

Sept. 5, 1961

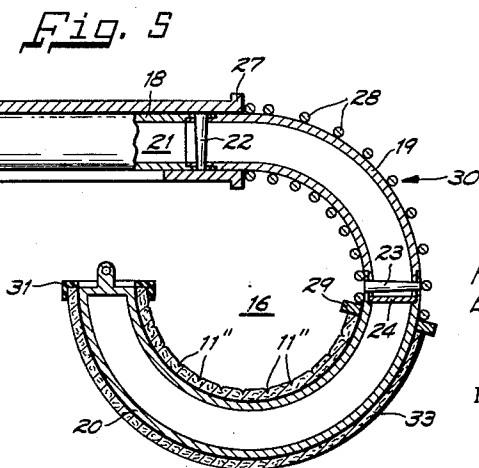
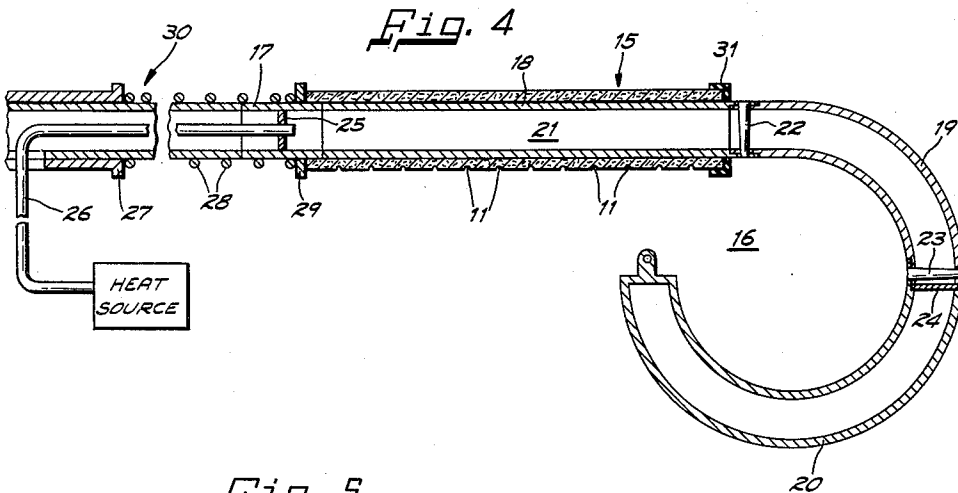
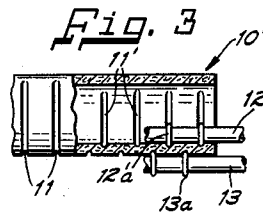
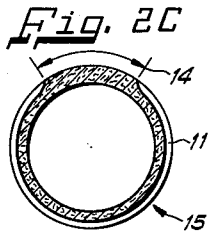
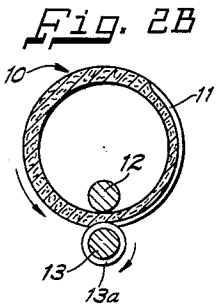
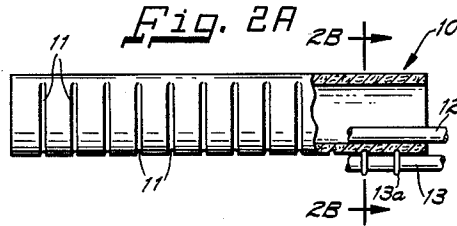
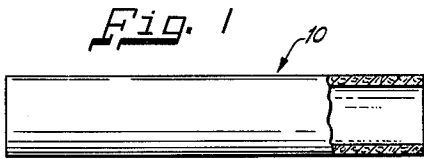
F. B. BURNS ET AL

2,998,985

SHORT RADIUS, FIBRE, PIPE BEND

Filed May 2, 1958

2 Sheets-Sheet 1



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Fig. 6

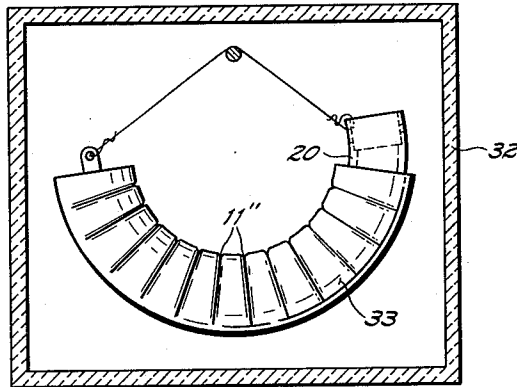


Fig. 7

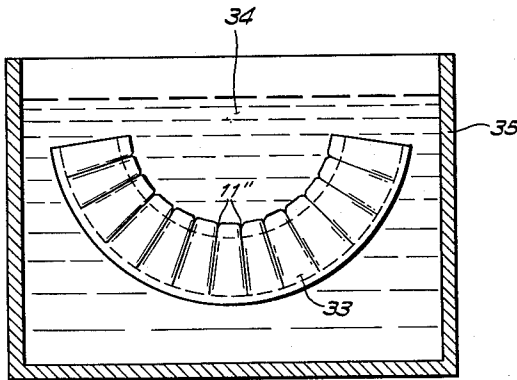
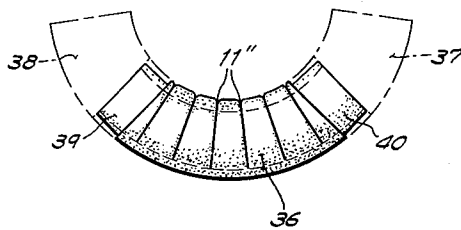


Fig. 8



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SHORT RADIUS, FIBRE, PIPE BEND

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This invention relates in general to a short radius, fibre, pipe bend and also to a method and apparatus for forming such short radius fibre bends adapted to later impregnation with a suitable saturant such as coal tar pitch and the like.

In recent years there has been a tremendous expansion in the use of tubular conduit and pipe formed of pulp fibre. In straight stock length, the material is well adapted to fast production by mass production techniques and when saturated with a suitable saturant such as coal tar pitch and the like, has good durability and use.

Much of the manufacture of various shaped components has heretofore been done by hand operation. Various shaped components have also been made from other materials. Utilization of these components in applications governed by installation and material codes has been in some cases refused in the interests of uniformity in the overall installation. Therefore, for purposes of uniformity, a pitch-fibre short radius elbow is very desirable. Further, even in hand operations, it has been very difficult to produce so-called short radius fibre bends due to the inherent characteristics of the wet tubes. One mass production technique for production of the short radius bends involves the use of container means for the containment of both the inner and outer surfaces of the tube during the manufacture process, this being undesirable in that many hand operations in opening and closing the outer container means are involved.

It is an object of the invention to provide as an article of manufacture, a short radius, fibre, pipe bend having regularly spaced compression crease marks on the inner side of the bend to thereby provide a more uniform and superior product as contrasted with a bend having random crease marks.

It is a further object of this invention to provide a new and better method and apparatus for the production of short radius bends.

Another object of this invention is to provide apparatus of the type aforementioned for forming short radius bends from elongated preformed wet tubes of fibrous material without requiring container means to prevent radial expansion of the bends during the manufacture thereof.

A further object of the invention is to provide an apparatus and method of the aforescribed type wherein parallel spaced compressive indentations are made on the outer periphery of the wet tube such that in making the short radius bend, the indentations become compression crease marks on the finished product.

A further object of the invention is to provide a method and apparatus for manufacturing short radius fibre bends which is easy to operate, easy to manufacture and maintain and is otherwise well adapted for the purposes for which it was designed.

The novel features that are characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood by the following description of specific em-

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bodiments when read in connection with the accompanying drawings in which:

FIG. 1 is a front plan view, partially in section, of a preformed wet elongated tube;

FIG. 2A is a view similar to FIG. 1 showing the tube undergoing a prestressing operation;

FIG. 2B is a sectional view along the lines 2B of FIG. 2A;

FIG. 2C is a sectional view similar to FIG. 2B showing the extent and depth of the indentation of the prestressing operation;

FIG. 3 is a fragmentary front plan view, a portion of which is in section, similar to FIG. 2A showing an alternative method of prestressing;

FIG. 4 is a semidiagrammatic view, a major portion of which is in section, of apparatus operable to form a short radius fibre bend;

FIG. 5 is a fragmentary sectional view of the apparatus in FIG. 4 at a different stage of the operation;

FIG. 6 is a semidiagrammatic view of another step in the manufacturing operation showing the short radius bend still on a portion of the mandrel and disposed in a drying oven;

FIG. 7 is a semidiagrammatic view of another step in the manufacturing operation showing the impregnation of the raw short radius fibre bends; and

FIG. 8 is a front view of the finished short radius fibre bends, the dotted portions showing stock that was removed in the finishing operation.

In the manufacture of short radius fibre bends, an elongate tube 10 may be formed of cellulose material on a standard forming machine and a plurality of laminates is convolutely rolled to a wall thickness which is standard for the straight stock pipe or conduit for which the finished product is to be associated. The tube after being rolled becomes substantially a seamless homogeneous mass wherein the interlaminar bonds approach the intralaminar bonds. The water content of this wet fibrous tube 10 is preferably that of the normal value made on the forming machine for use in the manufacture of straight stock fibre pipe or conduit. (It is to be noted that it is of considerable value to use a standard tube as a starting point for the short radius bends as this does not require a modification of existent production machinery or techniques.)

As shown in FIGS. 2A and 2B the wet tube 10 may be cut to appropriate length and subjected to a prestressing operation. The prestressing comprises the placing of indentations 11 at spaced parallel intervals along a portion of the outer periphery of the tube 10. The indentations may be formed by a suitable means such as a roller 12 which engages the inside of the pipe to provide a support for a roller 13 having enlarged indenting means 13a associated therewith. The indentations 11 are placed on the outer periphery of the tube 10 and are generally normal to the axis of the tube and preferably extend only around 290° of the periphery. The 70° of the outer periphery represented by reference numeral 14 is preferably not subjected to the prestressing operation.

As shown in FIG. 2A, the indentations 11 are, for example, placed at approximately 0.750 inch intervals along the outside of the tube. The spacing selected is desirable, for example, for a bend having a 7" radius to the inner surface of the bent tube. An example of the depth and width of the indentations 11 is to stress a 1/16 inch deep, 3/64 inch wide mark along the periphery. The above example dimensions are preferred dimensions for a four inch wet pipe made according to industry standards having a wet wall thickness of approximately 0.430 inch, the normal water content of the pipe being approximately 76 percent by weight. It is to be par-

ticularly noted that while this prestressing process is being described relative to 4 inch pipe, the concept of course has equal application to pipe and conduit of all sizes, although the precise dimensions, depth and spacings aforementioned may vary as per the size of the unit under consideration.

An alternative to the above prestressing operation is shown in FIG. 3 of the drawings, the inner prestressed indentations 11' being preferably offset relative to the outer indentations 11 and are placed on the tube 10' by the roller 12' having enlarged marking means 12a spaced therealong. The spacings between the indentations 11' are preferably the same as that between indentations 11; however, they are offset approximately 0.375 inch ($\frac{1}{2}$ the distance) with respect to the outside indentations 11.

While the means for forming the proper indentations 11 for prestressing the elongated wet fibre tube is shown as separate and discrete apparatus, it is, of course, apparent that the prestressing operation may be conveniently accomplished while the tube 10 is disposed on the forming apparatus 16 shown in FIGS. 4 and 5. This is particularly true of the preferred prestressing operation shown in FIGS. 2A, 2B and 2C, i.e., outside prestressing only.

Turning now to the bending operation, apparatus 16 is operable to form the tube 10 into the raw bend 33 shown in FIG. 5. More particularly, the bending apparatus 16 comprises three major components, i.e., the mandrel means, the tube mover means 30 and the tube freeing means. More particularly, the mandrel means comprises first, second and third portions, the first portion 18 being substantially a straight cylinder, the second portion 19 being a curved portion detachably connected to the first portion and the third portion 20 which has substantially the same radius of curvature as portion 19 and is detachably connected thereto. As shown in section, the interior of the mandrel means may be hollow and has closure means 25 and 24 disposed respectively in the first portion 18 and at the junction of portions 19 and 20 to define a chamber 21. Heat source means is attached by a suitable conduit 26 to the interior of the enclosure or chamber 21 to supply heat thereto as suitable and desired as shall later be described. It is to be particularly noted that end cap 24 prevents movement of heat between detachable portions 19 and 20. Pins 22 and 23 may be provided between portions 18 and 19 and 19 and 20, respectively, to provide detachable access to the portions as suitable and desired for reasons hereinafter appearing.

The tube mover means 30 comprises, for example, an air actuated cylindrical drive mechanism having an enlarged shoulder 27 which is adapted to engage a stiff helical spring 28 which in turn engages the tube engaging portion 29 which is here shown in the form of an annular ring. It is to be noted that a number of other mechanisms can be used to provide the function of the drive mechanism 30.

In the bending operation the wet prestressed tube 15 is loaded onto the straight portion 18 of the mandrel means when portions 19 and 20 are removed therefrom. A garter or tube protector 31 is placed on the front or leading end of the tube 15 to prevent splitting thereof. Next the portions 19 and 20 are attached to portion 18 and the driving member 27, which may be attached to an air cylinder not shown, is actuated. The force of the driving member 27 is transmitted to the tube engaging member 29 by the spring 28 which serves both as a force transmitting member and flexible drive means for pushing the tube 15 around the curvatures 19 and 20.

The normal tendency for the wet tube after loading same onto mandrel 18 is to adhere thereto. This characteristic is greatly heightened when a compressive force is applied to one end of the tube. In order to free the prestressed tube 15 for movement along the mandrel por-

tions 18 and 19, the heat source means is activated so as to supply a sudden hot jet of heat to enclosure or chamber 21 on the mandrels 18 and 19 to create a cushion of steam between the interior surface of the tube 15 and the exterior surfaces of the mandrel portions 18 and 19. Once the heat is admitted to the enclosure 21 sufficient to elevate the temperature to the desired level, the drive mechanism 30 must be actuated very quickly to prevent drying out and scorching of the prestressed tube 15.

Experimentally, it has been determined that the most beneficial results are obtained with an enclosure 21 temperature sufficient to produce a temperature, measured at the surface of the mandrels 18 and 19, above the boiling point of water. It is, of course, obvious that the mandrel may be heated by any suitable means and even may be disposed in an oven or the like for preheating thereof if desired.

After actuation of the drive mechanism 30, the tube 15 is pushed in a path such that it ends up on the detachable third mandrel portion 20. This mandrel portion 20 is preferably the exact curvature desired for the final radius of the bend and is cool since end wall 23 prevents substantial heat transfer thereto. The coolness of mandrel 20 also facilitates easy handling of the now bent tube 33 and mandrel portion 20.

The third mandrel portion 20 having the bend 33 disposed thereon is then detached from portion 19 and this assembly is then placed in a drying oven 32 (shown in FIG. 6). This assembly is then dried according to standard procedures, the particular temperatures and air movements required being determined according to conventional techniques.

After removal from the drying oven the dried bent tube 33 is removed from the mandrel portion 20 and is then disposed in a suitable impregnation tank 35 having coal tar pitch 34 therein all of which is shown semidiagrammatically in FIG. 7. The actual impregnation is also done according to conventional techniques, i.e., a combination of heated pitch, vacuum and pressure to assure complete and thorough impregnation. After removal of the now impregnated bend 33 from the impregnation tank 35, the bend is quenched in a conventional manner to congeal the coal tar pitch saturant 34. The bend is then subjected to a machining operation whereby the end portions 37 and 38 are removed and tapers 39 and 40 are formed at the ends of the segments for cooperation with other fittings as suitable and desired. Of course, other types of connection means, such as screw threads or the like, may be machined on the ends if desired. It is to be observed that the amount of stock 37 and 38 which is shown removed from the bend 33 is to be considered semidiagrammatic rather than a precise dimensioning.

It will be noted that during the forming or bending operation, the prestressed creases or indentations 11 on the tube 15 becomes compression crease marks 11' in both the fibre bend 33 and in the finished article 36. These crease marks 11' are, of course, no longer in a parallel relationship to each other. Rather, they are in alignment with the radii of the toroidal segment shape assumed by the bend in the bending and drying operations.

It will be further noted that the prestressed tube 15 was disposed on the mandrel 18 such that arc segment 14 was at the top of the apparatus so that when the driving mechanism was actuated, the larger diameter of the toroidal shape would not have any compression crease marks thereon. Stated another way, the compression crease marks 11' are disposed only on the small radius side of the curved mandrel since this is where the compression forces exist. In this regard, it has been found that short radius bends may be made without prestressing operation. However, a much more uniform product both in strength and in appearance, is obtained

by the prestressing operation. This obtains because the preselection of the points of stress provides less failure of interlaminar bonds which is occasioned by random stressing. The random stressing operation causes the weakest point to become weaker and since the break down of interlaminar bond is in many respects similar to a puncture type concept, random stressing provides many more rejects. The weakening of the weaker point will cause many more failures in a random stressed bend rather than in a prestressed bend.

It should be pointed out that the method and apparatus above described shifts the neutral axis from the center line of the tube to the outer side thereof during the bending operation. In most bending operations the center line of a tube is a neutral axis. This causes material below this axis to be in compression and material above this axis to be in tension. In fact the outer surface is actually stretched. Fibrous material cannot be stretched to any appreciable degree without tearing. In the instant method, most all of the forces in the bend are compressive forces due to shifting the neutral axis to the outer radius. The bending is, therefore, accomplished essentially through compression and it is particularly important that a minimum of disturbance be done to the fibrous inner structure of the tube wall to prevent weakening thereof. The prestressing operation together with the driving of the tube from the rear end thereof are particularly advantageous in this regard. It should also be noted that the speed of the drive mechanism is important. It must be fast enough so that tearing of the top surface of the tube does not occur. It is not exactly known why a slow drive will tear the upper surface. However, experiments show that speed of movement of the drive mechanism is essential to operation.

Although a specific method and embodiment have been shown and described, it is with full awareness that many modifications thereof are possible. The invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

What is claimed as the invention is:

1. As an article of manufacture, a short radius, fibre, pipe bend formed from a straight section of fibre pipe,

the material of the pipe having the ability to densify when wet, and having generally the shape of a segment of a toroid; said pipe bend being formed of a plurality of layers of cellulose fibre material which are held together by interlaminar fibre bonds, said fibre material being impregnated with a hardenable waterproofing material; said pipe bend further having a plurality of evenly spaced grooves formed in the surface thereof along the inner side of said bend, each of said grooves comprising a recess pressed into the surface of said pipe before bending thereof to thereby prestress and densify said fibres for a portion of the thickness of said pipe, each of said recesses having a depth of less than the thickness of said pipe, and a length of at least half of the periphery thereof and extending for a uniform distance from each side of the line forming the shortest arc of curvature of said bend, whereby the axis of bending of said pipe is beyond the midpoint thereof; said pipe bend further having a plurality of radially directed compression creases, each of said creases coinciding with one of said grooves, said pipe having a substantially smooth interior and exterior surface, said grooves and the resultant densified portions controlling the compressive stresses within the wall of the pipe on the inner side of the bend to minimize weakening of the interlaminar bonds and to maintain an unimpeded internal flow dimension within the pipe.

2. A short radius, fibre, pipe bend as set forth in claim 1, wherein the said grooves are formed on the internal and external surfaces of said pipe bend, said internal grooves being staggered relative to said external grooves.

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