June 8, 1943. E. D. BOYLE 2,321,277

METHOD OF MAKING CONCRETE PIPE

Original Filed March 30, 1939 4 Sheets-Sheet 1

Fig. 1.

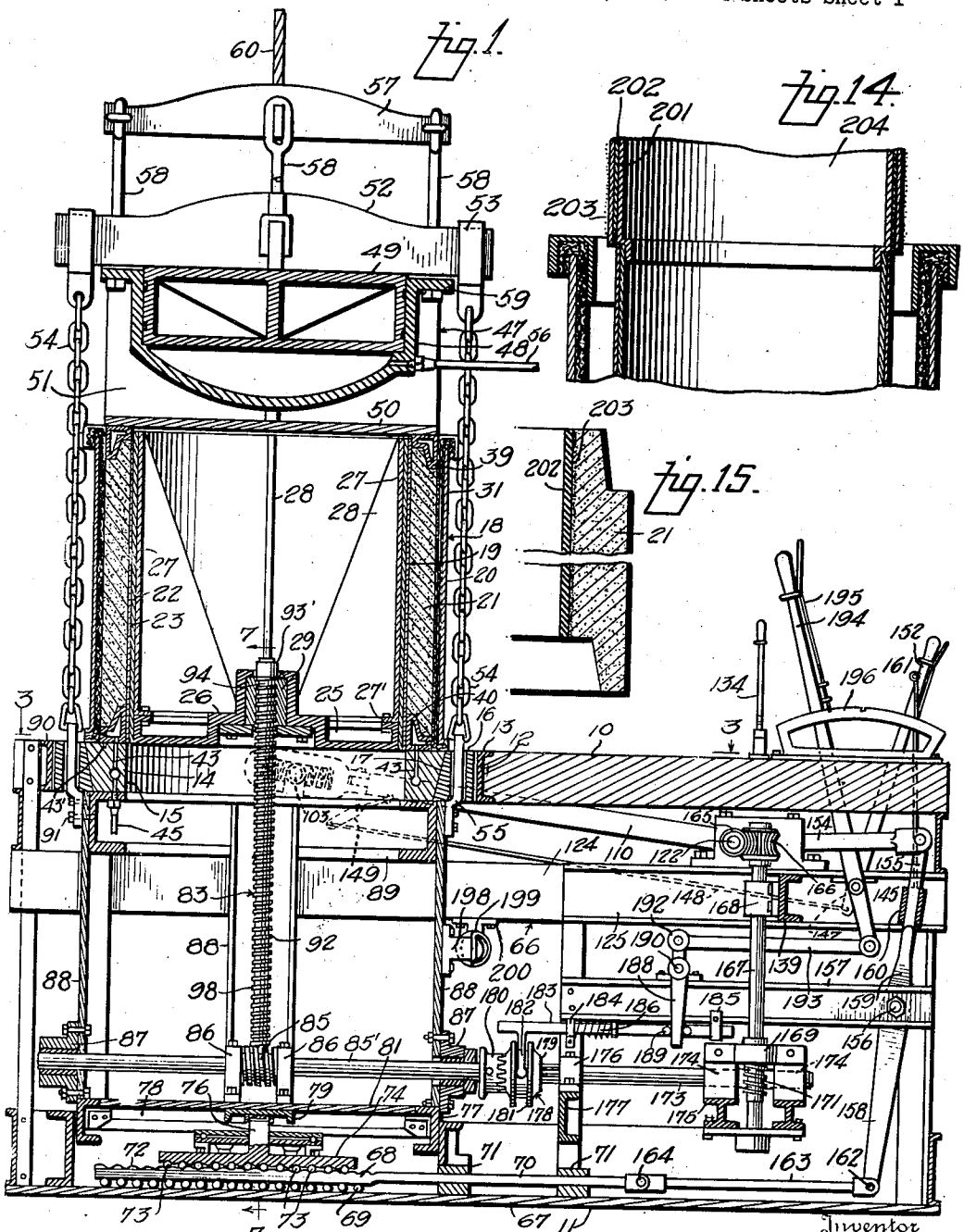
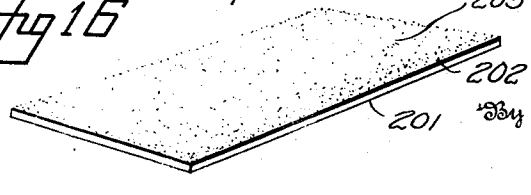


Fig. 14.

Fig. 15.

Fig. 16



Inventor
EDWARD D. BOYLE

Attorney

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Fig. 2.

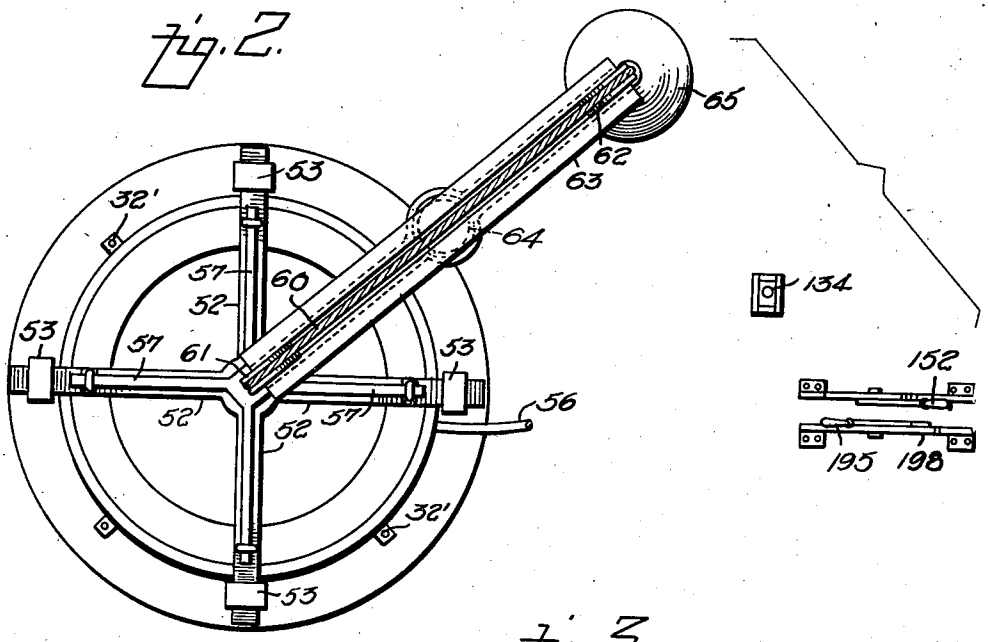
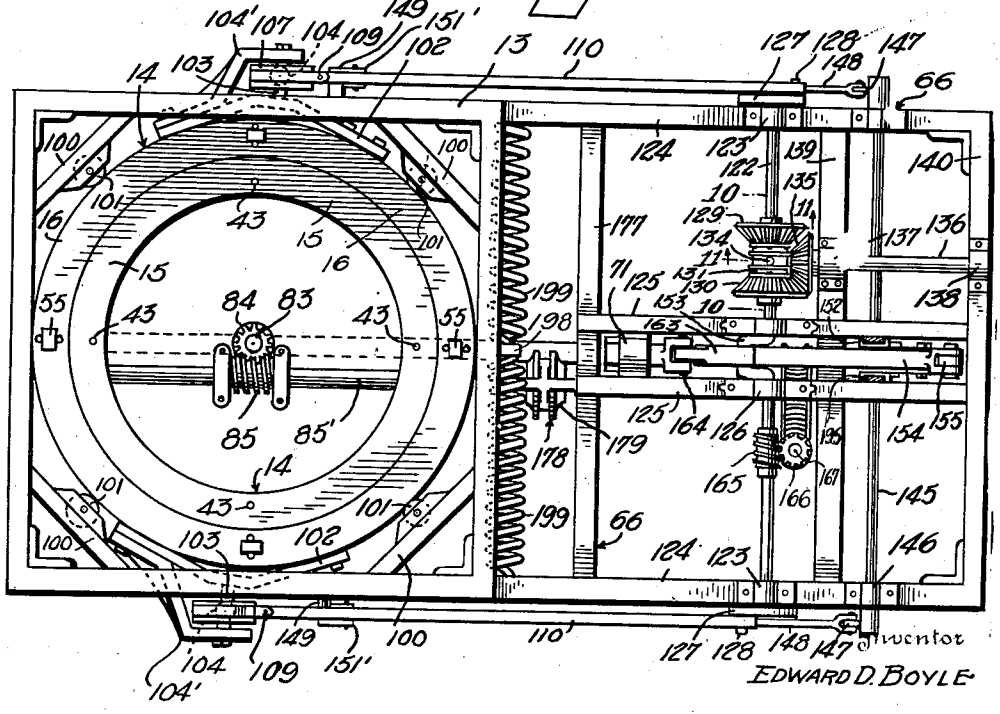


Fig. 3.



Inventor
EDWARD D. BOYLE

By C. L. Parker
Attorney

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METHOD OF MAKING CONCRETE PIPE

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Fig. 4.

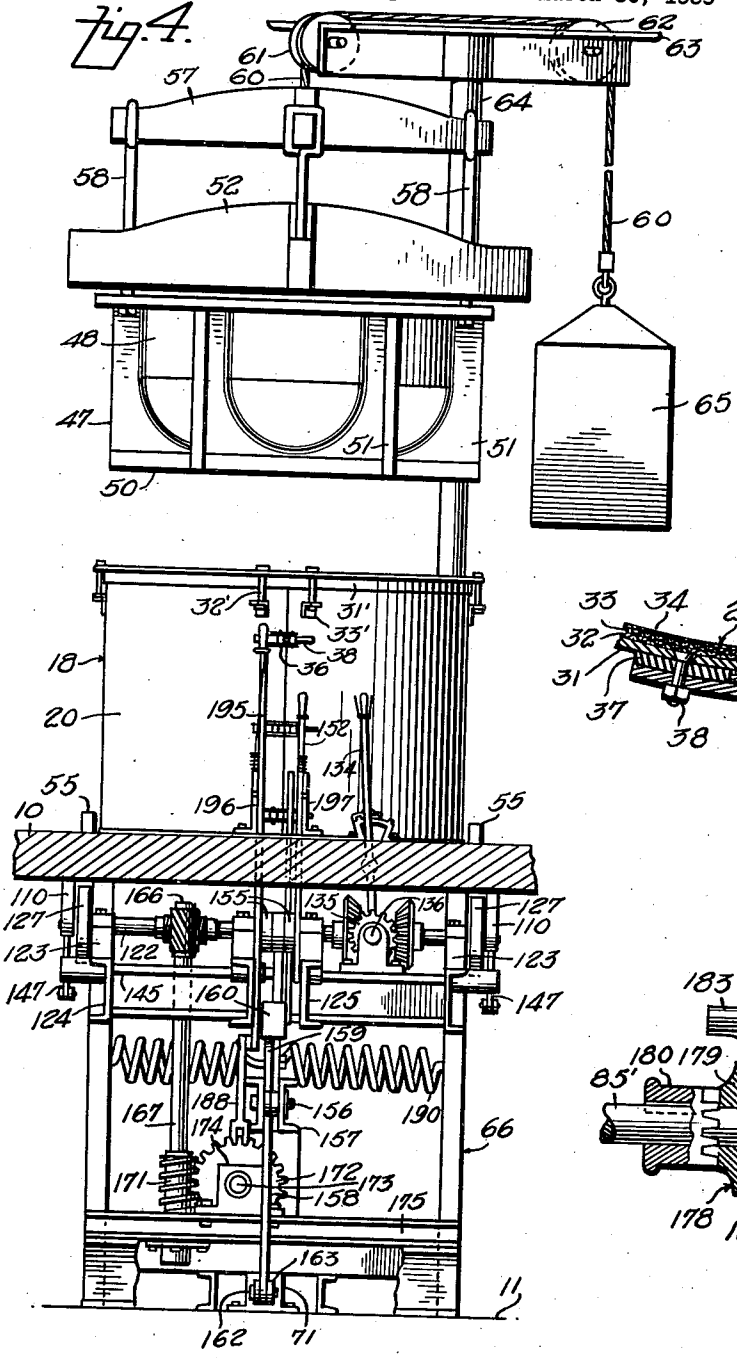


Fig. 5.

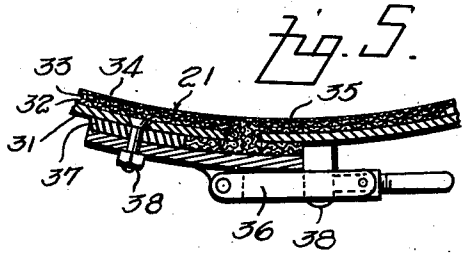
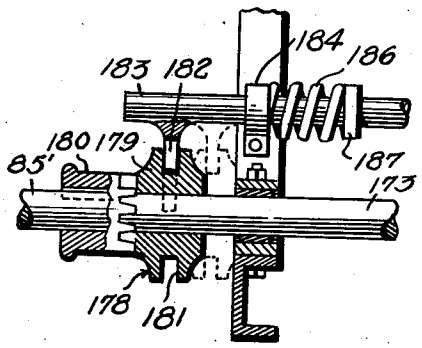


Fig. 6.



Inventor
EDWARD D. BOYLE

By

Attorney

June 8, 1943. E. D. BOYLE 2,321,277

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Fig. 7.

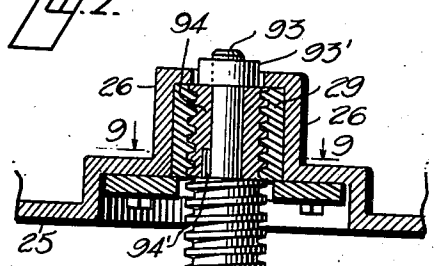


Fig. 8.

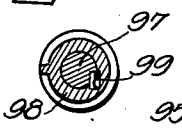


Fig. 9.

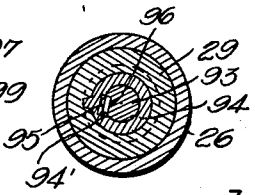


Fig. 10.

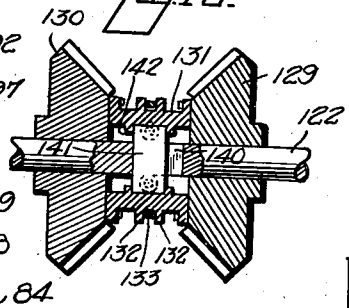
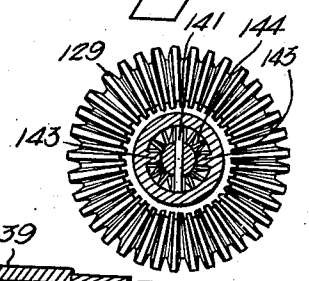


Fig. 11.



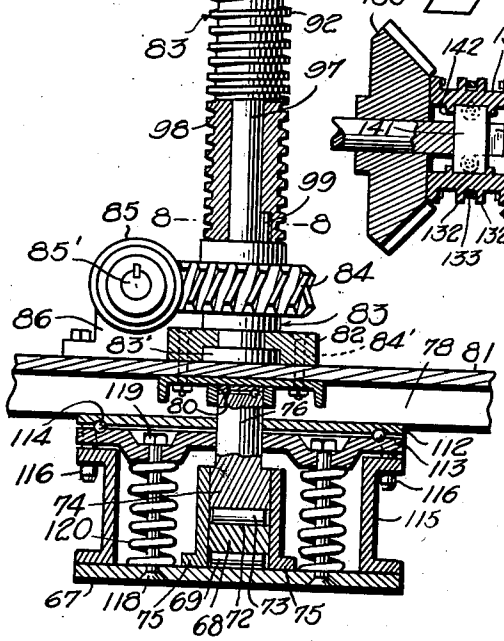


Fig. 12.

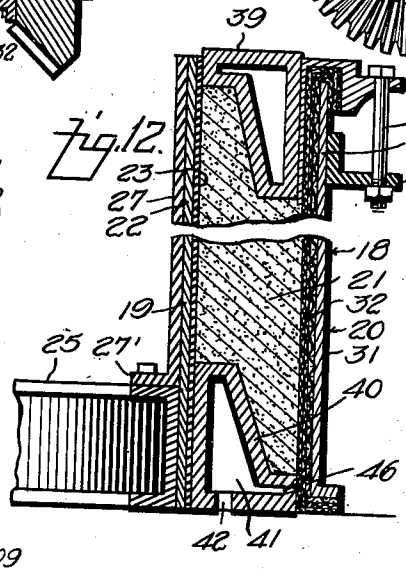
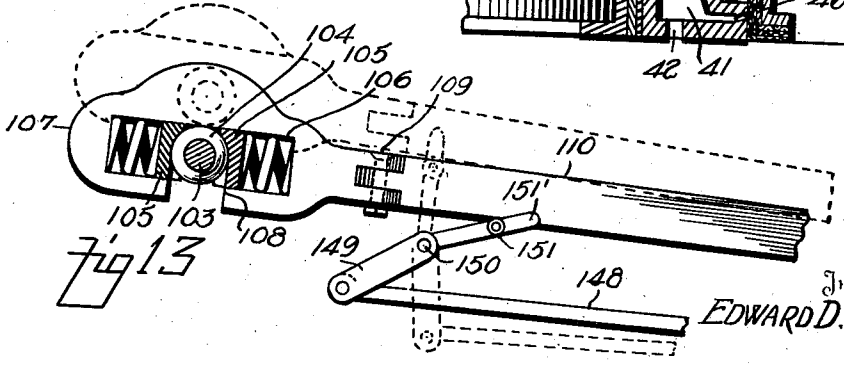


Fig. 13.



Inventor
EDWARD D. BOYLE

By C. R. Parker
Attorney

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UNITED STATES PATENT OFFICE

2,321,277

METHOD OF MAKING CONCRETE PIPE

Edward D. Boyle, Valdosta, Ga.

Original application March 30, 1939, Serial No. 265,035. Divided and this application September 14, 1942, Serial No. 458,279

9 Claims. (Cl. 25—154)

This invention relates to a method of making cementitious articles, and is a division of my copending application Serial No. 265,035, filed March 30, 1939, now Patent No. 2,296,018, granted September 15, 1942.

It is well known that the strength of concrete is greatly increased if the mix is pressed or squeezed after being poured or placed in a mold, to increase the density of the mass. One of the difficulties encountered in making molded concrete articles of maximum strength has been due to the fact that in order to impact the mass into the mold it has been necessary to use substantially less than the normal amount of water.

The mechanical features of the forms of apparatus used in such a method are advantageous but the practical results do not provide finished articles of maximum strength. Where efforts have been made to employ a greater amount of water in the mix, it has been found that the compressing of the mass makes it necessary to extract water from the mold and no adequate means has been provided for this purpose. Therefore, it has been found that with prior methods and apparatus it was impossible to secure an article of maximum density, and hence of maximum strength.

An important object of the present invention is to provide a novel method of making cementitious articles, and particularly concrete pipe, wherein the density of the mass and the strength of the resultant article is greatly increased by maintaining the mass under pressure axially of the mold while simultaneously effecting an axial vibratory movement of the mold to permit the sustained pressure to impact the mass to the greatest possible extent.

A further object is to provide a method of this character wherein the extracting of the excess water from the mold is greatly facilitated by the use of an externally applied vacuum thus greatly assisting in removing excess water from the mold and making it possible to start with an initial mix containing a normal amount of water.

In the drawings I have shown one form of apparatus particularly adapted for practicing the invention. In this showing:

Figure 1 is a vertical sectional view through the apparatus as a whole, parts being shown in section,

Figure 2 is a plan view of the apparatus,

Figure 3 is a horizontal sectional view on line 3—3 of Figure 1,

Figure 4 is an end elevation of the apparatus, the floor being shown in section,

Figure 5 is a detail sectional view taken transversely through the separable joint of the outer mold member,

Figure 6 is a detail sectional view through the driving clutch, parts being shown in elevation,

Figure 7 is an enlarged vertical sectional view on line 7—7 of Figure 1, parts being shown in elevation and parts being broken away,

Figure 8 is a detail sectional view on line 8—8 of Figure 7,

Figure 9 is a similar view on line 9—9 of Figure 7,

Figure 10 is a detail sectional view on line 10—10 of Figure 3,

Figure 11 is a similar view on line 11—11 of Figure 3,

Figure 12 is an enlarged fragmentary vertical sectional view through the mold and associated elements, parts being broken away,

Figure 13 is an enlarged fragmentary side elevation of one of the driving arms, parts being shown in section,

Figure 14 is a fragmentary vertical sectional view of the upper end of the mold to illustrate the making of a modified form of article,

Figure 15 is an enlarged fragmentary sectional view of one side of the modified form of finished article, parts being broken away, and,

Figure 16 is a detail perspective view of the sheet employed in making the modified form of article.

The practice of the method will become apparent from a consideration of the accompanying drawings which, as stated, show a form of apparatus particularly adapted for practicing the method. Referring particularly to Figures 1 and 2, the numeral 10 designates the floor of a building or any other place where the apparatus is set up and beneath which is formed a pit 11 in which parts of the operating mechanism of the apparatus are arranged. The floor 10 preferably is in the form of a concrete slab and is provided with a rectangular opening 12 having a rectangular structural frame 13 arranged therein and preferably formed of channel iron as shown in Figure 1.

A table indicated as a whole by the numeral 14 is arranged within the frame 13 and preferably is of circular shape as shown in Figure 3. The table comprises inner and outer circular elements 15 and 16 having downwardly converging conical engaging faces 17 whereby the inner member 15 seats within the outer member 16. These members may be positively secured together, if desired, by any suitable means (not

shown) but no securing means between these elements is necessary as will bcome apparent. The element 16 forms a permanent part of the apparatus and the inner element 15 is replaceable according to the size or types of similar articles to be made, as will be described later. The element 15 of the table supports a mold structure indicated as a whole by the numeral 18 and comprising inner and outer mold members each indicated as a whole by the respective numerals 19 and 20. These mold members are concentric and of different diameters to form a space in which a concrete pipe 21 or similar article is to be cast.

The inner mold member 19 comprises a cylindrical shell 22 having a surface covering 23 of rubber or any similar material having a low coefficient of surface friction when wet, for a reason to be described. Lower structural elements 25 are provided for supporting the inner mold member in a manner to be described and these structural elements are welded or otherwise secured to a central bearing housing 26. A plurality of braces 27 having downwardly and inwardly extending flanges 28 are employed for bracing the cylindrical shell 22 with respect to the bearing housing 26. The braces 27 have their lower ends turned inwardly as at 27' and secured to the structural members 25. The numeral 27 may indicate either a plurality of braces or a single cylindrical member carrying the angular braces 28 radially arranged as shown in Figure 1. The housing 26 receives an internally threaded bearing block 29 secured in position by a plate 30 or by any other suitable means.

The outer mold member 20 is in the form of a split cylinder 31 the joint of which is shown in detail in Figure 5, this joint being adapted to be opened to expand the outer mold member for the purpose of removing the article 21 as will be described. The cylinder 31 is provided with filter means lying against its inner face to facilitate the squeezing and extracting of water from the mold in the manner to be described. The filter means comprises a layer of relatively coarse wire cloth 32, adjacent the cylinder 31, an intermediate shell 33 of a finer mesh wire cloth, and an inner layer 34 of canvas or similar fabric, the filter means preferably being formed of the elements described but being of any form which will provide the desired results. The filter means has its ends turned between the adjacent edges 35 of the cylinder 31, and clamped in position, together with the edges of the outer mold, by any suitable quick-detachable latching elements 36, pivoted to the plates 37, connected to one edge of the outer mold, and engaging lugs 38, carried by the other edge of the outer mold, as shown in Figure 5. The upper end of the filter medium is turned over the upper end of the cylinder 31 and is received in a clamping ring 31'. This ring is drawn downwardly by bolts 32' passing through ears 33' prefereably welded to the cylinder, and the ring includes a sleeve 34' projecting downwardly into the mold for a purpose to be described.

The space between the mold members at the upper ends thereof is closed during operation by an upper pallet 39 which, in the case of the formation of a concrete pipe, forms the spigot end of the pipe. The pallet 39 is slidable in the sleeve 34', the latter protecting the filter structure from damage by the pallet 39. Moreover, the sleeve 34' acts as a gage to facilitate filling the mold with the mix, as will become apparent. If desired, suitable conventional packing means may be provided between the pallet 39 and the sleeve 34' and liner 23 to form leak-proof joints. The lower end of the space between the mold members is closed by a lower pallet 40 which forms the bell end of the pipe. The lower pallet is hollow as indicated by the numeral 41 and the bottom wall of the pallet is provided at spaced points with openings 42 each communicating with an opening 43 (Figure 1) formed in the table element 15. The lower pallet rests on the table element 15 and is fixed against lateral movement by lugs 43' engaging the table element 15. The openings 43 communicate with an encircling manifold 44 to which is connected a flexible pipe 45 from which air is exhausted during the making of the article 21, the exhaustion of air being accomplished by any desired form of vacuum-creating means. The pallet 40, as shown in Figure 12, is provided with a plurality of openings 46 through which water may drain from the filtering means into the hollow pallet 40. The expressing and extracting of the water is accomplished by the vacuum means referred to and by the subjection of the mix in the mold to pressure in the manner to be described.

At the points where it fits within the clamp 31' and extends beneath the lower edge of the outer mold member, the filter structure is provided with suitable means for providing leak-proof joints. For example, the filter structure may be impregnated with rubber cement or similar material to form, in effect, a gasket. Similar means may be employed in the portions of the filter structure which are folded over the edges of the split in the outer mold member whereby a leak-proof joint is provided between the folds referred to, which contact with each other when the outer mold member is closed.

A ram indicated as a whole by the numeral 47 is arranged above the mold structure and comprises a cylinder 48 having a piston 49 arranged therein. As shown in Figure 1 the top of the cylinder is open and the bottom of the cylinder is closed, and a platform 50 is welded to or otherwise carried by the cylinder and is braced with respect thereto by radial webs 51. A crosshead 52 is arranged over and engages the upper end of the piston 49 and is provided with radial arms receivable in loops 53 connected to depending chains 54, the lower ends of which are connected to lugs 55 which are rigidly connected to means to be described. The chains 54 fix the piston 49 against upward movement whereby the introduction of fluid pressure into the bottom of the cylinder 48 effects downward movement thereof to cause the platform 50 to exert sustained downward pressure on the upper pallet 39. A pipe 56 communicates with the bottom of the cylinder 48 for the introduction of pressure fluid thereinto.

Means are provided for facilitating the handling of the ram to permit it to be easily placed in operative position and removed from such position. An upper crosshead 57 is arranged above the crosshead 52 and is provided with a corresponding number of radial arms each carrying a depending bolt 58 extending loosely through the arms of the crosshead 52 and through a flange 59 formed at the upper end of the cylinder 48. The center of the crosshead 57 is connected to a cable or any other form of flexible element 60 as shown in Figure 4. This cable passes around pulleys 61 and 62 rotatably supported in the adjacent opposite ends of a cross member 63 and this cross member is ro-

tatably supported on the upper end of a mast 64. The other end of the cable 60 is provided with a counter-weight 65 preferably equal in weight to the sum of the weights of the ram, the chains 54 and the crossheads 52 and 57, whereby the operator may readily pull downwardly on the outer end of the cable 60 to elevate the ram and associated elements to permit them to be swung horizontally away from operative position. The ram and associated elements have been shown in elevated position in Figure 4.

A lower supporting structure is arranged in the pit 11 and is indicated as a whole by the numeral 66. This structure is made up principally of structural elements such as channel irons and may be of any desired form, and accordingly the specific elements of such structure will be referred to only with respect to the elements connected thereto or supported thereby. This supporting structure is arranged over a suitable base plate or the like 67 arranged in the bottom of the pit. A horizontal reciprocable actuating member 68 is arranged over the plate 67 and is supported for movement with respect thereto by a plurality of rollers 69, which may be conventional bearing rollers and may be fixed with respect to each other in any suitable manner. The member 68 is connected to an actuating rod 70 slidable in bearings 71 and reciprocated in the manner to be described.

As shown in Figure 1, the upper face of the actuating member 68 is corrugated or undulated as indicated by the numeral 72, the corrugations extending transversely of the direction of reciprocation of the member 68 and receiving a plurality of rollers 73. A plate 74 is arranged above the rollers 73 and is provided with a similarly undulated lower face resting on the rollers 73. The members 68 and 74 and the rollers 69 and 73 preferably operate between parallel guides 75 (Figure 7) supported by the bottom plate 67. The plate 74 is provided with an upstanding relatively heavy cylindrical stem 76 supporting at least a part of the load of the mold and associated elements in a manner to be described.

A lower preferably circular frame 77 is arranged just above the plane of the plate 74 and may be made up of channels as shown in Figure 1. This frame is provided with suitable cross braces in the form of parallel channels 78 and these channels are connected by a transverse channel 79 (Figures 1 and 7) which rests on the upper end of the stem 76 through the medium of a thrust bearing construction 80. A plate 81 may be arranged on the channels 78 and welded or otherwise secured to the channels of the frame 77 to fill the space therebetween. The plate 81 supports a thrust bearing 82 (Figure 7) which, in turn, supports the lower end of an operating screw structure indicated as a whole by the numeral 83. The thrust bearing 81 is split and formed to receive a head 83' on the lower end of the screw structure to prevent upward movement of the latter, as will become apparent. The thrust bearing may be bolted as at 84' to the plate 81 and channel 79.

The screw structure carries a worm wheel 84 driven by a worm 85 meshing therewith and carried by a shaft 85' journalled in bearing 86 projecting upwardly from the base of the thrust bearing 82. The ends of the shaft 85 project through bearings 87 carried by vertically extending supporting members 88, preferably in the form of relatively heavy channels, supported at their lower ends by and secured to the frame 77. The upper ends of the channels 88 are secured to a supporting structure 89, also preferably in the form of channels, and the table 14 rests upon and is secured to such supporting structure. The lugs 55 project through openings 90 formed in the table member 16 and the lower ends of these arms are bolted or otherwise secured as at 91 to the upper ends of the channels 88. Accordingly, these channels serve to anchor the lower ends of the chains 54. As previously stated, it is unnecessary to secure the table element 15 to the element 16, and it will be apparent that both of these elements are supported by the structure arranged therebeneath including the channels 88 and 89. The tapered engaging faces 17 serve to center the table element 15 with respect to the element 16 and the latter element is preferably secured to the supporting structure 88—89, although the lugs 55 may fit within the openings 90 to maintain the element 16 properly centered with respect to the screw structure 82.

It will become apparent that the inner mold member 19 is vertically movable into and out of the mold and vertical movement of this member is effected by rotation of the screw structure 83. The body of the screw structure is threaded as at 92 and the top portion of the body of the screw structure is reduced as at 93 to be received within a collar 94 which is of the same diameter as the threaded portion 92 and has external threads forming continuations of the threads 92. The collar 94 is threaded in the sleeve 29 and is rotatable in one direction on the reduced end 93, any desired form of overrunning clutch 94' engaging between the stem 93 and collar 94 to prevent relative rotation of the latter in one direction with respect to the stem 93. A thrust collar 93' on the stem 93 prevents upward movement of the collar 94 with respect to the stem 93.

The overrunning clutch may be in the form of a simple dog backed by a light spring 95 to tend to move one end into engagement with a notch 96 formed in the stem 93. When the clutch 94' is in operative driving engagement with the notch 96, the threads 92 and the threads of the collar 94 are arranged as continuations of each other and accordingly it will be apparent that rotation of the stem 93 in a counter-clockwise direction will drive the collar 94, thus moving the sleeve 29 downwardly from the position shown in Figure 7. However, the collar 29 may remain stationary during clockwise rotation of the stem 93 as viewed in Figure 9. This structure permits upward movement of the collar 29 to stop when its upper position is reached with the inner mold member 19 in operative position in the mold.

The lower end of the body of the screw structure is reduced to form a stem 97 on the lower end of which the worm wheel 84 is suitably mounted to drive the stem 97. Between the threaded portion 92 and the screw 87 an externally threaded collar 98 surrounds the stem 97. The collar 98 is rotatable with respect to the stem 97 when the latter rotates in a counterclockwise direction but is driven thereby when it rotates in a clockwise directtion by an overrunning clutch 99 similar to the clutch 94'. It will be apparent that these two overrunning clutches are oppositely arranged whereby rotation of the screw 92 to tend to cause the collar 29 to run beyond either collar 94 or 98 will result in such collar being freed from connection with the screw structure, thus permitting the inner mold member 19 to have its vertical movement arrested at

either limit of movement. When the clutch 99 is in operative engagement with the stem 97, as shown in Figure 8, clockwise rotation of the stem 97 will drive the collar 93 and the threads thereof will form continuations of the threads 92, and accordingly it will be apparent that the sleeve 29 will be caused to move upwardly.

Highly advantageous results are obtained by oscillating the mold structure on its axis, and accordingly means are provided for effecting such oscillation and for supporting the mold for such movement. It will be apparent that the mold structure and associated parts are at least partly supported on the stem 76 (Figure 7) and this stem obviously permits oscillatory movement of the mold structure on its axis. The channel frame structure 13 is rectangular as previously stated and as shown in Figure 3, and the corner portions of such structure are provided with angular supports 100 each of which carries a roller 101 engaging the periphery of the table element 16. In the arrangement shown four of the rollers 101 are employed and accordingly these rollers adequately fix the mold structure against lateral movement while at the same time providing anti-friction means for permitting operation of the mold structure on its axis.

The table element 16 is provided at opposite sides with brackets 102 each of which carries a stud 103 on the end of which is arranged a ball 104. The brackets, studs and balls project through suitable elongated openings in the side frames of the structure 12. Each ball 104 is arranged between a pair of complementary socket members 105 slidable in a recess 106 formed in a head 107 as shown in Figure 13. Each head 107 is provided with an opening 108 in the bottom thereof registering with the recess provided between the socket members 105 to permit the head to be lifted as shown in dotted lines in Figure 13 to completely release the head 107 from the associated ball 104. The surfaces of the sockets 105 which engage the ball 104 are shaped to correspond to the latter to form ball and socket connections between the heads 107 and the balls 104. The studs 103 may extend beyond the balls 104 and heads 107 for connection with the brackets 102 by braces 104'.

Each head 107 is pivotally connected as at 109 to the adjacent end of a driving rod 110. The rods 110 are oppositely reciprocated in a manner to be described to rock the mold structure on its axis, and the pivots 109 permit the heads 107 to swing laterally to accommodate the socket members 105 to the arcuate path of travel of the balls 104.

From the foregoing description it will be apparent that the present apparatus provides a mold structure wherein the mold may be oscillated on its axis during the filling of the mold to compact the mass therein by discharging bubbles of air from the mix, the apparatus also operating after the mold is closed, and sustained pressure is applied thereto by the ram, to vertically vibrate the mold structure to provide a resultant article of great density and strength.

Obviously the load imposed on the parts of the apparatus at the bottom thereof which effect the vertical vibratory motion is extremely heavy and accordingly it is desirable to provide some means for lessening the load on the parts referred to. Referring to Figure 7 the numerals 112 and 113 designate a pair of plates arranged in superimposed relation and provided with anti-friction bearings 114 therebetween whereby the plate 112, which engages the structural elements 78 may oscillate therewith. The plate 113 is arranged above the upper flanges of channels 115 arranged parallel to each other and welded or otherwise secured to the base plate 67. Depending pins 116 are carried by the plate 113 and extend through suitable openings in the flanges of the channels 115 to fix the plate 113 against rocking movement on the axis of the stem 76.

Bolts 118 project upwardly from the plate 67 and may have their heads countersunk in the bottom of such plate as shown in Figure 7. Four of the bolts are preferably employed, such bolts being arranged in the form of a square for a purpose to be described. Each bolt has its upper end extending through the plate 113 and provided with a nut 119 to limit upward movement of the plate 113, and each bolt is surrounded by a heavy compression spring 120. The bolts 118, and consequently the springs 120, being arranged in the form of a square, are equidistantly spaced from the stem 76 and accordingly the loads imposed on the springs are uniformly distributed with respect thereto. The springs are preferably of such tension as to substantially wholly support the load when the parts are stationary and when the load is at its minimum as when making pipes or similar elements of the minimum size and weight. For all other loads, it will be apparent that the springs at least partly support the load, thus relieving the rollers 69 and 73 and associated parts of at least a portion of the load.

Suitable apparatus is employed for effecting the mechanical operation of the parts described. The operating apparatus is located in the pit beneath the floor slab and is shown at the right hand side of Figures 1 and 3. A shaft 122 extends transversely of the apparatus and is supported at its ends in bearings 123 carried by parallel channels 124 forming a part of the supporting structure 66. Similar parallel structural elements 125 are arranged adjacent the center of the apparatus and also support bearing 126 for the shaft 122. Outwardly of the frame members 124 the shaft 122 carries disks 127 each of which is provided with a crank pin 128 connected to the adjacent end of one of the driving rods 110. It will be apparent that when the heads 107 are in engagement with the balls 104, rotation of the shaft 122 will oscillate the mold structure on its axis.

The shaft 122 is provided with a pair of bevel gears 129 and 130 spaced from each other and connected by a drum 131 having parallel flanges 132 to provide a groove receiving a fork 133 arranged on the lower end of a shift lever 134 (Figure 1) by means of which the gears 129 and 130 may be shifted. These gears are adapted to be meshed with a bevel pinion 135 carried by a main drive shaft 136 journalled in bearings 137 and 138 carried by structural elements 139 and 140 forming a part of the supporting frame 66. The shaft 136 may be driven from any suitable source of power.

Shock absorbing means is preferably provided between the gears 129 and 130 and the shaft 122 to minimize shocks incident to the driving of the apparatus. Referring to Figures 10 and 11 it will be noted that the shaft 122 is slotted as at 140 to receive a flat relatively wide driving element 141 which is longitudinally slidable in the slot 140 upon sliding movement of the drum 131. The interior of the drum may be provided with any suitable means such as annular ribs

142 to engage the driving member 141 and slide the latter coincidentally with the sliding of the drum 131. As shown in Figure 11 the drum is provided with diametrically opposite radial ribs 143 spaced 90° from the projecting ends of the driving member 141 and compression springs 144 are arranged in the spaces between the ribs 143 and the projecting ends of the member 141. Power is thus transmitted to the shaft 122 by the member 141 with the spring 144 acting as cushion driving means.

The gears 129 and 130 are so spaced as to permit them to be moved to a neutral position with both gears out of engagement with the driving pinion 135 and any suitable conventional means (Figure 4) may be employed for holding the shift lever 134 in its neutral or driving positions. When the shaft 122 is being driven to perform any of its intended functions it will be apparent that the disks 127 will be driven, and means is provided for lifting the arms 110 to disengage the heads 107 from the balls 104 when it is not desired to oscillate the mold. A transverse shaft 145, journalled in suitable bearings 146, is provided outwardly of the frame members 124 with depending arms 147 connected to rods 148 and each of these rods is connected to one end of a bell crank lever 149 (Figure 13) pivotally supported as at 150 and carrying a roller 151 engageable beneath one of the arms 110. Accordingly, rocking of the shaft 145 is adapted to engage or disengage the heads 107 from the balls 104. The upper end of each bell crank lever 149 is extended slightly beyond its roller 151 and is bifurcated as at 151' to receive the lower edge of the adjacent rod 110 to act as a guide for the latter, particularly while the rods 110 are being raised and lowered. A lever 152 is employed for rocking the shaft 145.

Between the parallel frame members 125, the shaft 122 is provided with a crank 153 (Figure 3) and a connecting rod 154 is connected at it respective ends to the crank 153 and to the upper end of a lever 155 (Figure 1) this lever having its lower end pivoted as at 156 to a channel 157 forming a part of the supporting structure 66. A second lever 158 is also pivoted at 156 and has an upper end 159 extending upwardly above the pivot. A sleeve 160 is slidable on the lever 155 and upon downward movement is engageable with the lever end 159 to lock the levers 155 and 158 together under which conditions operation of the connecting rod 154 will rock the lever 158. A rod 161 is connected to the sleeve 160 and extends upwardly through a suitable opening in the floor slab 10 to be grasped by the operator to move the sleeve 160 upwardly and downwardly. The sleeve 160 may be frictionally engageable with the lever 155 to prevent it from accidently sliding downwardly or any suitable means (not shown) may be provided for this purpose.

The lower end of the lever 158 is pivotally connected at 162 to one end of a connecting rod 163. This rod has its other end pivotally connected at 164 to the adjacent end of the rod 70. When the sleeve 160 is moved downwardly to engage the lever end 159, it will be apparent that the operation of the crank 153 effects reciprocation of the actuating member 68 (Figure 1) through which the vertical vibratory motion is transmitted to the mold structure.

The shaft 122 is also employed for driving the worm structure 63 to raise and lower the inner mold member. The shaft 122 is provided with a worm 165 meshing with a worm 166 carried by a vertical shaft 167 journalled in upper and lower bearings 168 and 169, the former of which is carried by the cross member 139 extending between the channels 125. The lower end of the shaft 167 is provided with a worm 171 (Figures 1 and 4) meshing with a worm wheel 172 carried by a shaft 173. On opposite sides of the worm wheel 172 the shaft 173 is journalled in bearings 174 supported on structural members 175. The bearing 169 is supported on the tops of the bearings 174, as shown in Figure 1. Adjacent its other end the shaft 173 is supported in a bearing 176 carried by a structural member 177.

A clutch indicated as a whole by the numeral 178 (Figures 1 and 6) is operable for connecting the shafts 85 and 173. The clutch comprises a pair of clutch elements 179 and 180 the latter of which is keyed on the shaft 85. The clutch element 179 is splined on the shaft 173 and is grooved as at 181 to receive a fork 182 carried by an operating rod 183. This rod is slidable in bearings 184 and 185 and a spring 186 is arranged between the bearing 184 and a collar 187 to urge the clutch element 179 away from the clutch element 180. Accordingly, the clutch elements are biased out of operative engagement and in such positions of the clutch elements the mold structure is free to oscillate on its axis.

A depending crank arm 188 (Figure 1) has its lower end engageable between pins 189 carried by the rod 183. The arm 188 is carried by a shaft 190 journalled in the bearing 191. An upwardly extending crank arm 192 is carried by the shaft 190 and is pivotally connected to one end of a rod 193. The other end of this rod is connected to the lower end of a lever 194 which is pivotally supported by the shaft 145. The lever 194 is provided with a conventional latch mechanism 195 engageable with a quadrant 196 supported on the top of the floor structure 10. The lever 152 may be similarly latched with respect to a quadrant 197, these two quadrants being shown in end elevation in Figure 4.

In order to connect the clutch elements 179 and 180 it is necessary for these elements to be approximately aligned after oscillating movement of the mold structure has taken place. Accordingly, one of the structural supports 88 (Figure 1) is provided with an outstanding lug 198 and a tension spring 199 extends on opposite sides of this lug as shown in Figure 3 for connection with brackets 200 (Figure 1) carried by the frame members 124. The springs 199 are sufficiently strong to properly center the mold structure when the heads 107 are disconnected from the balls 104 but do not interfere with the oscillation of the mold structure.

The apparatus lends itself readily to the making of concrete pipes lined with asphalt or the like, as illustrated in Figures 14, 15 and 16. Such lining of the pipe will be referred to more particularly later but it consists generally in coating a flat sheet of paper 201 of the proper size with a layer of asphalt 202 which is coated, before drying, with a layer of sand 203 whereupon the paper is wrapped around a cylinder 204 arranged above and in axial alignment with the inner mold member. The cylinder 204 is of the same diameter as the external diameter of the mold member to permit the sliding of the paper, with the asphalt and sand thereon, downwardly over the inner mold member, after which the pipe is molded in accordance with the operation of the

apparatus to be described. The finished pipe made with the asphalt coating is shown in Figure 15, the paper having been removed.

The operation of the apparatus is as follows:

Assuming that the ram has been elevated and swung clear of the molding apparatus and that the upper pallet has been removed, and assuming that the inner mold member or core mold is in the operative position shown in Figure 1, the mold is ready to be filled. Under such conditions, the lever **194** will be moved to the right of its position shown in Figure 1 to disengage the clutch **178**, whereupon the lever **152** will be moved to the position shown in Figure 1 to drop the heads **107** into engagement with the balls **104**.

Assuming that the gears **129** and **130** are in neutral position, the operator will move the lever **134** to bring either of these gears into engagement with the driving gear **135** (Figure 3). It will be obvious that the shaft **122** may be rotated in either direction to effect reciprocation of the arms **110** and thus impart rocking movement to the mold structure. Initial driving engagement of the gears referred to will be cushioned by the shock absorbing mechanism shown in Figures 10 and 11. The entire mold structure thus will be oscillated on the axis of the mold and the mix is poured into the mold during such oscillatory movement. In filling the mold, the lower edge of the sleeve **34'** may be employed for determining the depth of the mix, the latter being poured to a small predetermined depth above the lower edge of the sleeve **34'**, depending upon the size of the mold. When pressed, the surface of the mix will move down to about the lower edge of the sleeve **34'**.

The oscillating operation is important inasmuch as it serves to compact the mix in the mold to eliminate voids, all air bubbles being discharged from the mix. In this connection attention is invited to the face that in order to secure dense molded concrete articles it has been the practice to use a minimum amount of water in the mix because of the difficulty of expressing water from the mold in order to permit the concrete to be impacted. With the present apparatus a normal amount of water may be employed and accordingly the oscillating movement referred to effectively rids the mix of all occluded air, thus preventing the presence of any voids in the finished article.

After the mold has been properly filled the operator will place the upper pallet **39** in position, whereupon the cross arm **63** (Figures 2 and 4) may be readily swung on the axis of the mast **64** to place the ram in axial alignment with the mold. The counterbalancing weight **65** is then pushed upwardly to permit the platform **50** to seat upon the upper pallet, whereupon the chains **54** will be connected to their respective arms of the crosshead **52**.

The compressing and densifying operation is now ready to take place and it will be obvious that before such operation is performed it is desirable to disconnect the heads **107** from the balls **104**. The clutch **178** is left disengaged during the impacting operation as will be apparent. The operator will admit fluid pressure through the pipe **56** to the ram cylinder to create a sustained downward force on the upper pallet, whereupon the vertical vibratory movement may be imparted to the mold. The apparatus is preferably stopped with the lever **155** (Figure 1) in alignment with the lever arm **159**, whereupon the operator will push downwardly on the handle **161** to slide the sleeve **160** over the lever arm **159**, thus connecting the levers **155** and **158** together as a unitary lever. The gears are then again shifted to effect reciprocation of the actuating member **68**. Since this reciprocation will be effected by the crank **153** through the connecting rod **154** and the levers referred to, it will be apparent that the direction of rotation of the shaft **122** is unimportant and either gear **129** or **130** may be engaged with the driving pinion **135**.

The rollers **69** support the actuating member **68** for horizontal reciprocating movement over the base plate **67** and the movement of the member **68** is guided by the guiding means shown in Figure 7, namely, the guides **75**. The action of the rollers **73**, operating over and against the undulated faces of the members **68** and **74** imparts a sharp vibratory movement to the entire mold structure through the frame members **88**, and this operation is performed while the pressure against the upper pallet **39** is maintained by the ram. The maintenance of this pressure together with the vertical vibratory motion imparted to the mold structure serves to impact the concrete in the mold to provide a uniformly dense article the strength of which is much greater than in pipes and similar articles molded with conventional forms of apparatus. As previously stated, the mix is placed in the mold with the usual amount of water therein, or at least substantially more than the minimum amount of water necessary, in which case the absorption of the water by the concrete will take place to a far greater extent than when the minimum amount of water is employed, thus resulting in increasing the strength of the resultant article not only because of the impacting operation but also because of the high degree of water absorption. It will be apparent that during the subjection of the mix to pressure and vibration, the pressure created in the mix will tend to express water therefrom. The water flows through the canvas or similar lining **34** of the outer mold, thence through the fine mesh wire **33** and into the meshes of the coarse wire **32**, whereupon it is free to flow downwardly through the opening **46** (Figure 12) and into the space **41**.

The expressing action may be greatly increased by the means employed for creating a partial vacuum in the space **41**. The pipe **45** (Figure 1) is connected to a source of vacuum to maintain a substantially reduced pressure in the manifold passage **44** and accordingly in the passages **43** and space **41**, through the openings **42**. This operation greatly facilitates carrying excess water from the mold, thus also facilitating the production of a concrete article of great density.

After the impacting operation has been completed the article is ready to be removed from the mold. The operating parts of the apparatus may be temporarily stopped and the operator will pull upwardly on the handle **161** to disengage the sleeve **160** from the lever arm **159**. The operator will then disconnect the chains **54** from the crosshead **52**, whereupon the operator may pull downwardly on the cable **60** to lower the counterweight **65** and thus elevate the ram structure, as shown in Figure 4. The ram then may be freely swung away from the mold. The upper pallet is then removed and this operation is facilitated by transmitting a rocking movement to the pallet about the axis of the mold while pulling upwardly on the pallet, the rocking movement assisting in breaking the vacuum which will be created beneath the pallet when a lifting force is transmitted thereto.

It will be apparent that upon conclusion of the oscillation of the mold structure the springs 199 will have automatically returned the mold structure to its normal position with the clutch elements 179 and 180 in alignment. The operator will now move the lever 195 to the left to the position shown in Figure 1 and will latch it in such position, it being necessary to fit the lever 194 against movement to the position referred to since such movement takes place against the compression of the spring 186. This operation engages the clutch elements 179 and 180, whereupon the screw structure 83 is ready to be operated to withdraw the core mold from the mold structure.

The screw structure may now be rendered operative by engaging one of the gears 129 and 130 with the driving pinion 135, the gear employed depending upon the direction of rotation of the shaft 136. Assuming that the gear 139 is to be employed, this gear is shifted into engagement with the pinion 135 whereupon rotation of the shaft 122 will drive the shaft 167 through the gears 165 and 166 (Figures 1 and 3) and the shaft 167 will drive the shaft 173 through the gears 171 and 172 (Figure 4). The shaft 85 thus will be driven through the clutch 178, and the worm 85 will drive the screw structure through the worm gear 84. The screw structure will be rotated in a counter-clockwise direction as viewed in Figure 9, in which case the collar 94 will be locked by the overrunning clutch 94' to the stem 93 to be positively driven with the body of the screw structure. Accordingly it will be apparent that the collar 94 will rotate within the threaded sleeve 29 to move the core mold downwardly. Attention is invited to the fact that the core mold is provided with a covering material having a low coefficient of friction when wet, such as rubber, and accordingly the core mold readily may be moved downwardly completely out of the mold. It will be noted that the external diameter of the core mold and its supporting structure is equal to the internal diameter of the table element 15, thus permitting the core mold to be moved downwardly until its upper edge is completely below the bottom of the mold proper.

The outer mold member with the molded article therein is then removed to the site of the curing process, whereupon the outer mold member is removed by releasing the latches 36, and returned to the machine for the next molding operation. As previously stated, the article will be of uniform high density, and will possess far greater strength than is true of pipes and similar concrete articles molded with prior types of apparatus. In this connection it is pointed out that a substantial saving in material may be effected since the pipe may be made thinner for a given use, and for this reason it ordinarily is necessary to use the filter means only in connection with the outer core member. For thicker articles it will be apparent that the filter means may be duplicated over the radially outer face of the inner mold member 22, the strands of fabric forming the filter means preferably being arranged at a 45° angle so as to permit ready expansion and contraction of the filter structure.

When it is desired to make the next article the mold elements are again reassembled, it being apparent however, that the core mold will have been arranged in its lowermost position following its withdrawal from the previously formed article. Assuming that the gear 129 will have been in mesh with the pinion 135 to withdraw the core mold downwardly, it will be apparent that when the sleeve 29 reached a position solely engaging the sleeve 98 (Figure 7) this sleeve will have been free to remain stationary during rotation of the screw structure, and the latter will be operative upon engagement of the gear 130 with the pinion 135 to move the core mold upwardly.

This operation reverses the previous direction of rotation of the screw structure 83, thus causing the overrunning clutch 99 to form a positive driving connection between the stem 97 and collar 98 to move the sleeve 29 upwardly. When the core mold reaches its operative position the sleeve 29 will solely engage the collar 94 and since the stem 93 will be rotating in a clockwise direction as viewed in Figure 9, the collar 94 is free to remain stationary. It will be apparent that the overrunning clutches associated with the collars 94 and 98 serve to prevent any damage to the apparatus through continued rotation of the screw structure after the inner mold member has fully reached either its operative or inoperative positions.

It will be apparent that the apparatus may be employed for making pipes and other similar cementitious articles of different diameters. The outer table element 16 forms a permanent part of the apparatus, but the inner table element 15 is replaceable for pipes or the like of different diameters, the table element 15 shown in Figure 1 being the one employed for making the maximum size pipe for the apparatus. Where smaller pipes are to be employed different table elements will be used having different internal diameters according to the external diameter of the core mold to be drawn therethrough. The external shape and size of each table member 15, however, will be the same in order that there may be proper engagement between the conical faces 17. Each table member will be provided with a manifold opening 44 and passages 43 and the latter will communicate through openings 42 (Figure 12) of whatever size lower pallet element is intended to be used for the particular table element 15. The platform 50 of the ram obviously is engageable with upper pallet elements 39 of different sizes, depending upon the size of pipe or the like which is being made.

Where an acid-proof lining is desired for the pipe or the like, a piece of suitable paper 201 is cut to a width equal to the height of the core mold and of a length equal to the circumference of the core mold plus a little allowance to provide a lapped joint when the paper is placed around the core mold in a manner to be described. The paper is placed flat on a suitable plate and then is covered with asphalt or the like to a suitable depth, for example, one-fourth inch. Sand or the like is then sprinkled evenly over the surface of the asphalt and effectively bonds therewith.

A sheet of flexible material is laid over the sand, and the plate, on which the paper has been placed to receive the coating of asphalt and sand, is tilted over to transfer the sheet to the flexible sheet laid thereover, the latter sheet serving as a support to facilitate the handling of the paper sheet. The paper sheet with the asphalt and sand thereon is then wrapped around a suitable cylinder 204 (Figure 14) which is of the same diameter as the inner core mold. If the paper is cut in the manner stated its length will be

slightly greater than the circumference of the cylinder **204** to overlap the ends of the paper, and these overlapping ends are secured together by applying a coat of asphalt between the overlapping ends and then rolling the cylinder **204** over the joint thus provided to seal the overlapping ends of the paper together.

The cylinder **204** is preferably provided with a depending annular flange of a size adapted to fit within the upper end of the core mold as shown in Figure 14, whereby the cylinder **204** will be centered with respect to the core mold. The outer surface of the core mold and the outer surface of the cylinder **204** will have been previously lubricated and accordingly it will be apparent that the paper and asphalt sheet may be readily slipped downwardly over the core mold. The paper sheet, being of a width equal to the height of the inner core mold will just cover the surface of this mold, and after it has been placed in position the cylinder **204** may be removed.

Upon the removal of the cylinder **204** from the top of the inner mold member, the mold is ready to be used in the manner previously described, the mold being filled while being oscillated on its axis, and then being closed and subjected to the pressure of the ram and the vertical vibratory motion. After the molding operation has been finished the article will be removed from the mold with the paper in position against the inner face of the layer of asphalt **202**. In the curing operation, the paper will be wetted and thus softened, whereupon it may be readily removed leaving the asphalt lining shown in Figure 15.

The use of the sand coating on the asphalt serves three purposes. In the first place, it prevents adhesion of the asphalt to the flexible sheet used to facilitate the placing of the sheet around the cylinder **204**. In the second place, the sand facilitates the moving of the paper sheet downwardly over the inner core member, the sand providing an anti-friction surface over which the operator's hands may be placed to slide the paper downwardly. In the third place, the sand, which was initially bonded with the asphalt, will become bonded with the pipe as the latter is formed, thus causing a close and permanent adhesion of the asphalt lining to the pipe.

It will be apparent that the apparatus is particularly useful in the practice of the method. The method forming the subject matter of the present invention broadly comprises subjecting the mix in the mold to the sustained pressure as provided by the ram, and simultaneously subjecting the mold to a vibratory motion transmitted thereto coaxially thereof, thus providing a resultant product of uniform high density and great strength. The method also contemplates the expressing of the water from the mold during the subjection of the mix to the pressure and vibration, and it also contemplates the facilitation of the removal of the water by the use of a partial vacuum, this step in the method not only reducing the time necessary for the operation of the mold but also facilitating the reduction of the water content in the mix to the desired minimum. The highly desirable results of the method are also greatly enhanced by the first step of the method employed for making the cylindrical articles, namely, the oscillation of the mold on its axis during the filling of the mold, attention being invited to the fact that this step of the method is practicable and advantageeous for the reason that the method permits the use of a normal amount of water in the mix whereby the mix is sufficiently thin to permit the oscillating movement to be effective in removing occluded air from the mix whereby the resultant uniform high density of the article is made possible.

The method, therefore, contemplates the oscillation of the mold on its axis during the filling of the mold. This step is important for two reasons in the production of the final article. In the first place, it facilitates the filling of the mold by accomplishing an even distribution of the material in the shortest possible time and eliminates any necessity for the manual spreading of the mix around the top of the mold before the molding operation is started. As stated, the use of the relatively thin mix necessary to the filling of the mold and the leveling of the mix at the upper end of the mold by oscillation of the mold is made possible because of the steps referred to which are employed during the molding operation. In the second place, oscillation of the mold on its axis during the filling of the mold tends to maintain a homogeneous distribution of the materials in the mix, thus resulting in a stronger final product.

While I have disclosed the preferred practice of the method, it is to be understood that the details of procedure of the method may be variously modified without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. The method of making concrete pipes and the like in a mold having its axis vertically arranged, which comprises filling the mold from the top thereof, oscillating the mold on its axis to compact the mix and discharge air therefrom, closing the top of the mold and then subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold to provide a resultant product of uniformly high density.

2. The method of making concrete pipes and the like in a mold having its axis vertically arranged, which comprises filling the mold from the top thereof, oscillating the mold on its axis to compact the mix and discharge air therefrom, closing the top of the mold and then subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold, and expressing excess water from the mold during the application of said pressure and said vibratory motion, to provide a resultant product of uniformly high density.

3. The method of making concrete pipes and the like in a mold having its axis vertically arranged, which comprises filling the mold from the top thereof, oscillating the mold on its axis to compact the mix and discharge air therefrom, closing the top of the mold, subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold, and connecting a source of partial vacuum to the interior of the mold to assist in removing water therefrom to provide a resultant product of uniformly high density.

4. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, and then simultaneously subjecting the mix to a sustained pressure exerted coaxially

of the mold and transmitting a vibratory motion to the mold coaxially thereof to provide a resultant product of uniformly high density.

5. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, simultaneously subjecting the mix to a sustained pressure exerted coaxially of the mold and transmitting a vibratory motion to the mold coaxially thereof, and expressing excess water in the mix from the mold during the transmission of said pressure and said vibratory motion to provide a resultant product of uniformly high density.

6. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, closing the top of the mold and then subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold to provide a resultant product of uniformly high density.

7. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, closing the top of the mold and then subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold, and expressing excess water from the mold during the application of said pressure and said vibratory motion, to provide a resultant product of uniformly high density.

8. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, simultaneously subjecting the mix to a sustained pressure exerted coaxially of the mold and transmitting a vibratory motion to the mold coaxially thereof, and connecting a source of partial vacuum to the interior of the mold to assist in removing water therefrom to provide a resultant product of uniformly high density.

9. The method of making concrete pipes and the like which comprises pouring a relatively thin mix into a mold and simultaneously oscillating the mold on its axis to uniformly distribute and compact the mix in the mold and discharge air therefrom, closing the top of the mold, subjecting the mix in the mold simultaneously to a sustained pressure and a vibratory motion both applied axially of the mold, and connecting a source of partial vacuum to the interior of the mold to assist in removing water therefrom to provide a resultant product of uniformly high density.

EDWARD D. BOYLE.