a path surrounding a single curved projection of the axis of the tube, while confining the interior surface of said tube against radial contraction and confining the exterior surface of said tube against radial expansion, compressing said tube against radial expansion, compressing said tube thickness thereof and expelling moisture therefrom to reform the tube and impart a self-sustaining set to the tube having a curvature conforming to said curved projection and then removing the jacket from the reformed tube.

4. The method of fabricating a curved fiber tube as claimed in claim 3, wherein the jacket is formed of tubular knit fabric.

5. The method of fabricating a curved fiber tube as claimed in claim 3, wherein the jacket is tubular fabric folded over one end of the tube and extending to the other end of the tube along both the internal and external surfaces of said tube.

6. Apparatus for fabricating curved fiber tubes comprising a split hollow die having a circular internal cross-section throughout and having a curved axis, a multi-part core of circular cross-section throughout rigidly supported wholly from one end of said hollow die, in said

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die and extending through said die to form between the walls of said die and said core an annular curved cavity open at the other end of said die, a hollow cylindrical feeding barrel having an internal diameter greater than that of said cavity attached to the open end of said die and a cylindrical mandrel mounted within said barrel and having an outer diameter less than that of said core, and an annular ram movable between said barrel and said mandrel for forcing a fibrous tube mounted on said mandrel off said mandrel into and along said annular curved cavity.

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