March 14, 1950 F. G. CARRINGTON 2,500,799

STIFFENER FOR CENTRIFUGAL MOLDS

Original Filed July 8, 1943 2 Sheets-Sheet 1

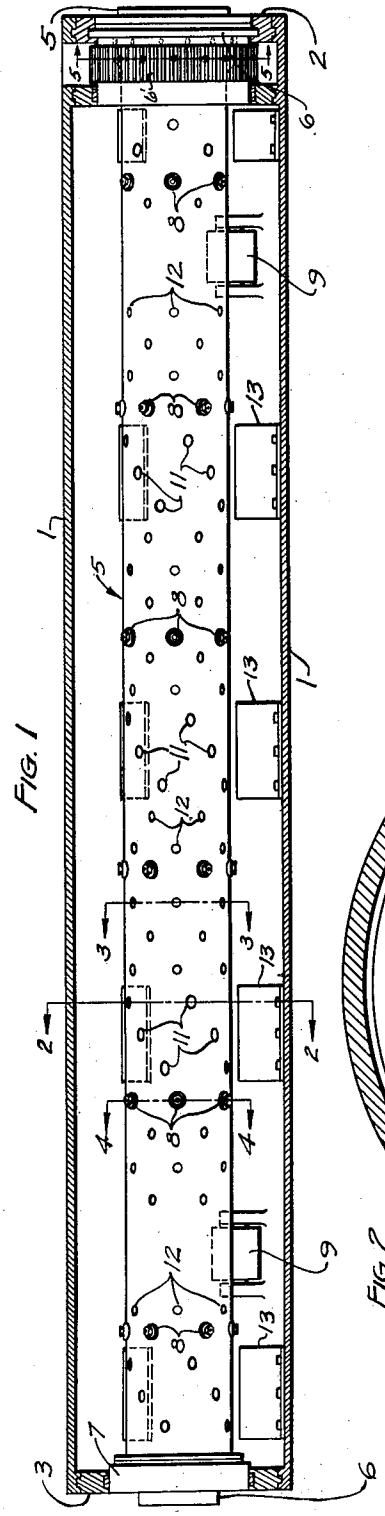


FIG. 1

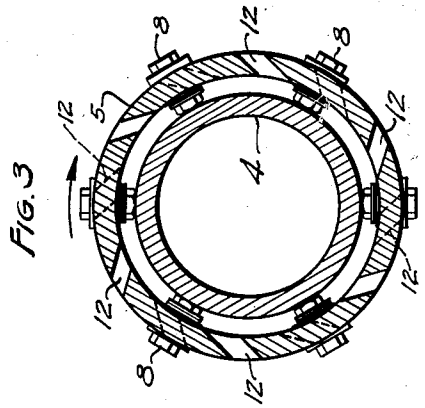


FIG. 3

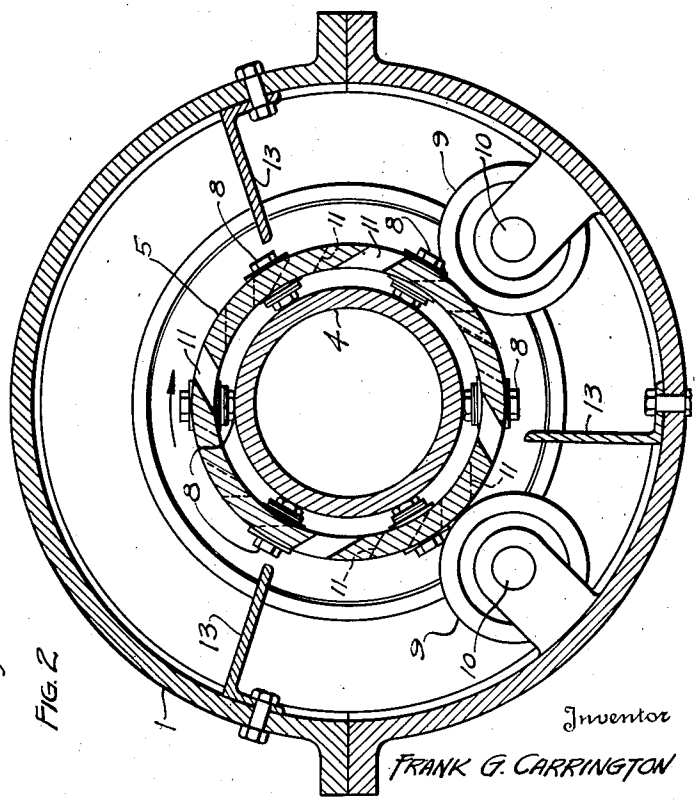


FIG. 2

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FIG. 5

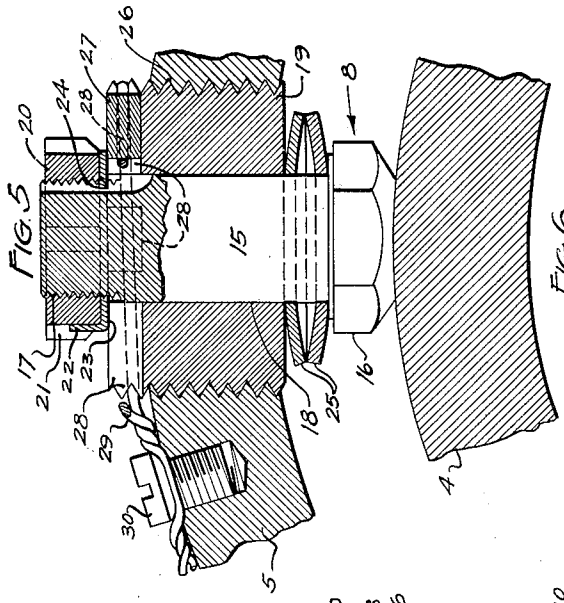


FIG. 6

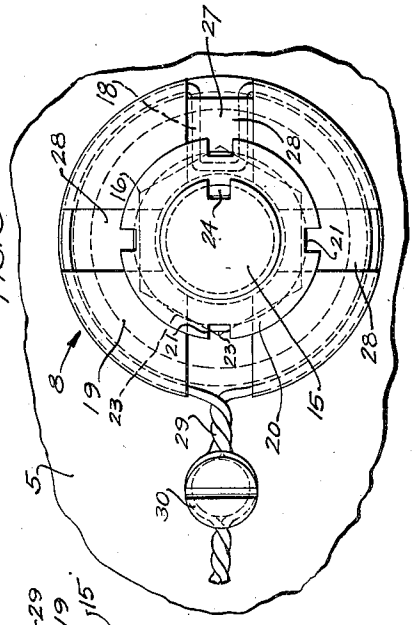
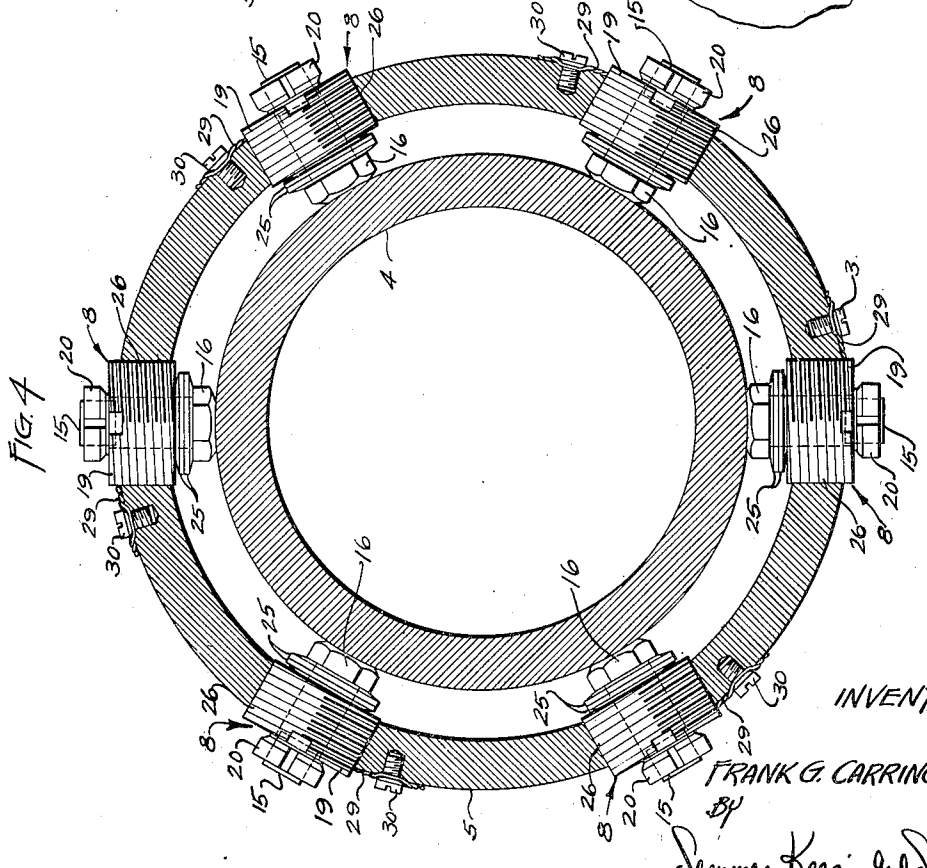


FIG. 4



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STIFFENER FOR CENTRIFUGAL MOLDS

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Original application July 8, 1943, Serial No. 493,908. Divided and this application December 6, 1946, Serial No. 714,391

1 Claim. (Cl. 22—65)

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The present invention relates to apparatus for the centrifugal casting of cylindrical bodies, such as pipe, and is a division of my copending application Serial No. 493,908, filed July 8, 1943, now Patent Number 2,412,601, issued December 17, 1946. More particularly, the invention has reference to apparatus for inhibiting warpage of a centrifugal pipe casting mold.

Centrifugal pipe casting machines, one type of which is the De Lavaud, usually employ a non-rotating water box in which is rotatably mounted a cylindrical metallic mold, opposite ends of which are journalled in the water box. These molds are usually made from steel in lengths of 18 feet and in diameters to cast 3 inch and larger pipe. Considering these molds as beams supported adjacent their ends, it will be seen that they will be subjected, especially in the smaller sizes, to bending stresses and, in the larger sizes, to stresses which tend to flatten or distort them out of round. Both of these effects are accentuated and may become undesirably great when the molds are heated to temperatures reached in casting.

If the thickness of the mold wall is increased to overcome the above bending and flattening tendencies, an increase in expansion stresses will result due to a lessening of the heat transfer properties of the thickened mold, and will usually result in internal distortion and cracks in the mold wall. As an example, it has been found that a mold having a one-inch wall thickness will cast approximately 4,000 pipe, while if the wall thickness is increased to one and one-half inches, the useful life of the mold will be reduced to approximately 1,000 pipe.

From the above, it will be seen that while a thin wall mold has a distinct advantage of a long, useful life, in order to obtain its maximum casting efficiency, its beam strength must be increased or stiffened to counteract its warping tendencies. Attempts have been made to increase the stiffness of a centrifugal mold without increasing its wall thickness by the provision of a reenforcing sleeve placed about the mold. These prior attempts, however, have not proved entirely satisfactory because the reenforcing sleeve has either interfered with cooling of the mold, or the means heretofore provided for attaching the sleeve to the mold introduces other destructive stresses in the mold.

It is, therefore, one of the objects of this invention to overcome the disadvantages of the prior art by providing an improved means for stiffening a centrifugal pipe mold.

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Another object of the invention is to utilize the advantages of a thin wall mold while providing means for increasing the beam strength thereof without imposing destructive stresses in the mold.

Yet another object of the invention is to provide a stiffener for a centrifugal pipe mold which surrounds the mold over its entire length and is radially spaced therefrom by diametrically opposed, pre-loaded elements which exert their forces only against the convex arc of warpage occuring in the mold.

A still further object of the invention is to provide stiffening means for a centrifugal mold of the above character which will allow a free flow of cooling medium between the stiffening sleeve and the mold.

With these and other objects in view, the invention embraces broadly the provision of a stiffening sleeve about a cylindrical mold with the sleeve being spaced radially from the mold by slidable pin elements carried by and spaced circumferentially about the sleeve at spaced intervals over its length, the pins being spring loaded toward the mold but the extent of movement toward the mold being blocked substantially to the concentric space distance between the mold and sleeve.

In the accompanying drawings which show a preferred means for carrying the invention into practiced effect:

Figure 1 is a longitudinal sectional view taken through the water box of a De Lavaud centrifugal pipe casting machine showing the mold thereof stiffened in accordance with this invention;

Figure 2 is a cross sectional view of the mold, sleeve and water box taken on the line 2—2 of Figure 1 looking in the direction of the arrows;

Figure 3 is a cross sectional view of the mold and sleeve taken on the line 3—3 of Figure 1 looking in the direction of the arrows;

Figure 4 is a somewhat enlarged cross sectional view of the mold and sleeve taken on the line 4—4 of Figure 1 looking in the direction of the arrows;

Figure 5 is a transverse sectional view of one of the loaded spacing elements showing the associated parts of the mold and sleeve; and

Figure 6 is a top plan view of the spacing element shown in Figure 5.

The centrifugal pipe casting machine illustrated in Figure 1 is of the De Lavaud type and comprises a non-rotating water box 1 which is substantially cylindrical in cross section and provided with end walls 2 and 3. Rotatably mounted axially within the water box 1 is a cylindrical pipe mold 4 surrounded by a stiffening sleeve 5. The

right-hand end of the sleeve and mold assembly (as viewed in Figure 1), which may be considered the bell end of the mold, is provided with an externally flanged ring 6 journalled for rotation in an internally grooved bearing in the end wall 2 of the water box. The ring 6 may also carry torque transmitting means, such as a ring gear 6' for effecting rotation of the mold from a source of power (not shown). The opposite or spigot end of the mold, sleeve assembly is provided with a ring 7 journalled in a bearing in the end wall 3 of the water box.

The stiffening sleeve 5 extends the full length of the mold and is preferably spaced therefrom, concentrically therewith at its opposite ends by means of spacer rings (not shown) but which may be carried by opposite ends of the sleeve 5 and provide just sufficient clearance with the outer surface of the mold to allow the radial expansion of the mold at these points without exerting undue stresses in the mold. Intermediate its ends, the sleeve 5 is spaced from the mold by a series of circumferential rows of loading elements, designated generally as 8, which will be described in detail hereinafter. Intermediate portions of the sleeve 5 may be supported against deflection by suitable means such as rollers 9 journalled in bearing 10 carried by the water box 1.

The mold 4 is cooled during casting operations by the circulation of water from the water box 1 through the space between the sleeve and the mold, preferably by means such as disclosed in the above-mentioned copending application Serial No. 493,908. These circulating means will not be described in detail herein but generally comprise circumferential groups of alternate intake ports 11 and exhaust ports 12 through the wall of the sleeve 5 over substantially the length thereof. Preferably, a group of intake ports are located in the middle portion of the mold and a group of exhaust ports at each end to effect a circulating flow of the cooling water from the middle part of the mold towards opposite ends thereof. At opposite ends of the mold, there may be provided impelling means, such as shown in application Serial No. 493,908, for increasing and controlling the circulating flow of cooling liquid. Radial baffles 13 may be provided on the inner surface of the water box to prevent spinning of the liquid therein by the rotating mold.

The sleeve 5, which remains substantially cool and at a substantially even temperature, is subjected only to the bending stresses between its ends, which are absorbed by the rollers 9. During the casting cycle, the mold 4, on the other hand, is subjected to expansion and contraction, and to warpage. The maximum degree of such warpage for a mold of a given length, wall thickness and diameter, and under given conditions of heating, has been learned from experience. By way of example, a six-inch mold, having a one-inch wall and a length of eighteen feet, will warp, under normal casting conditions, about one-quarter inch. This factor being known, it is a simple matter from well-known formulae to calculate the number, distribution and amount of loads necessary to counteract this warping throughout the length of the mold. In calculating these loads, the tendency of the cylindrical mold to corrugate during expansion at the points at which they are applied must also be considered. Here again, well-known formulae may be applied to determine the maximum load which will not exceed the strength of the wall section of the cylinder. From these calculations, considering a

mold of six-inch diameter and eighteen foot length having a wall thickness of one inch, it is determined that if six loads, each capable of exerting a known force, are radially spaced at equal distances about the circumference of the mold and each circumferential row of loads arranged at three-foot intervals along the length of the mold, the force necessary to counteract the one-quarter inch warpage normally to be expected will be several times less than that that which will produce corrugating distortion of the cylinder.

As shown in the drawings, the loading elements 8 are distributed as described above, and each comprises a thrust member in the form of a pin 15 provided with a head 16 at one end and screw threads 17 at the opposite end. The pin 15 is slidably mounted in the central bore 18 of an exteriorly threaded quill 19 and is maintained in adjusted axial position with respect thereto by means of a nut 20 drawn up on the threaded end 17 of the pin. The nut 20 is provided with radial slots 21 adapted to receive the locking lug 22 of a lock washer 23 which is splined onto the pin as shown at 24.

A plurality of annular cupped spring members 25 are interposed between the head 16 of the pin 15 and the base of the quill 19 and urge the pin radially inwardly of the stiffening sleeve when mounted thereon. The normal compression force, or the load exerted by these spring members, it will be understood, may be calculated as described above and their actual compression force regulated by tightening or backing off the nut 20.

The loading members 8 are arranged about the mold, as best shown in Figures 1 and 4, by inserting the quills 19 into threaded radial apertures 26 provided in the wall of the stiffening sleeve 5.

In order to prevent the spring pressure of diametrically opposed pins from counter-balancing each other, the pin is first adjusted in its quill against the compression of its springs 25 by means of the nut 20 until a loading equivalent to that necessary to prevent the maximum warpage or deflection of the mold is reached, and the nut is then locked against further movement. The quill 19 is next screwed into its aperture 26 in the stiffening sleeve until the head 16 of the pin is seated against a cold mold. After this, the quill 19 is locked in position by means such as a key 27 inserted in one of a plurality of radial slots 28 arranged in the upper face of the quill. A wire 29 is threaded through the key 27, passed around the projecting end of the quill 19, twisted and secured beneath the head of a screw 30 threaded into the stiffening sleeve 5.

In the adjusted positions of the loading element 8, it will be seen that the inward movement of the pins 15 will be limited substantially to the concentric space distance between the mold and sleeve.

With the loading elements 8 thus arranged and adjusted, as the mold expands radially under heat, all of the pins 15 will be pushed radially outward in their quills 19 against the compression of the springs 25, diametrically opposing loading elements counter-balancing each other for mold warpage to the extent of its radial expansion. This radial expansion has been found to be only .003" for a 6" diameter mold and the warping effect thereof may be considered negligible.

As the mold tends to warp or deflect further, however, the movement of the pins toward the mold on the concave arc of the warp will be blocked by their nuts 20 engaging the outer ends of the quills 19 and the loading effect of these

pins on the mold relieved. The pins 15 on the convex arc of the warp, on the other hand, exert their loading force on the mold and check further warping. By this urging the pins 15 against the face of the mold on the convex arc of the warp and blocking the movement of the pins toward the mold on the concave arc of the warp, the mold is maintained substantially straight.

I claim:

In a centrifugal pipe casting machine of the type having a cylindrical mold subject to temporary warpage, a rigid cylindrical sleeve surrounding the mold and spring loaded thrust means supporting the mold centrally in the sleeve, the improvement comprising a plurality of unitary assemblies each including an externally screw threaded and axially bored quill member screw threaded into a radial aperture extending through the cylindrical wall of the sleeve, said apertures being arranged in diametrically opposed pairs circumferentially spaced around the sleeve and spaced along the length thereof, each of said quill members having means accessible externally of the sleeve for rotating the quill to adjust the same radially of the sleeve, a thrust member having a shank slidably mounted in the bore of the sleeve and having a radially enlarged head spaced from the inner end of the quill to engage the surface of the mold, compression

spring means interposed between the head and inner end of the quill, the shank extending from the outer end of the quill, a nut screw threaded on the outer extension of the shank and engageable with the outer end of the quill for limiting movement of the head toward the mold under pressure of said spring means, said nut being accessible externally of the sleeve for adjustment on said shank to adjust the compression force of the spring means and the limit of movement of the thrust member relative to the quill, the diameter of said quill being the major diameter of said assembly whereby the assembly may be attached to the sleeve from the exterior thereof, and separate means for securing the nut and quill in the respective adjusted position thereof.

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REFERENCES CITED

The following references are of record in the file of this patent:

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