

May 29, 1956

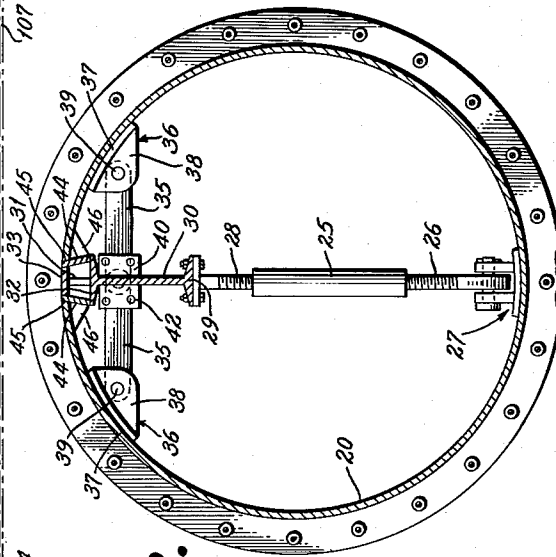
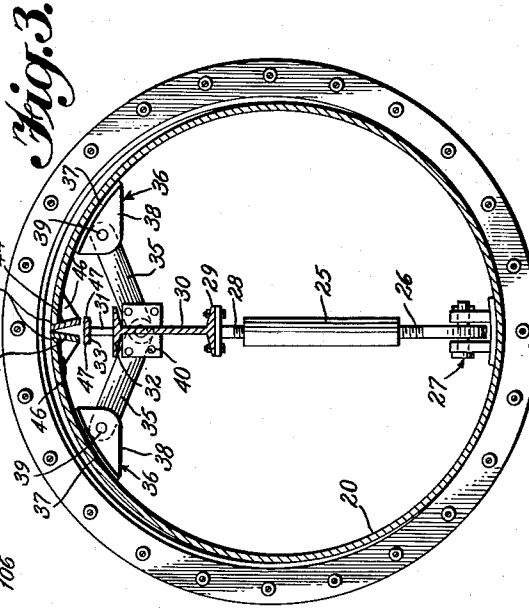
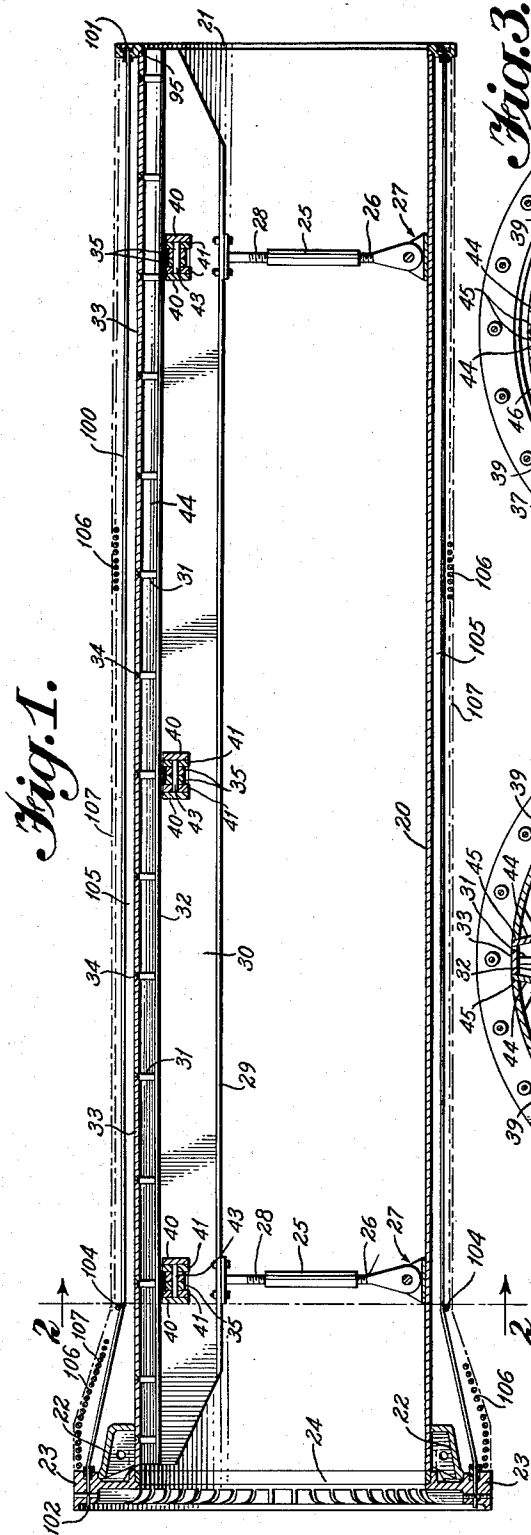
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2,747,249

METHOD AND APPARATUS FOR MAKING PRESTRESSED CONCRETE ARTICLES

Filed May 14, 1952

4 Sheets-Sheet 1



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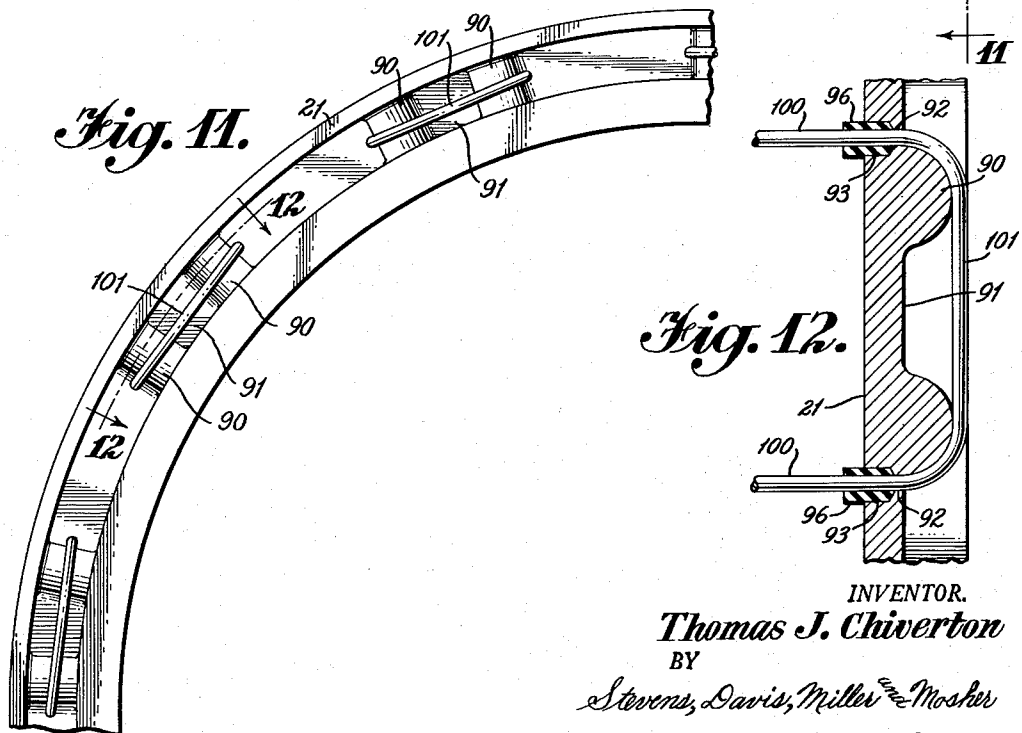
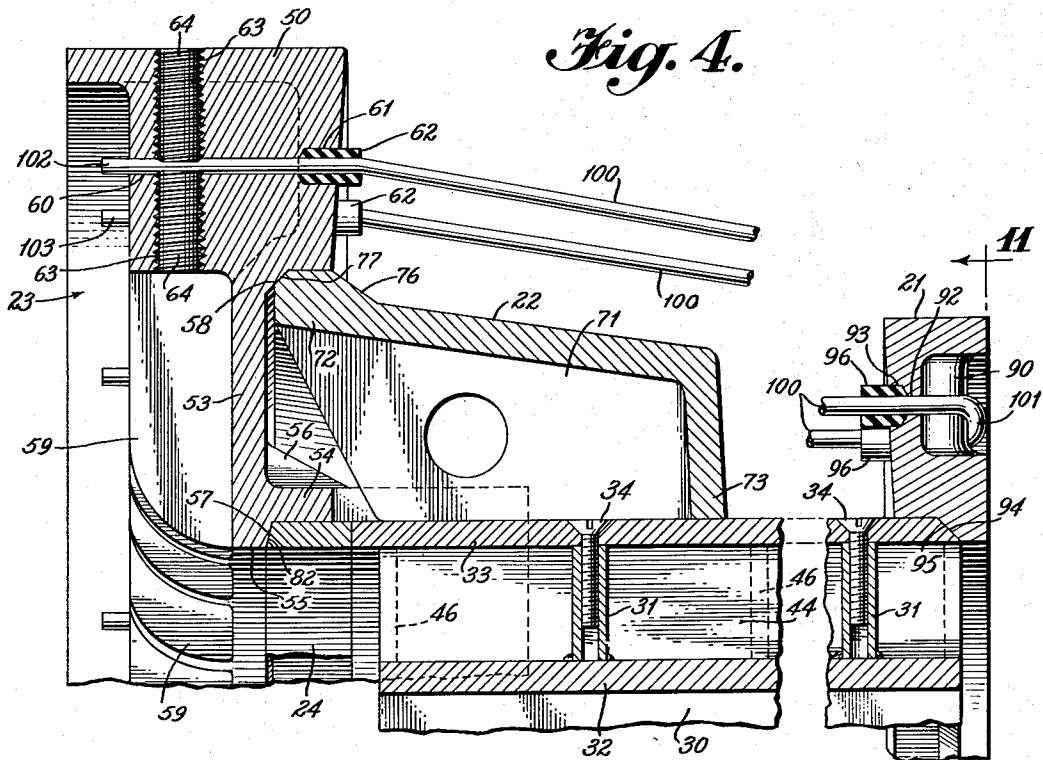
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METHOD AND APPARATUS FOR MAKING PRESTRESSED CONCRETE ARTICLES

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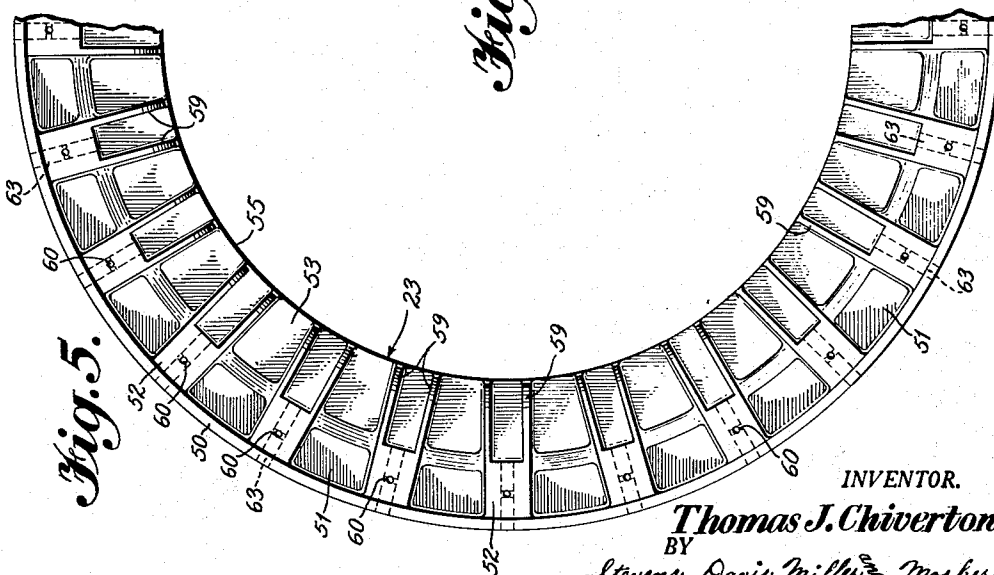
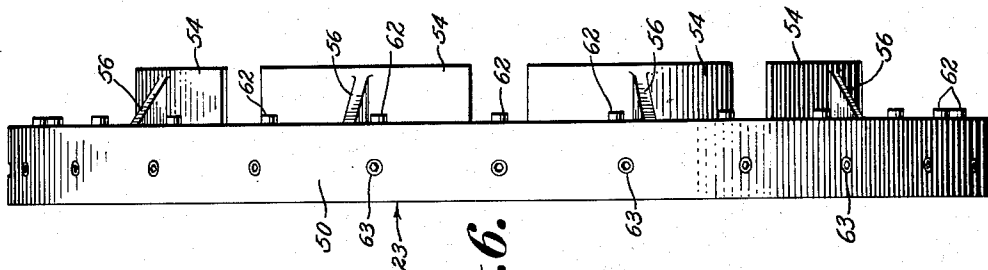
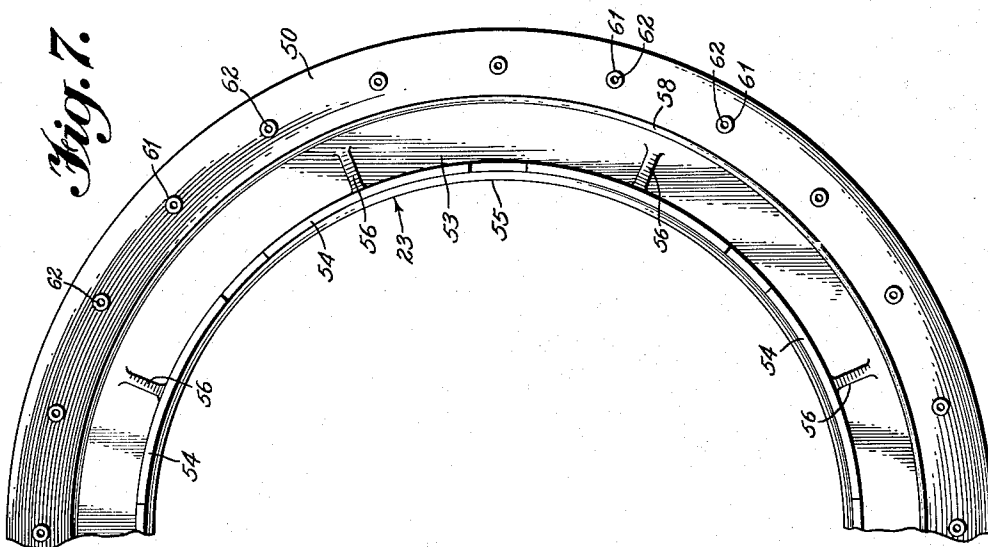
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METHOD AND APPARATUS FOR MAKING PRESTRESSED CONCRETE ARTICLES

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4 Sheets-Sheet 3



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Fig. 9.

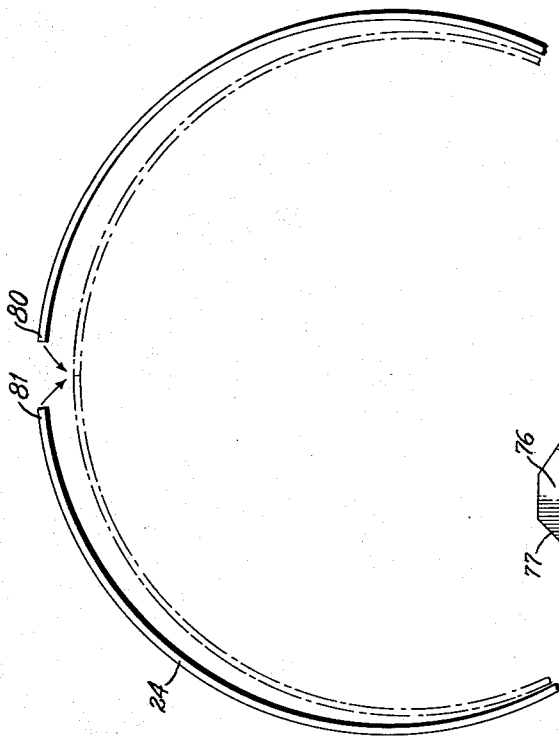


Fig. 10.

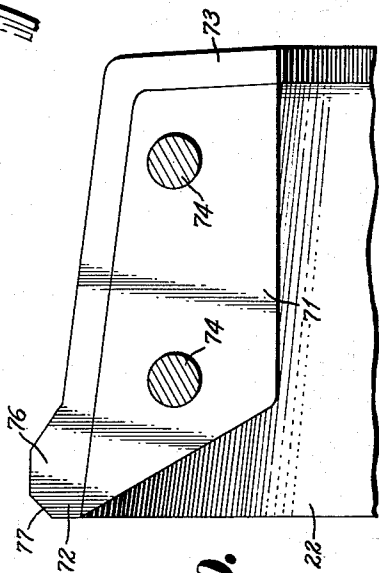
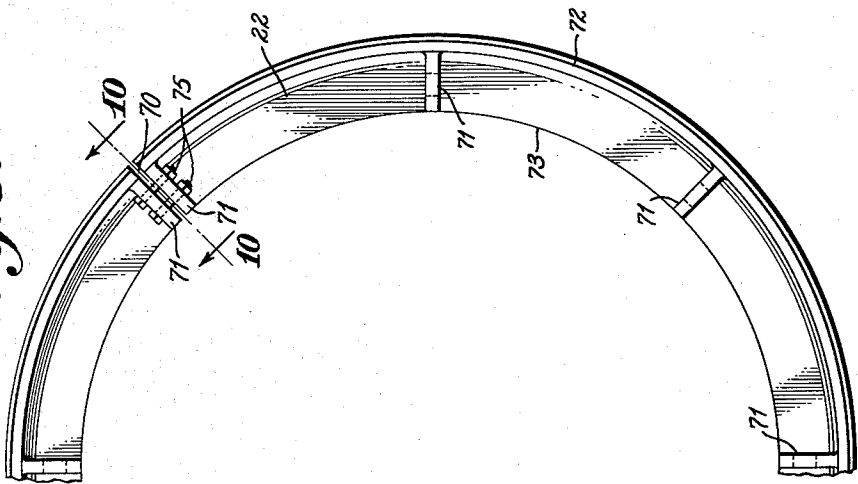


Fig. 8.



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METHOD AND APPARATUS FOR MAKING PRESTRESSED CONCRETE ARTICLES

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5 Claims. (Cl. 25—128)

This invention relates to a method and apparatus for making prestressed concrete articles and more particularly to a method and apparatus for making prestressed concrete pipes or other annular articles.

While the present invention has reference to all known types of concrete articles, for the purpose of convenience, the following discussion will be confined to concrete pipes. In the past concrete pipes have been made by molding a core of concrete into the form of a pipe. During the molding thereof a plurality of tensioned wires were embedded into the concrete core, each being anchored at the ends of the pipe after the concrete has set and hardened. Thereafter the pipe was wire wound in a known manner. Finally, a concrete covercoat was applied over the wire windings. This covercoat served no useful purpose structurally, but only protected the wire windings from extraneous attack or corrosion. Although useful as a protective covering, nevertheless, it subjected the pipe to several serious disadvantages as it could not be considered in the design for external or internal loads, it increased the dead weight of the pipe, and since it was not prestressed, it was subject to cracking due to temperature changes, plastic flow of the core as a result of the prestressing, shrinkage, and other stress changes. It is understood that the above plastic flow is manifested as an elastic deformation which takes place in both directions of the prestressing forces.

Accordingly, it is the prime object of this invention to provide a method for making a prestressed concrete pipe which will eliminate the above enumerated disadvantages and to provide a molding apparatus for doing same.

This is accomplished by the present invention by controlling the application of the prestressing forces to the pipe in such a way that the major part of the elastic deformations of the pipe are not permitted to occur until the covercoat has been placed and cured or hardened sufficiently to insure bond and strength to withstand the compressive forces which will be induced when the prestressing forces are applied to the pipe.

Other objects and advantages of the present invention will become readily apparent from the following description when taken in conjunction with the drawings in which:

Figure 1 is a view in vertical section taken along the longitudinal axis of the molding apparatus of the present invention;

Figure 2 is a view in vertical section of Figure 1 taken along line 2—2;

Figure 3 is a view similar to Figure 2 showing the operation of the molding cylinder;

Figure 4 is a view in section of the bell end ring;

Figure 5 is a view in top plan showing one face of the bell end ring;

Figure 6 is a view in elevation showing the side of the bell end ring;

Figure 7 is a view in bottom plan showing the other face of the bell end ring;

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Figure 8 is a view in plan showing the bell forming ring;

Figure 9 is a view in plan showing the split elongation ring;

Figure 10 is a view in section of Figure 8 taken along line 10—10;

Figure 11 is a view in plan showing the spigot forming end ring (see Figure 4, line 11—11); and

Figure 12 is a view in section of Figure 11 taken along line 12—12.

Referring now to the drawings in detail, Figure 1 shows the molding apparatus of the present invention completely assembled and ready for use. The molding apparatus consists of an elongated steel cylinder 20 which is split along a line running parallel to the long axis of the cylinder 20. At one end of the cylinder 20 is located a spigot forming end ring 21. At the other end of cylinder 20 is located a split bell forming ring 22, a bell end ring 23, and a split elongation ring 24. Within the cylinder 20 adjacent its ends are a pair of turnbuckles 25 each having one shaft 26 pivotally supported by a plate-pin assembly 27 fixed to the inner surface of cylinder 20. The other shafts 28 of turnbuckles 25 are fixed by rivets or other suitable means to the bottom flange 29 of an I beam 30 aligned with the split in cylinder 20. A plurality of tubes 31 are welded to the top flange 32 of beam 30 at spaced intervals. A narrow plate 33 is attached to tubes 31 by tapping tubes 31 and securing with bolts 34.

In order to stabilize the vertical movement of the beam 30 responsive to operation of turnbuckles 25 the following is provided. At each of three spaced points within cylinder 20, a pair of arms 35 are pivotally connected between a pair of brackets 36 fixed to the inner surface of cylinder 20 as by welding and beam 30. The bracket 36 consists of a plate 37 having two elements 38 extending from plate 37 in spaced relation. One end of an arm 35 fits between elements 38 and a pin 39 passes through arm 35 and elements 38 forming the pivotal connection. The connection between the other ends of arms 35 and beam 30 consists of a pair of outer plates 40 fixed to the sides of a rectangular hole in the web of beam 30 by suitable means such as welding. A pair of inner plates 41 are fixed to the outer plates 40 by bolts 42. The ends of arms 35 fit between inner plates 41 and are pivotally supported by a pin 43 which passes through arms 35 and inner plates 41. Bars 44 are fixed to each edge 45 of split cylinder 20 at an angle to each other by means of gussets 46 welded at spaced intervals to the inner surface of cylinder 20 and bars 44. The arrangement of bars 44 is such that upward movement of plate 33 as a result of the appropriate directional turning of turnbuckles 25 will cause the edges 47 (see Figure 3) of plate 33 to engage the bars 44 forcing them apart. The wedge-like interaction between plate 33 and bars 44 provides an effective means for expanding or contracting cylinder 20 and thereby changing its diameter. The foregoing is graphically illustrated in Figures 2 and 3. In the former figure the cylinder 20 is shown fully expanded and in the latter figure the cylinder is shown fully contracted.

The details of bell end ring 23 are shown in Figures 4—7, inclusive. The ring 23 has a main body portion 50 which is cut out at spaced intervals as indicated by 51. The solid parts of body 50 are indicated as 52. Depending from body 50 is a plate-like inner ring 53. A series of flanges 54 project normally from ring 53 adjacent its inner edge 55 at spaced intervals. The support of each flange 54 is strengthened by means of a web 56 connected between ring 53 and flange 54. Between the flange 54 and edge 55, the ring 53 is provided with a tapered machined surface 57. There is also a tapered machined

surface 58 between ring 53 and body portion 50. The support of ring 53 to body portion 50 is strengthened by webs 59 connected between the two parts. Each solid part 52 is provided with an axial bore 60 which is enlarged at 61 to receive a soft rubber nipple 62 having a central bore. Solid part 52 is also provided with a radial bore 63 which intersects bore 60 and is threaded to receive a pair of threaded pins 64. The bell end ring 23 is cast in the form shown and finished by machining tapered surfaces 57 and 58 and drilling bores 60 and 63 and threading bore 63.

The details of the bell forming ring 22 are shown in Figures 4, 8 and 10. The ring 22 is cast generally L-shaped in cross section as shown and is split as indicated at 70. In order to strengthen the ring 22, gussets 71 are arranged at spaced intervals between the extreme edges 72 and 73 of ring 22. The gussets 71 adjacent the split in the ring 22 are arranged with a pair of threaded holes 74. Thus the ring 22 can be tied together by bolting the gussets 71 together as indicated at 75. This arrangement enables the ring 22 to be readily adjusted to the proper size. Edge 72 is further provided with a raised portion 76 which has a machined tapered surface 77 complementary to surface 58 of bell end ring 23.

The details of the split elongation ring 24 are shown in Figures 4 and 9. The normal condition of ring 24 is such that its ends 80 and 81 are a determined distance apart as shown. Movement of the ends 80 and 81 together as indicated in Figure 9 results in the ring 24 contracting and becoming slightly tensioned. One edge 82 of ring 24 is beveled to match the machined tapered surface 57 of bell end ring 23.

The details of the spigot forming end ring 21 are shown in Figures 4, 11 and 12. The ring 21 is cast in the form shown in the drawings. The ring 21 is cut out to present at spaced intervals pairs of knob-like projections 90 having a hollow area 91 between them. The ring 21 is provided with bores 92 having enlarged portions 93. The bores 92 are arranged in pairs so that they pass through ring 21 just outside the knob-like projections 90. The ring 21 is also provided with a machined tapered surface 94 to abut against the edge of cylinder 20 and the edge of plate 33 each of which present a matching tapered surface 95. Soft rubber nipples 96 having a central bore are fixed in enlarged portions 93.

In order to make a bell end concrete pipe the following procedure is recommended. The molding apparatus is assembled by placing the spigot forming end ring 21 on one end of contracted cylinder 20 and the bell forming ring 22 and bell end ring 23 on the other end of cylinder 20. The plate 33 is then set in place between bars 44 and turnbuckles 25 are operated to expand cylinder 20 to the condition shown in Figure 2. This results in the machined surface 94 of ring 21 bearing against machined surfaces 95 of the cylinder 20 and plate 33 at the spigot end. At the bell end, the end of the cylinder bears against machined surface 57 of ring 23 and the bell forming ring 22 is expanded with the cylinder 20 and restrained to the proper diameter by bolts 75. Also, the raised portion 76 of ring 22 fits beneath body portion 50 of ring 23 and machined surface 77 of ring 22 bears against and matches machined surface 58 of ring 23.

Thereafter, longitudinal prestressing wires 100, looped as indicated at 101, are threaded through each pair of bores 92. The wire 100 passing through each bore 92 also passes through the nipple 96 located with each bore 92. The looped portion 101 passes over the pair of knob-like projections 90 associated with the pair of bores 92. The ends 102 and 103 of wire 100 are then passed through nipples 62 and bores 60 in ring 23 corresponding with the bores 92 of ring 21. The ends 102 and 103 are anchored in bores 60 by means of pins 64 in bores 63 bearing toward each other and clamping the wire end between them. After all the longitudinal wires 100 have been placed and anchored, as above set

forth, they are prestressed to the required tension by means of a jack means (not shown) which pulls the bell end rings 22 and 23 axially away from cylinder 20. When the prescribed elongation of wires 100 has been obtained, the elongation ring 24 is sprung in place between the end of cylinder 20 and machined surface 57 of ring 23. It will be noted that edge 82 of ring 24 is beveled to match surface 57 and when ring 24 is in position, surfaces 82 and 57 bear against each other. The jack means (not shown) is then released from the bell end transferring the full load of wires 100 to the cylinder 20. A wire bellyband 104 restrains wires 100 conforming them to the shape of the bell end.

A concrete core 105 is built up in the mold cavity of the assembled mold by any known means and cured by allowing it to set and harden. Thereafter, tensioned circumferential wire 106 is wound on the hardened core throughout its length by any known means. Finally, a covercoat 107 of concrete is applied over the wire 106 and cured by allowing it to set and harden.

It will be noted that at this point the tensioned longitudinal wires 100 do not exert any forces on the core 105 and that the reaction of this pretensioning is carried by the cylinder 20. Hence, none of the longitudinal stresses are carried by the core 105. The compressive stresses produced by wire 106 are partly resisted by core 105 but to a larger extent by cylinder 20. The resistance of cylinder 20 to these compressive stresses is sufficient to permit only a minor part of the total elastic deformation to take place.

After the covercoating operation is complete, the stresses carried on the molding apparatus in both directions, namely axial and radial, must be transferred simultaneously and without shock to the core 105 and covercoat 107. This transfer of longitudinal and circumferential prestressing forces can be accomplished by manipulating turnbuckles 25 simultaneously. As the turnbuckles 25 slowly withdraw plate 33 from between bars 44, the stresses carried by the molding apparatus, and more particularly cylinder 20, are uniformly transferred to the concrete pipe. As soon as there is the slightest reduction in diameter of cylinder 20, the bell forming ring 22 deforms inwardly at the same rate due to split 70. The surface 57 of ring 23 and surface 94 of ring 21 are tapered as previously mentioned so that there is no restraint as elastic deformation takes place due to the circumferential prestressing. The nipples 62 and 96 around the longitudinal wires 100 also permit radial movement of wires 100. Thus the core 105 and covercoat 107 are completely unrestrained with respect to the circumferential prestressing and can uniformly deform elastically in this direction without setting up local stresses due to non-uniform application of the circumferential forces involved.

At the slightest inward movement of the cylinder 20, the longitudinal forces produced by wires 100 act simultaneously at both ends of the pipe on the tapered surfaces 57 and 58 of ring 23, tapered surface 82 of ring 24, tapered surface 77 of ring 22, tapered surface 95 of cylinder 20 and plate 33, and tapered surface 94 of ring 21. As the diameter of cylinder 20 decreases, the bell end ring 23 and spigot forming end ring 21 move toward each other sliding on the tapered surfaces, thus permitting the longitudinal stresses to be transferred to the core 105 and covercoat 107 uniformly and simultaneously with the circumferential stresses. The forces are transferred gradually and without shock.

As the core 105 has previously assumed a minor part of the compression forces of the circumferential stresses because of the elastic deformation of the cylinder 20, it is obvious that in the initial condition the core 105 carries a slightly higher unit stress than the covercoat 107. This condition is not serious, however, and tends to equalize in time due to plastic flow and shrinkage of the pipe. The final condition of the pipe closely approximates a monolithic cross section uniformly prestressed.

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To remove the molding apparatus the longitudinal wires 100 are unclamped and the bell end assembly consisting of rings 22, 23 and 24 is removed. The wires 100 are then cut at the spigot end at looped portions 101 and ring 21 is removed. Cylinder 20 is then withdrawn from the pipe. The wires 100 are then cut flush with the ends of the pipe and the recesses formed by nipples 62 and 96 are sealed by any suitable means with concrete, mortar, or the like.

If desired, the wedging action of plate 33 and bars 44 can be enhanced by filling the space between plate 33 and top flange 32 of beam 30 with concrete and shaping to a wedge configuration which is trapezoidal in cross section.

While the present invention has been shown and described in conjunction with a single embodiment, nevertheless, various modifications and changes obvious to one skilled in the art are within the spirit, scope and contemplation of the present invention.

What is claimed is:

1. A method of making prestressed concrete articles that comprises establishing a first tensioned wire between two spaced points on a molding apparatus defining a mold cavity so that said wire extends through at least a portion of said mold cavity, anchoring the ends of the wire in the molding apparatus, molding concrete in a portion of said mold cavity to cover said wire, establishing another tensioned wire in the free portion of said mold cavity which extends through the mold cavity in a direction different from said first wire, resisting the forces of said other wire by the molding apparatus, molding concrete in the remaining portion of the mold cavity, and transferring the forces of said wires to the molded concrete uniformly and simultaneously.

2. A method of making prestressed concrete annular articles that comprises establishing an annular mold cavity, anchoring a tensioned wire between two spaced points to extend through said cavity axially thereof, molding concrete in a portion of said cavity to cover said wire, establishing another tensioned wire circumferentially around the molded concrete, maintaining the molded concrete substantially free of the forces of said other wire, molding concrete in the remaining portion of said cavity, and transferring the forces of said wires to the molded concrete uniformly and simultaneously after it has cured.

3. A method of making a prestressed concrete pipe or the like that comprises establishing a tensioned wire between two spaced points on a molding apparatus defining

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a mold cavity in the shape of a pipe so that said wire extends axially through at least a portion of said cavity, anchoring the ends of said wire in said apparatus, molding a concrete core in said cavity covering the axially extending wire, winding a tensioned wire circumferentially around said core after it has cured, resisting the circumferential forces of the windings of wire by the molding apparatus, covercoating said core and circumferentially wound wire with concrete, and transferring the axial and circumferential forces of said wires to the core and covercoating uniformly and simultaneously after the covercoating has cured.

4. Apparatus for molding prestressed concrete pipes or the like that comprises a cylinder split longitudinally and having on one end a tapered surface, a first ring mounted on the end of said cylinder having a tapered surface that matches and bears against the tapered surface on the end of said cylinder, a second ring mounted on and bearing against the other end of said cylinder and means to reduce the diameter of said cylinder by moving the edges of said split towards each other to permit said rings to move toward each other.

5. Apparatus for molding prestressed concrete pipes or the like that comprises a cylinder split longitudinally and having on one end a tapered surface, a first ring mounted on one end of said cylinder having a tapered surface that matches and bears against the tapered surface on the end of said cylinder, a split ring bearing against the other end of said cylinder on one side and presenting a tapered surface on its other side, a second ring having on one edge a tapered surface that matches and bears against the tapered surface of said split ring, a pair of bars each having one edge connected to one edge of the longitudinal split and projecting toward the interior of the cylinder angularly offset from each other, a plate received between said bars, and means to remove said plate from between said bars to reduce the diameter of said cylinder to permit said rings to be moved toward each other.

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