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APPARATUS FOR MAKING LONGITUDINALLY PRESTRESSED CONCRETE PIPES

Filed Oct. 23, 1961

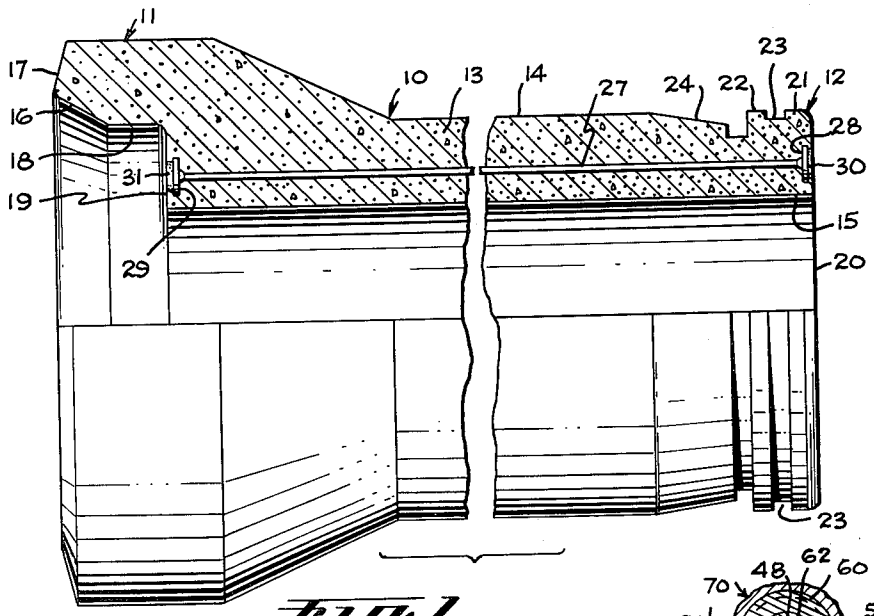


Fig. 1

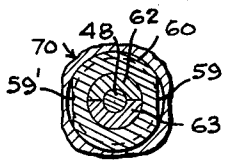


Fig. 4

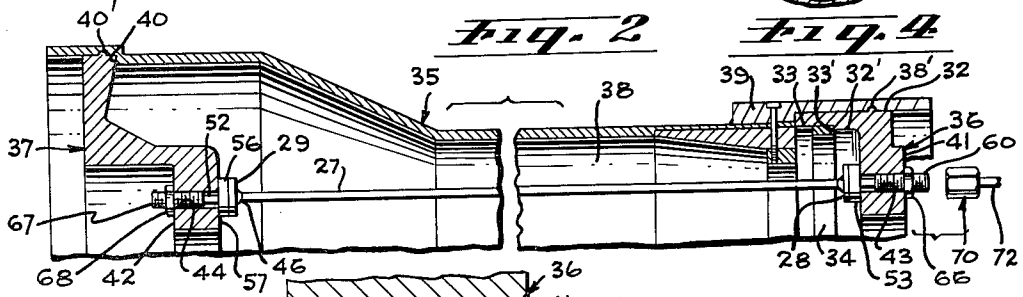


Fig. 2

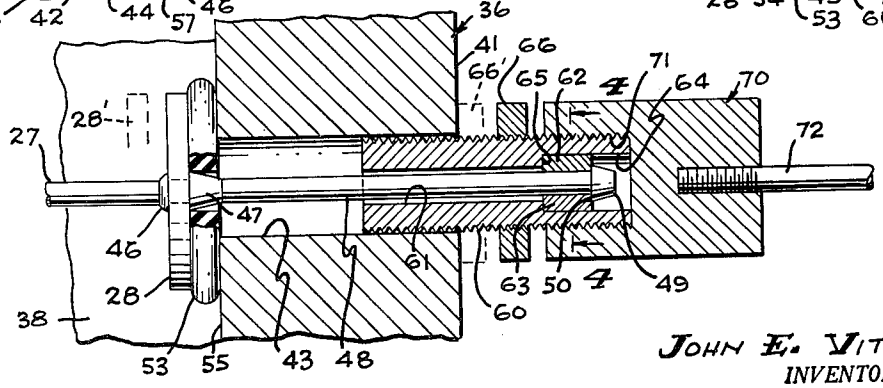


Fig. 3

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APPARATUS FOR MAKING LONGITUDINALLY PRESTRESSED CONCRETE PIPES

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The invention relates to molded prestressed concrete pipes wherein the prestressing is in a longitudinal direction or lengthwise with respect to the pipe. The invention further involves the method of longitudinally prestressing the pipe and the provision of a mold to make exercise of the method possible in order to produce a longitudinally prestressed pipe.

In the fabrication of concrete pipes wherein the sizes may perhaps be larger than usual or wherein pressures present in liquids or gases in the pipes after being laid tend to be higher than can be safely accommodated by ordinary molded concrete pipes, prestressing the pipe has been used to improve its strength.

The prestressing herein referred to consists of making use of steel reinforcing material to which the prestressing is applied. Although circumferential prestressing has become relatively well known and of increasing importance, longitudinal prestressing is also a factor of considerable consequence. To longitudinally prestress a pipe of this kind, steel rods have been laid lengthwise with respect to the pipe spaced circumferentially about the pipe mold and then prestressed in the mold before and during and after the placement of the concrete in the mold. Certain problems have accompanied the employment of prestressed longitudinal rod members partly because of the fact that the rod members have to protrude beyond the mold in which they are held until the pipe has set and partly because the manner of handling longitudinal rods heretofore known and available has required use of rods of relatively large diameter constructed of steel capable of only a limited degree of prestressing. The technique heretofore employed has further required relatively high priced rod assemblies used in such fashion that the application of the rods to the molds, the prestressing method, and the subsequent removal of the rods from the mold has been prohibitively time consuming thereby adding unnecessarily to the cost of pipe of this kind.

An object of the invention is to provide a new and improved mold for the molding of longitudinally prestressed concrete pipes which is simple to assemble and disassemble, which is relatively quick and efficient to use, and which is productive of a materially improved product.

Still further among the objects of the invention is to provide a new and improved longitudinally prestressed concrete pipe mold which makes possible the employment of longitudinal steel elements relatively smaller in diameter and at the same time capable of supporting higher tensile stresses, the rods additionally being capable of having incorporated at the ends thereof a means for retaining washers bearing upon the ends of the pipe which is simple to apply, which affords the degree of safety needed under considerable tension, and which contributes materially to the effectiveness of the completed pipe.

Still further among the objects of the invention is to provide new and improved longitudinal prestressing rods for molded concrete pipe which are simple, inexpensive, and effective and capable of being installed with the requisite degree of dependability and safety much more quickly than those heretofore available.

With these and other objects in view, the invention

consists in the construction, arrangement and combination of the various parts of the device whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims, and illustrated in the accompanying drawings.

FIGURE 1 is a side view of a completed longitudinally prestressed concrete pipe foreshortened and showing one side in section.

FIGURE 2 is a fragmentary longitudinal sectional view of the mold for making the concrete pipe of FIGURE 1.

FIGURE 3 is a fragmentary longitudinal sectional view of the right-hand end of the mold shown in FIGURE 2.

FIGURE 4 is a cross-sectional view taken on the line 4—4 of FIGURE 3.

In an embodiment of the invention chosen for the purpose of illustration, there is shown a molded concrete pipe or pipe core **10** of the usual kind wherein the material is coarse aggregate, sand, and cement. In this example, the pipe is constructed with a bell end **11** and a spigot end **12**. The pipe or core consists of a wall **13** having an outer surface **14** and an inner surface **15**. The distance between inner and outer surfaces comprises the wall thickness which depending upon the diameter of the pipe may vary from one to two inches or even possibly some thicknesses greater or smaller than this. At the bell end is a flared surface **16** communicating between an exterior face **17** and a cylindrical recess **18** at the bottom of which is a shoulder **19**. At the spigot end **12** is an end face **20**, there being also provided a flange consisting of an end band **21** and an inner band **22** separated by an annular recess **23**. A section **24** of reduced diameter lies adjacent the inner band **22** and connects with the outer surface **14** of the wall **13**.

A series of longitudinal prestress rods **27** lie imbedded in the wall **13** and extend between the end face **20** at the spigot end and the shoulder **19** at the bell end. Washers **28** and **29** at the respective ends anchored to the rods lie partially submerged or imbedded beneath the end face **20** in one instance and the shoulder **19** in the other instance, there being employed a sealing plug **30** adjacent the washer **28** and a similar sealing plug **31** adjacent the washer **29**.

The rods **27** are placed under pretension and held in prestressed condition during the pouring and setting of the concrete comprising the pipe wall. After the concrete has been set and cured, the exterior application of prestressing is removed and the rods remain prestressed tending to pull the washers at the respective ends inwardly and thereby set up a prestressed condition in a longitudinal direction between opposite ends of the pipe. The manner in which the rods are positioned prior to molding and thereafter released forms an important part of the present disclosure and invention in company with the specific design of a mold to achieve the result and technique of handling the mold.

In FIGURES 2, 3 and 4, there is disclosed a mold in which the concrete is placed and cast and permitted to set. The mold consists of a two-part longitudinally split shell **35** at the spigot end of which is placed a spigot end ring **36** and at the bell end of which is placed a bell end ring **37**. The end rings and shell thus assembled form a mold cavity **38**. The spigot end ring **36** may be a single member consisting of an outer annular portion **32**, an intermediate portion **32'**, and an inner portion **33** of diameter greater than the portion **33**, thereby forming a shoulder **33'**. A snap ring **34** is compressed within the portion **33** and bears against the shoulder **33'**. The parts just described form the bands **21** and **22** and recess **23** previously made reference to. A groove and bead connection **38'** together with an annular abutment **39** of the shell serves as a means of positioning the spigot end ring **36** properly with respect to

the shell. An abutment **40**, annular in shape, at the bell end of the shell with the help of a groove and bead connection **40'** serves as a means of positioning the bell end ring **37**. The spigot end ring **36** provides an outwardly facing spigot end boss presenting a shoulder **41** and the bell end ring provides a corresponding outwardly facing bell end boss presenting a shoulder **42**. Use of bosses for the rings of smaller size is to assure that bolt holes **43** will all be of the same length for the different sizes of pipe molds. Extending around the circumference of the spigot end ring **36** is a series of smooth walled holes **43**, one of which is shown in FIGURES 3 and 4. Similarly, there are provided smooth walled holes **44** in the bell end ring **37** one of which is shown in FIGURE 4. The number of such holes is not crititcal, there being provided as many as six, eight, ten or more, usually equally spaced circumferentially around the rings depending upon the amount of prestressing to be given to the pipe. The holes **43** and **44** are, of course, in longitudinal alignment so as to accommodate the rod **27** in each instance which extends between them.

The manner of constructing and mounting the rod **27** which may better be described as a prestressed rod assembly is particularly significant in the invention herein disclosed. It will be understood that the rod is preferably of high tensile steel and in practice is usually about one fourth inch in diameter. A good type of material is ASTM A227. Opposite ends of the rod assembly are substantially identical; hence, a detailed explanation of the spigot end of the rod assembly which is shown in detail in FIGURE 3 will suffice for both. As indicated, the washer **28** is fixed in position upon the rod **27** by employment of a fillet **46** of the rod material itself on one side of the washer and a second fillet **47**, also of the rod material itself formed on the opposite side. These fillets are pressed outwardly at the proper location by some appropriate conventional means after the washer has been applied over the rod and held in place so that upon completion the washer will be anchored in a selected location upon the rod.

Extending beyond the washer **28** is an end portion **48** of the rod which terminates in a button **49** provided on its inner side with a relatively flat annular shoulder **50**. The end portion **48** is long enough so that it extends entirely through the spigot end ring **36** and for a substantial distance outwardly beyond the spigot end shoulder **41**. As has been previously described, the opposite end of the rod **27** is similarly constructed with respect to the mounting and location of the washer **29** beyond which extends an end portion **52** provided similarly with an end button (not shown).

When the rod in each instance is to be mounted in the mold, the end portion **48** will be positioned so as to extend through the smooth walled hole **43** and the end portion **52** will extend through the smooth walled hole **44**. The washers **28** and **29** are spaced a distance apart such that they lie slightly inwardly with respect to the interior faces of the respective end rings. The distance between the washers will, of course, be something less than the distance between the inside faces of the end rings. In order to seal the interior of the mold and because the diameter of the end portion **48**, for example, is so much smaller than the smooth walled hole **43**, a radially split packing ring **53** is pressed between the washer **28** and an inner face **55** of the spigot end ring **36**. A similar radially split packing ring **56** is used adjacent the inner face **57** of the bell end ring for the same purpose.

At the spigot end there is provided an exteriorly threaded bolt **60** which slides freely within the smooth walled hole **43**. Flats **59** and **59'** (FIG. 4) are provided at diametrically opposite locations on the bolt to form wrench holes. A bore **61** extends centrally through the bolt and is slightly larger in diameter than the diameter of the end button **49**, thereby to permit the bolt to be

slid over the end button to the position shown in FIGURES 2 and 3. In order to anchor the button within the exteriorly threaded bolt, there is provided a split collar comprising halves **62** and **63**, as shown in FIGURE 4. The split collar slides freely within an enlargement **64** of the bore **60** which provides a shoulder **65** at the bottom of the enlargement upon which the split collar rests. Assembled as shown with the split collar and the end button contained within the enlargement, the threaded bolt will be firmly attached to the end portion **48** of the prestressed rod **27** at the spigot end. A nut **66** threadedly engages the exterior of the threaded bolt and can be threadedly rotated along the bolt from the solid line position of FIGURE 3 to the dotted line position of engagement with the spigot end shoulder **41**, as shown at **66'**. Similarly at the opposite or bell end there is provided an exteriorly threaded bolt **67** which slides freely within the smooth walled hole **44** and has a nut **68** to hold it in position upon the bell end shoulder **43**. A similar split collar (not shown) anchors the end portion **52** of the rod within the bolt.

When the parts are assembled in the positions shown in FIGURES 2 and 3, the end portions are positioned within the appropriate smooth walled holes and the nuts **66** and **68** initially adjusted by finger pressure so as to properly space the washers relative to the end rings. It may be preferable to screw down the nut **68** to a slightly greater degree in order to compress the packing ring **56** firmly into position. All of the rods **27**, however many there may be in a particular instance, will be assembled in the same manner. It is quite likely that as initially assembled, the washer **28** may assume the broken line position **28'** of FIGURE 3. After being thus assembled, a puller attachment **70** having an interiorly threaded socket **71** is threadedly engaged over the exterior of the threaded bolt **60** as shown in FIGURE 3. A puller arm **72** attached to the puller attachment **70** is then subjected to tensioning and this in turn stretches or prestresses the rod **27** inasmuch as at its opposite end of the rod is anchored firmly in position by the presence of the nut **68** applied against the bell end shoulder **42**. The tensioning thus applied will be sufficient to cause a slight elongation in the rod **27** sufficient to move the washer **28** from the broken line position **28'** to the solid line position **28** shown in FIGURE 3 where it will press sufficiently against the packing ring **53** to seal closed the smooth walled hole **43**. After the full amount of stress has been applied by employment of the puller arm, the nut **66** will be threaded finger tight through the position **66'** against the spigot end shoulder **41** thereby to preserve the prestress tension in the rod **27**. After this has taken place the puller attachment **70** may be removed from the exteriorly threaded bolt and the mold is then in assembled condition with all rods **27** effectively prestressed.

The mold cavity **38** will then be filled with moist concrete in the usual fashion having the concrete packed and vibrated properly so as to make it as dense as possible within the shell and to compact it firmly around the rods **27** so as to completely encase the rods in concrete. After the mold has thus been filled, the concrete is permitted to set up and will then preferably be cured while still in the mold. When final curing has been effected the mold will be removed.

Prior to removal of the mold, the nuts **66** and **68** will be unscrewed from all of the bolts **60** and **67**. After this has been accomplished, the bolts will be capable of sliding freely through the smooth walled holes in each instance and the end rings can be withdrawn. The shell will also be removed in a conventional fashion from the exterior of the pipe or core and the product will be complete except for the fact that end portions **48** and **52** need to be removed. Removal is accomplished by cutting off the end portions with an abrasive wheel or other appropriate cutting device so that the cut is made as far as

possible below the end face **20** at the spigot end and the shoulder **19** at the bell end. The depth of cut below the surface is not, however, critical. In fact, because of use of relatively thin rods **27** which need be of no heavier section at the end portions this cut-off operation is substantially a simple procedure and one which can be quickly and easily accomplished. After the end portions have been cut off as described the sealing plugs **30** and **31** are positioned so that their outer surfaces are flush with corresponding portions of the pipe and the longitudinally prestressed pipe is then in the condition shown in FIGURE 1. It will be understood, of course, that there is considerable tension in each rod **27** which tends to draw inwardly upon the respective washers **28** and **29**. These washers, however, effect compression in the concrete itself aided by the adhesion of the concrete throughout the length of each of the rods **27**. The prestress, extending as it does throughout the entire length of each section of pipe, adds the necessary strength to the pipe which is expected of the longitudinally prestressed condition.

While the invention has herein been shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures and methods.

Having described the invention, what is claimed as new in support of Letters Patent is:

1. A longitudinally prestressed concrete pipe mold assembly comprising a cylindrical mold shell, end rings at the ends of the shell having each an outwardly facing end face shoulder, a plurality of longitudinal prestress rods in circumferentially spaced relationship about the interior of said shell, each rod comprising an end button on at least one end spaced so as to be located outside the respective end ring and a washer at each end spaced inwardly from the respective end button and anchored in fixed position on the rod, said washers being spaced inwardly of the respective end rings, each end ring having a hole therethrough for each rod, a unitary bolt loosely received in the hole in the respective end ring, means securing each end of the rod to the respective end ring against tension acting inwardly relative to the end ring, at least one of said means comprising a bolt in the hole in the respective end ring having a bore therethrough greater in diameter than the end button, said bore having an enlargement at one end forming a shoulder and a split collar surrounding said rod and forming an anchor in said enlargement between the shoulder and the button, and a nut on the bolt in snug engagement with the respective end ring after the rod has been placed under longitudinal tension whereby to preserve the tension in the respective rod until concrete has been placed and allowed to set in the mold.

2. A longitudinally prestressed concrete pipe mold assembly comprising a cylindrical mold shell, end rings at the ends of the shell having each an outwardly facing end face, a plurality of longitudinal prestress rods in circumferentially spaced relationship about the interior of said shell, each rod comprising an end button at each end and a washer at each end spaced inwardly from the respective end button and anchored in fixed position on the rod, said washers being spaced inwardly of the respective end rings, each end ring having a hole therethrough for each rod, a unitary bolt loosely received in each hole and having a bore therethrough greater in diameter than the end button, said bore having an enlargement at one end forming a shoulder and a split collar surrounding said rod and forming an anchor in said enlargement between the shoulder and the end button, and a nut on the bolt at each end of rod in snug engagement with the respective end ring after the rod has been placed under longitudinal tension whereby to preserve the tension in the respective rod until concrete has been placed and allowed to set in the mold.

3. A longitudinally prestressed concrete pipe mold assembly comprising a cylindrical mold shell having a bell end and a spigot end, a bell end ring at the bell end having an outwardly facing bell end shoulder and a spigot end ring having an outwardly facing spigot end shoulder, a plurality of longitudinal prestress rods in circumferentially spaced relationship about the interior of said shell, each rod comprising an end button at each end having an inwardly facing shoulder and a washer at each end spaced inwardly from the respective end button and anchored in fixed position by the material of the rod, said washers being spaced inwardly of the respective end rings, each end ring having a smooth walled hole therethrough for each rod, an exteriorly threaded unitary bolt loosely received in each hole end having a bore therethrough greater in diameter than the end button, said bore having an enlargement at one end forming a shoulder and a split collar surrounding said rod and forming an anchor in said enlargement between the shoulder and the end button, a tension puller releasably attachable to one of said bolts and a nut on the bolt at each end of the rod in snug engagement wtih the bolt and the respective end ring after the rod has been placed under longitudinal tension whereby to preserve the tension in the respective rod until concrete has been placed and allowed to set in the mold.

4. A longitudinally prestressed concrete pipe mold assembly comprising a cylindrical mold shell, end rings at the ends of the shell, a plurality of longitudinal prestress rods in circumferentially spaced relationship about the interior of said shell, each rod comprising an end button on at least one end spaced so as to be located outside the respective end ring and a projection at each end spaced inwardly from the respective end button and anchored in fixed position on the rod, said projection being spaced inwardly of the respective end ring, each end ring having a hole therethrough for each rod, a unitary bolt loosely received in the hole in the respective end ring, means securing each end of the rod to the respective end ring against tension acting inwardly relative to the end ring, at least one of said means comprising a tubular element in the hole in the respective end ring having a bore therethrough greater in diameter than the end button, said bore having a shoulder therein and a blocking member forming an anchor in said bore between the shoulder and the button, an adjusting means on the tubular element in snug engagement with the respective end ring after the rod has been placed under longitudinal tension whereby to preserve the tension in the respective rod until concrete has been placed and allowed to set in the mold.

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