

Dec. 17, 1963

H. D. BOGGS ETAL

3,114,173

APPARATUS FOR LOADING PIPE CASTING MOLDS

Original Filed June 28, 1956

9 Sheets-Sheet 1

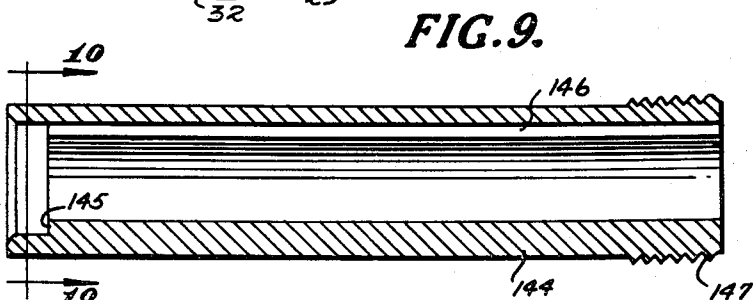
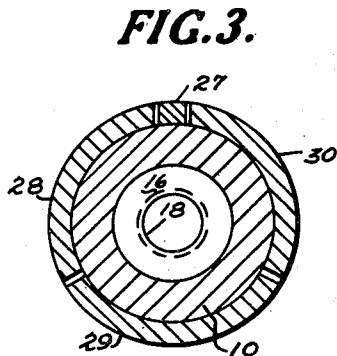
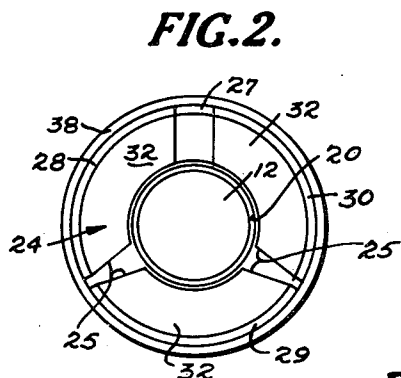
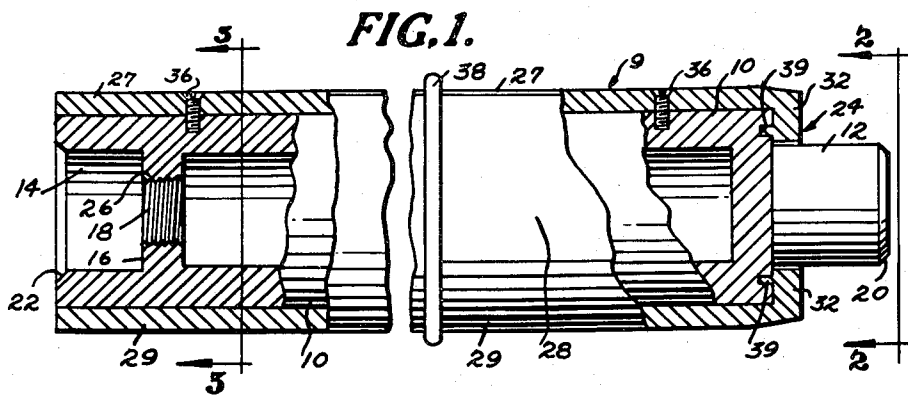
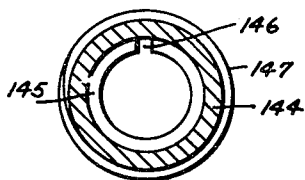


FIG. 10.



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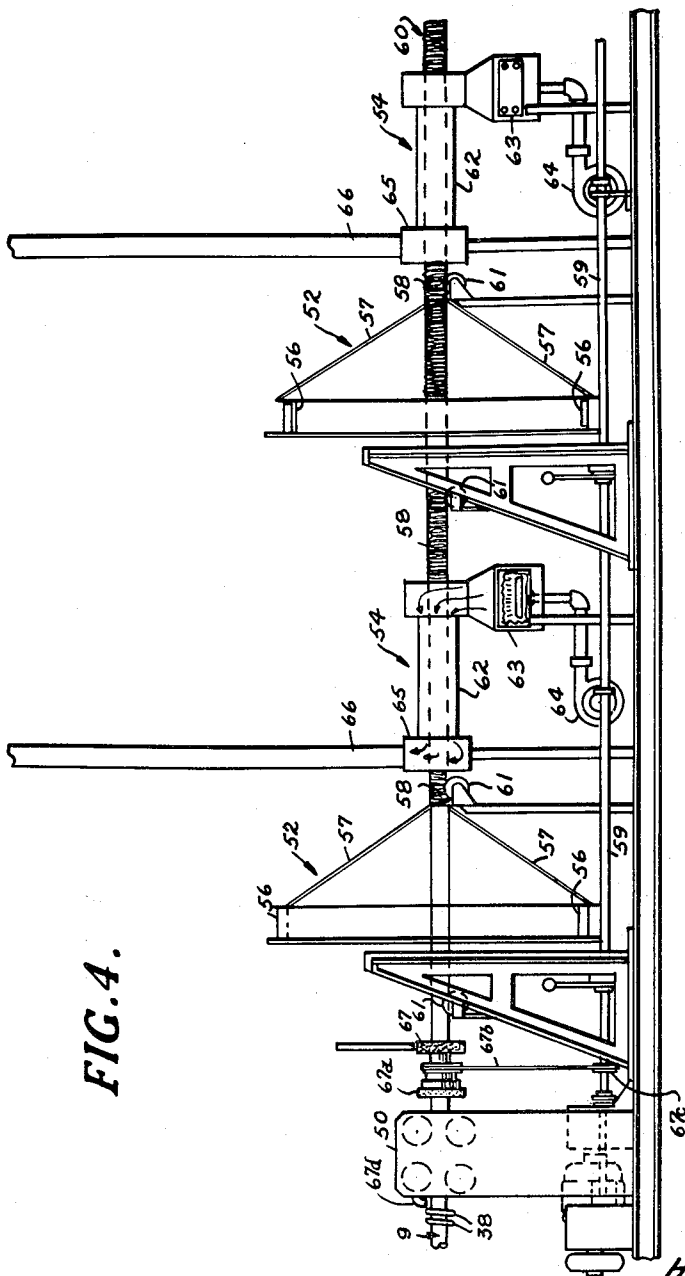


FIG. 4.

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FIG. 5.

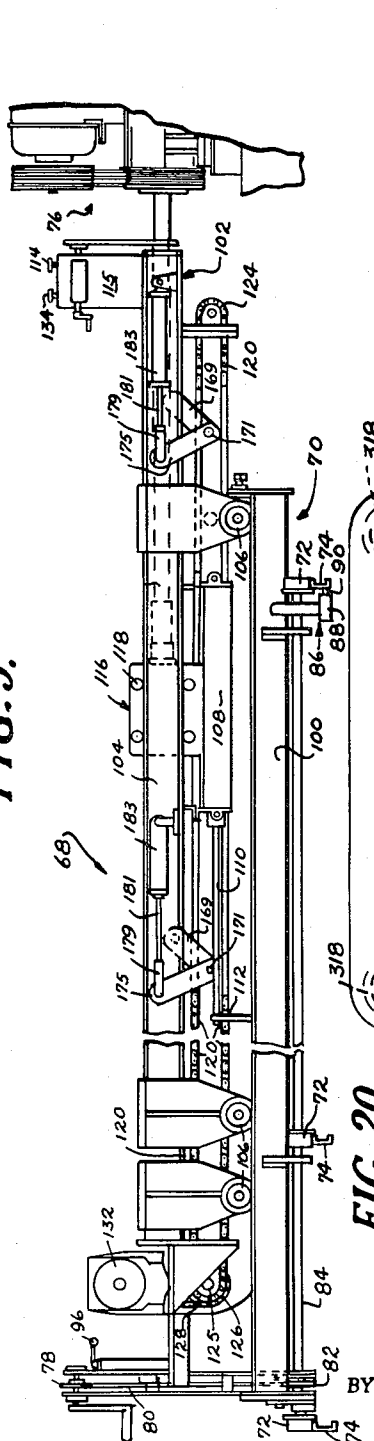
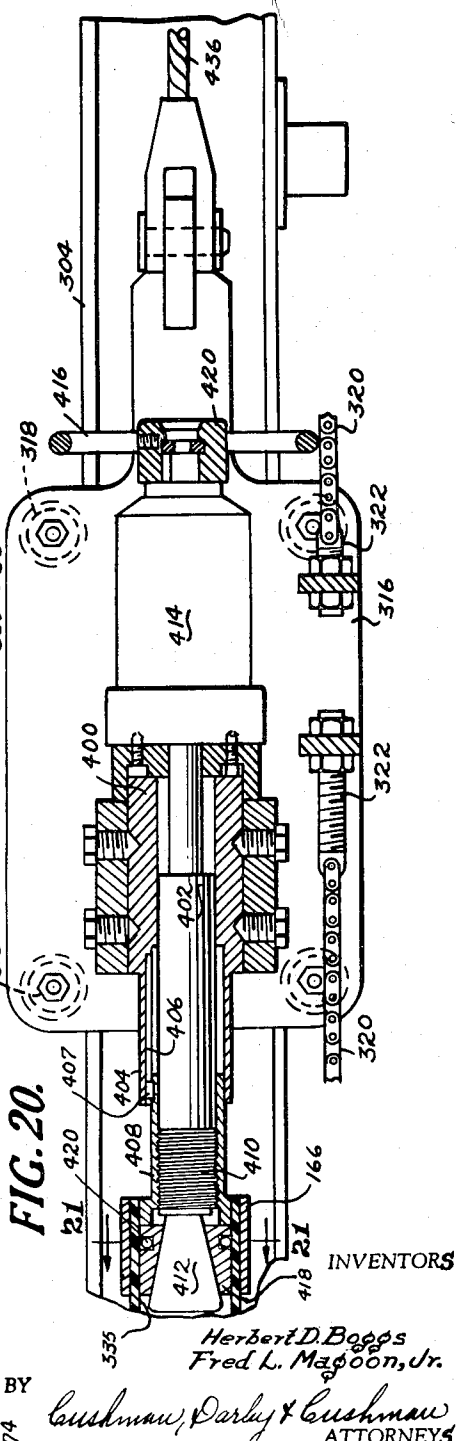


FIG. 20.



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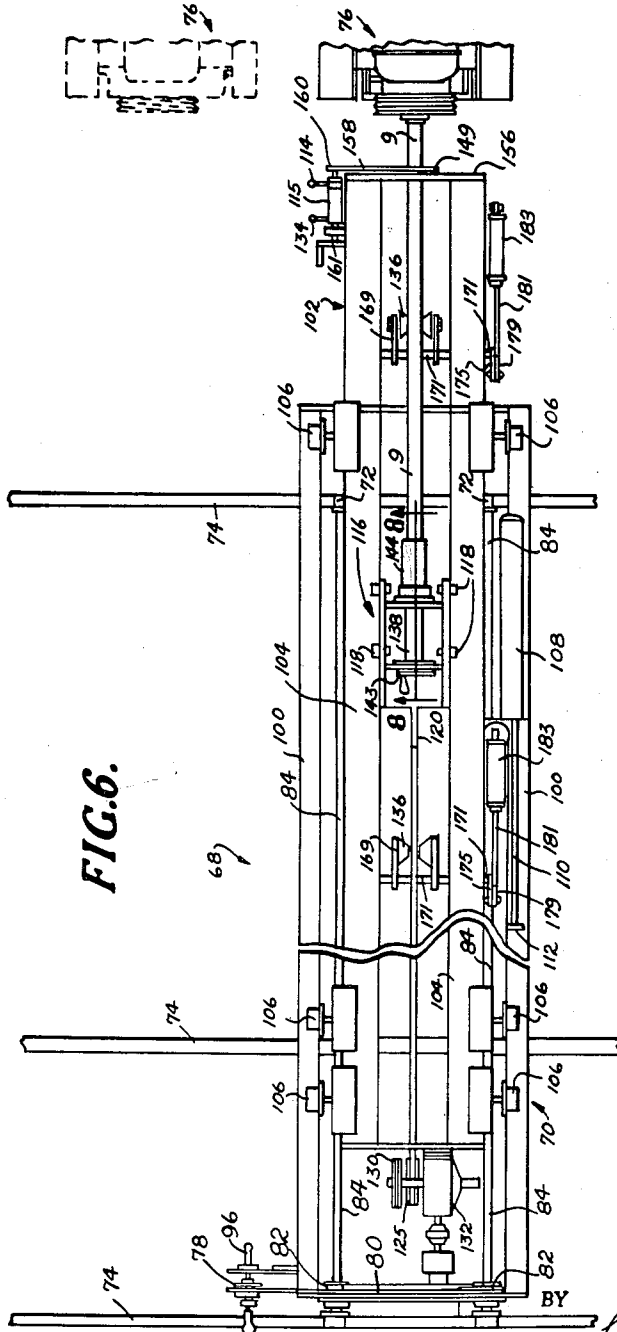


FIG. 6.

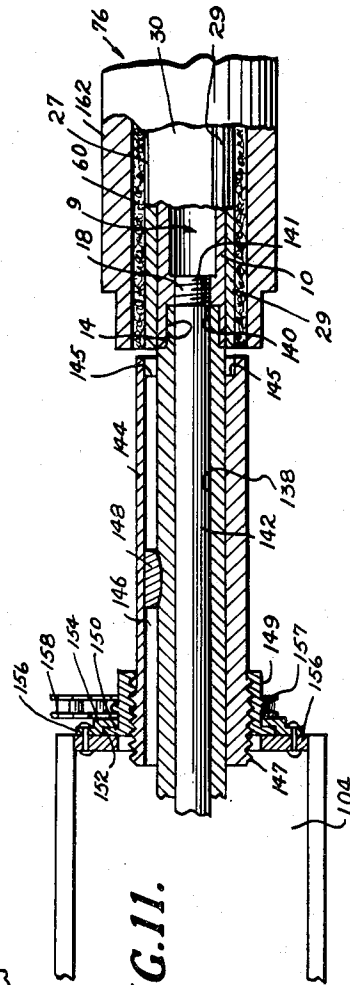


FIG. 11.

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FIG. 18.

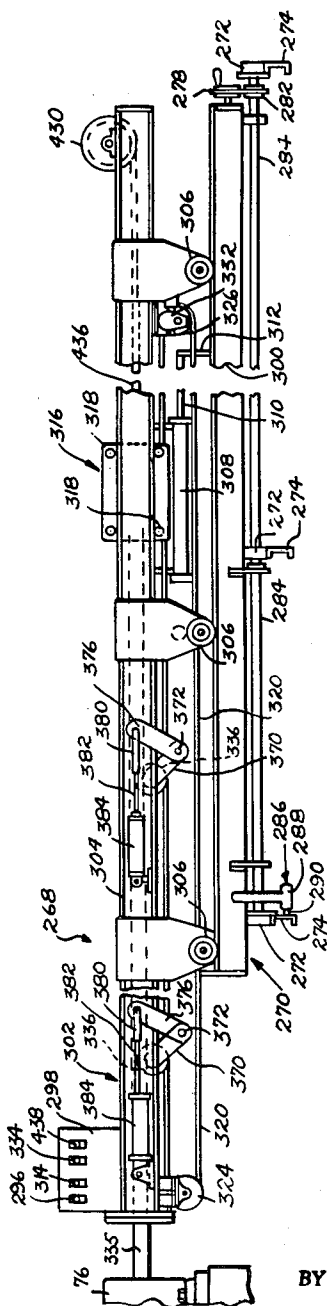


FIG. 21.

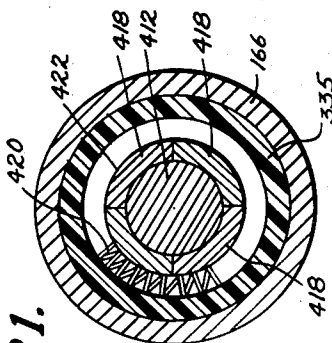
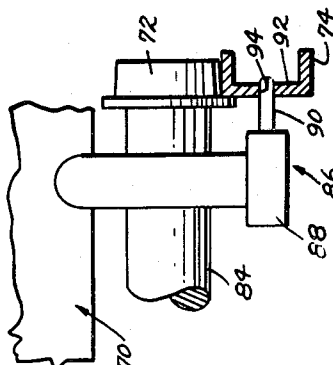


FIG. 7.



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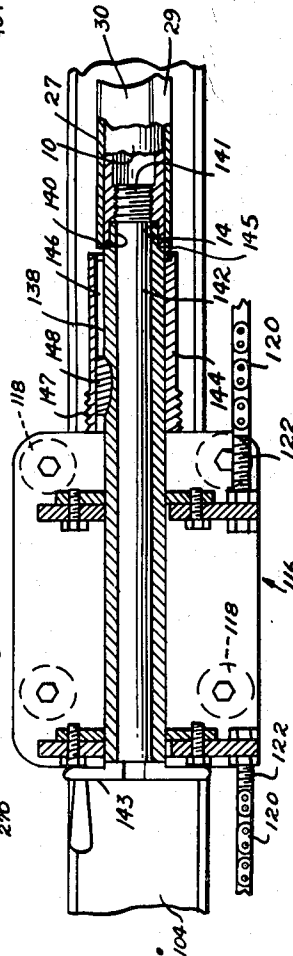
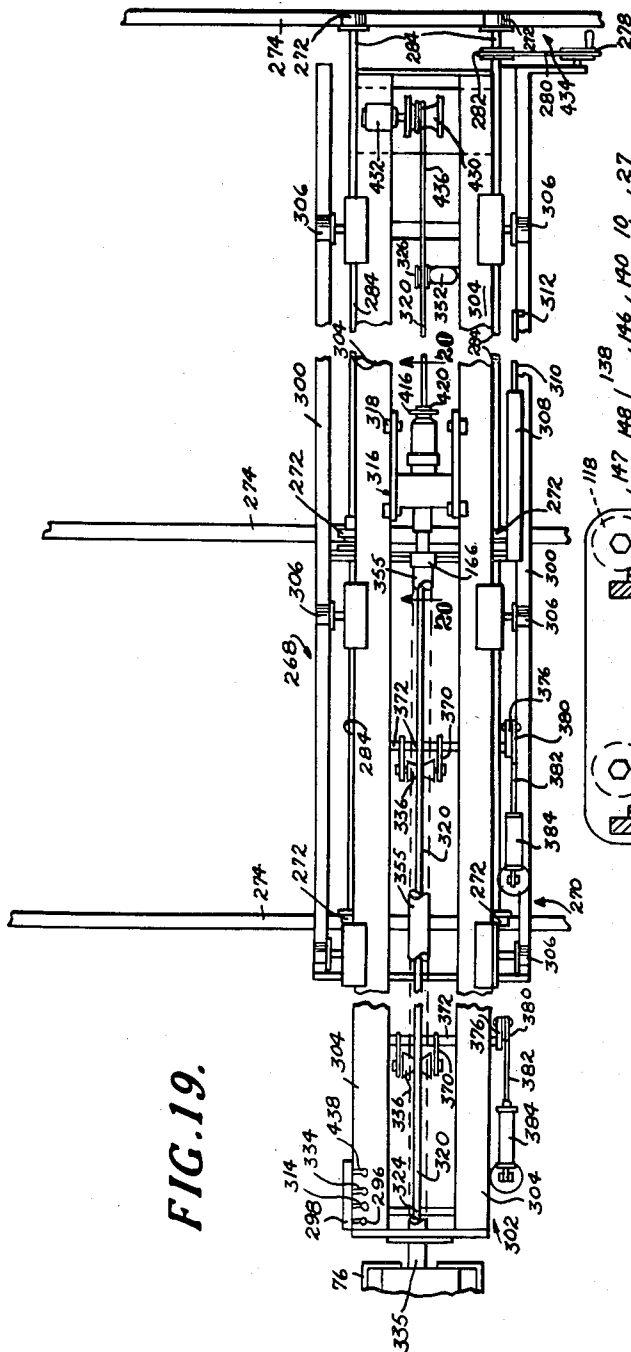
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FIG. 12.

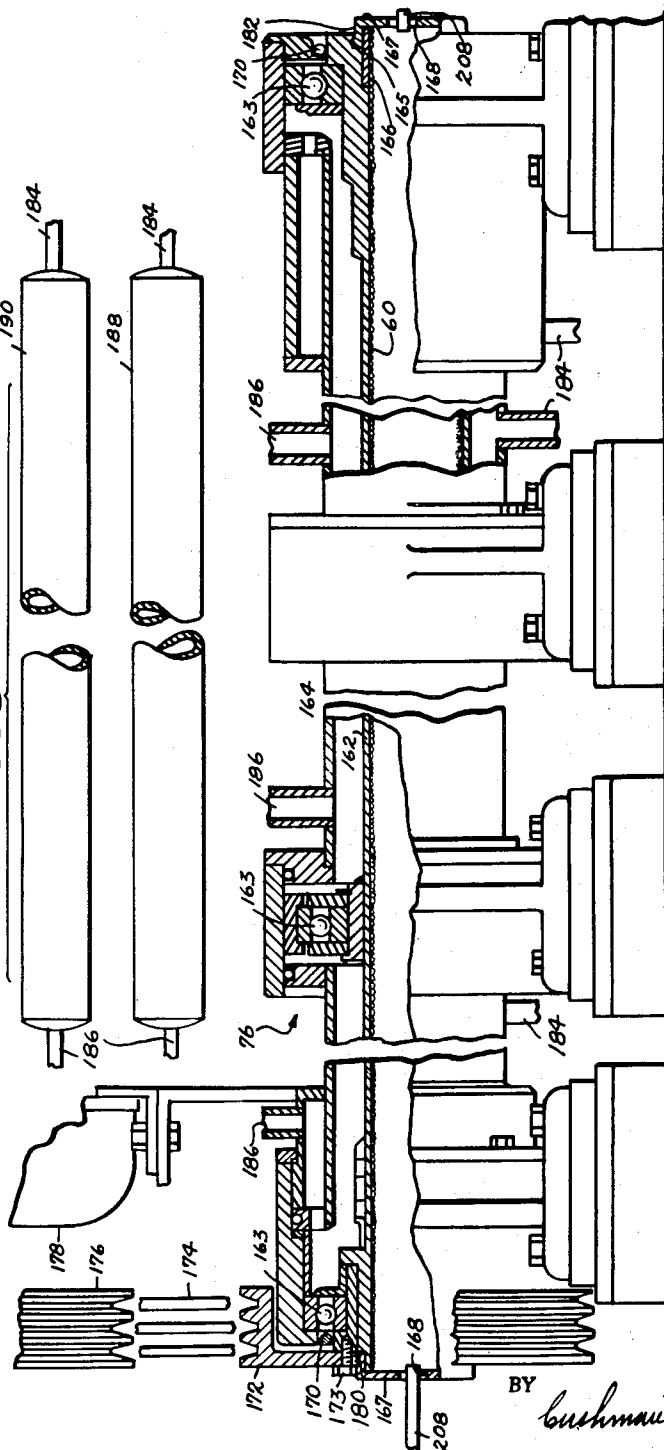
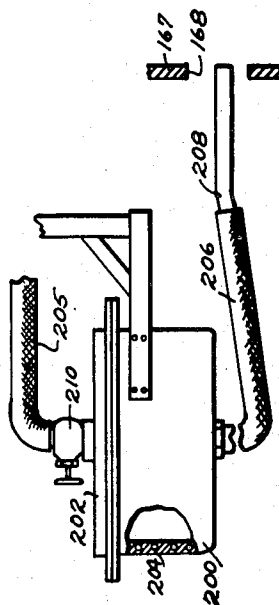


FIG. 13.



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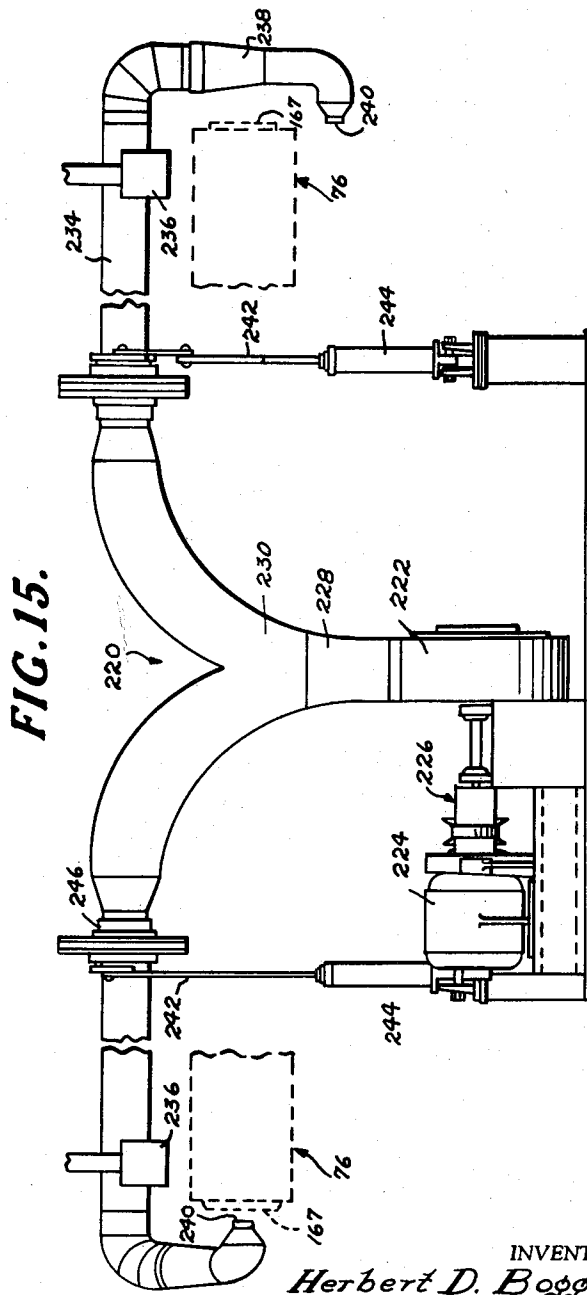
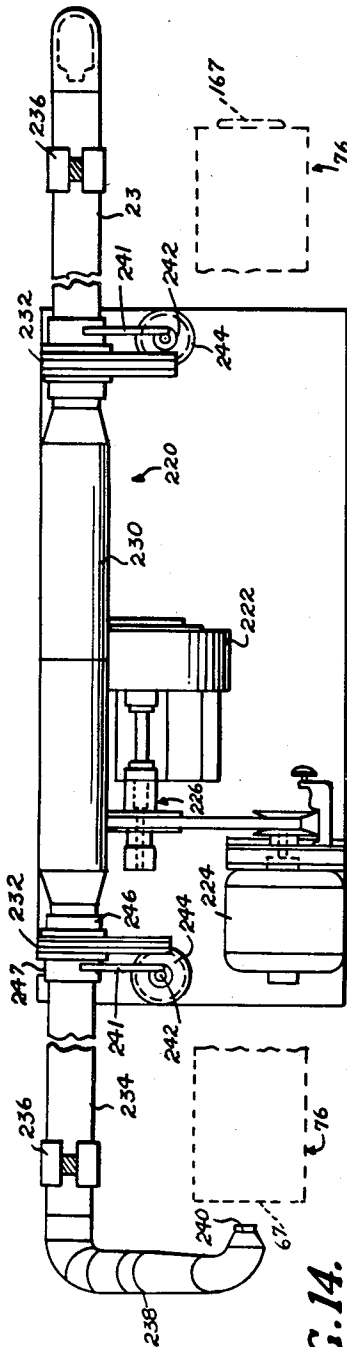
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APPARATUS FOR LOADING PIPE CASTING MOLDS

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9 Sheets-Sheet 8



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FIG. 16.

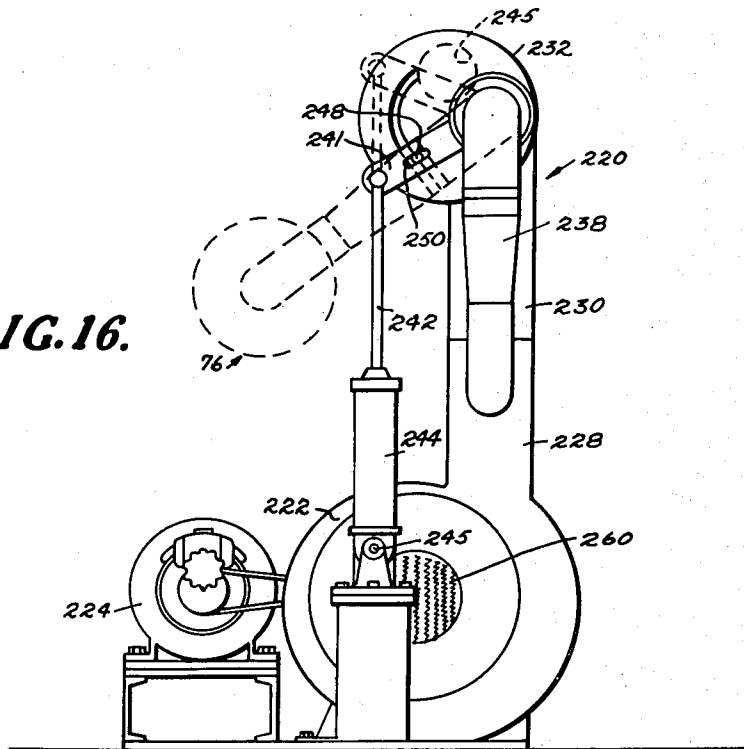
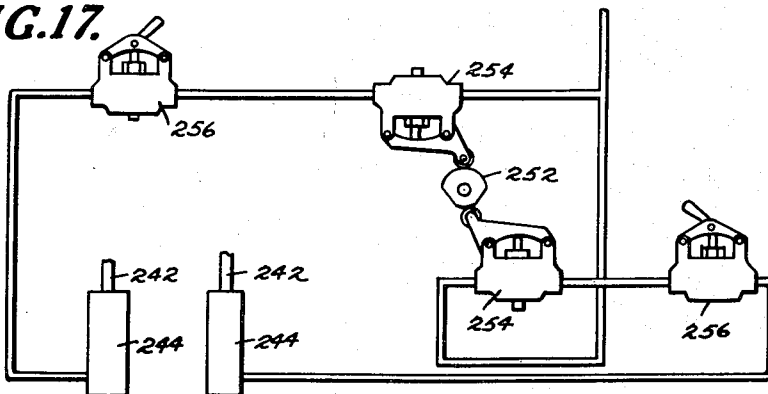


FIG. 17.



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3,114,173

APPARATUS FOR LOADING PIPE CASTING MOLDS

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Original application June 23, 1956, Ser. No. 594,565, now Patent No. 2,997,737, dated Aug. 29, 1961. Divided and this application Dec. 29, 1960, Ser. No. 79,295
10 Claims. (Cl. 18—26)

This invention relates to methods and apparatus for the manufacture of plastic pipe, and, more particularly, of centrifugally cast plastic pipe which is reinforced by woven glass filaments.

The arts concerning the manufacture of fibrously reinforced plastic piping and, more specifically, piping formed from thermosetting plastic material, such as thermosetting resins, and reinforced with various fibrous elements, and more specifically with fibrous elements formed of glass filament formations, have been extensively disclosed and discussed in detail in the copending applications of H. D. Boggs, Serial No. 200,193, filed December 11, 1950, now Patent No. 2,776,450, Serial No. 264,976, filed January 4, 1952, now Patent No. 2,785,442, and Serial No. 459,092, filed September 29, 1954, now abandoned, and in the following copending applications assigned to a common assignee: Kenneth A. Schafer, Serial No. 280,766, filed April 5, 1952, now abandoned, and Lewis Perrault, Serial No. 404,329, filed January 15, 1954, now abandoned.

It is within the contemplation of this invention to prepare uniformly formed, fibrously reinforced, plastic piping of the type illustrated or discussed in some of these applications, as well as provide improvements in the apparatus and methods, for preparing such plastic pipe, described in others of these applications.

It is therefore an object of this invention to provide new and improved means, and new and improved combinations of means, for manufacturing fibrously reinforced plastic pipe.

It is another object of this invention to provide new and improved apparatus for manufacturing fibrously reinforced plastic pipe which provides greater uniformity of product and better quality control.

It is another object of this invention to provide new and improved apparatus for manufacturing fibrously reinforced plastic pipe, which apparatus can be easily and continuously operated by a small labor force.

More particularly, it is an object of this invention to provide new and improved means for the insertion of the elongated fibrous reinforcement element into a mold wherein the pipe is to be formed by the introduction of a plastic material into and about the fibrous reinforcement element.

These and other objects of this invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawings in which:

FIGURE 1 is an elevational view, with portions broken away, to show details of interior construction of a mandrel assembly;

FIGURE 2 is an end view of the mandrel taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a section taken along lines 3—3 of FIGURE 1;

FIGURE 4 is an elevational view of the braiding and cleaning apparatus;

FIGURE 5 is an elevational view of the mold-feeding assembly;

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FIGURE 6 is a plan view of the mold-feeding assembly;

FIGURE 7 is an elevational view, partially in section, illustrating details of the means for locking the mold-feeding assembly in position;

FIGURE 8 is a section taken along lines 8—8 of FIGURE 6;

FIGURE 9 is a vertical sectional view of a collar;

FIGURE 10 is a section taken along lines 10—10 of FIGURE 9;

FIGURE 11 is a vertical sectional view of the collar illustrated in FIGURES 9 and 10 being threaded into position at the mold end of the mold-feeding assembly;

FIGURE 12 is an elevational view, partially in section, of the mold assembly;

FIGURE 13 is an elevational view, with portions broken away to illustrate interior details, of the resin impregnating means;

FIGURE 14 is a plan view of the air-blowing assembly; FIGURE 15 is an elevational view of the air-blowing assembly;

FIGURE 16 is an end view of the air-blowing assembly;

FIGURE 17 is a schematic diagram of the air pressure system used in energizing the air-blowing assembly;

FIGURE 18 is an elevational view of the pipe-ejecting assembly;

FIGURE 19 is a plan view of the pipe-ejecting assembly;

FIGURE 20 is a section taken along lines 20—20 of FIGURE 19; and,

FIGURE 21 is a section taken along lines 21—21 of FIGURE 20.

General Description

Before making a detailed disclosure of the apparatus and methods for forming plastic pipe which constitute this invention, a general description will be presented.

The apparatus of this invention includes a mandrel assembly upon which reinforcement elements in the form of concentric sleeves or tubes of glass fiber are woven or braided by conventional braiding apparatus. The mandrel assembly consists of a cylindrical mandrel core enclosed within a cylindrical mandrel sleeve, the latter being separated into several longitudinally extending segments. A plurality of fibrous tubes are braided in concentric layers on the exterior of the assembled mandrel, with each of the fibrous tubes being subjected to a heat cleaning treatment prior to being circumscribed by the next tube. Each mandrel assembly has a length equal to a length of the sections of the pipe to be formed and is arranged to smoothly abut, in tandem relation, against another mandrel assembly to form, in effect, a continuous mandrel, so that the braiding machines form continuous lengths of concentric fibrous tubes which are subsequently cut off in lengths approximating that of each individual mandrel assembly.

In other words, after the concentric fibrous reinforcement elements have been formed upon the tandemly arranged mandrels, the mandrels are separated with reinforcement elements being cut at the points of separation. Thereafter each mandrel, which is circumscribed by a reinforcement element consisting of two or more concentric woven fibrous sleeves or tubes, is placed on a mold-feeding assembly, which serves a plurality of pipe casting molds. The mold-feeding assembly is aligned with, and selectively positioned relative to, a selected mold and then mechanisms thereon are operated to insert the mandrel assembly, together with the woven reinforcement element, into the mold. Other mechanisms on the mold-feeding assembly are then operated to withdraw the core of the mandrel assembly from the mold, leaving a major portion of the mandrel sleeve, together with the fibrous

reinforcement element, therewithin. The remaining elements or segments of the mandrel sleeve are then removed by hand, or by other means, to leave the woven fibrous reinforcement element smoothly disposed against the inner periphery of the cylindrical casting mold.

This invention also includes means for introducing heat settable material, such as thermosetting resins and the like, through the ends of the molds and uniformly along the entire length of the interiors thereof in a manner which will not disturb the placement of the individual fibers of the woven fibrous reinforcement element disposed therewithin.

This invention further includes means for centrifugally casting plastic impregnated fibrously reinforced piping by providing means for concurrently heating and rotating the mold, as well as for concurrently cooling and rotating the mold.

It is also within the contemplation of this invention to provide means for uniformly heating the contents of the mold, prior to the heat setting of the thermosetting material, by blowing heated air through alternating ends of the mold.

It is also within the contemplation of this invention to provide means for uniformly cooling newly formed plastic impregnated, fibrously reinforced pipe while it is undergoing an exothermic reaction within the mold, just after it has been heat set into its final physical form, by blowing air through the alternating ends of the mold.

There is a pipe ejecting assembly, arranged to serve a plurality of the casting molds, which is aligned with a mold in which the plastic pipe has been formed, and which carries mechanisms thereon to withdraw the newly formed plastic pipe from the molds in a manner which eliminates any danger of damage to the pipe.

For the sake of clarity, the various apparatus and means briefly described hereinabove will be separately described and illustrated.

The Mandrel Assembly

Referring to FIGURE 1, the mandrel assembly, generally indicated at 9, includes a mandrel core 10 which is formed of cylindrical stock and may be hollow to save material and avoid excessive weight. One end of the mandrel core 10 has a cylindrical projection 12 of reduced diameter, and the other end is formed to define a cylindrical socket 14, which is dimensioned to snugly, but slidably, receive a projection 12 from another identical mandrel. The bottom or end wall 16 of the socket 14 has a centrally located threaded aperture 18 therein, although if the mandrel core 10 is formed of solid stock, the aperture will be replaced by a similarly located threaded socket.

The free end of the projection 12 may be beveled, as at 20, and the mouth of socket 14 may be beveled, as at 22, to facilitate the entrance of a projection into the socket. Similarly, the mouth of the aperture 18 may be beveled, as at 26, to aid in the reception of either a projection 12 of another similar mandrel or a member which will be described hereinafter. It should be noted that the axial length of each projection 12 is somewhat greater than the depth, or axial length of each socket 14, the difference in length being substantially equal to the axial length of a collar, generally indicated at 24, formed by the end portions of the slips 27, 28, 29, and 30 (FIGURES 2 and 3), which will now be described.

Each mandrel is provided with a plurality of, and in a preferred embodiment four, slips 27, 28, 29, 30. The slips 27, 28, 29 and 30 are formed of relatively thin lengths of metal, each having an arcuate cross section, and the slips of a given mandrel, when properly arranged together, form a cylindrical sleeve which encloses the exterior periphery of the mandrel core 10 and which extends the entire length thereof. Each of the slips has a shoulder 32 welded, or formed, thereon to extend radially inward, relative to the arcuate curvature of a section

thereof. The free end of each of the shoulders 32 is arcuately curved, about the same center as the arcuate curve of its slip, so that the combination of the shoulders of all of the slips 27, 28, 29 and 30 fitted on a given mandrel core 10 form an inwardly extending, circumferential collar, generally indicated at 24, on the sleeve formed thereby. Actually, as best shown in FIGURE 2, this circumferential collar is only approximated and is not complete because the radially-inwardly extending neighboring surfaces 25 of some of the shoulders 32 are not parallel, but rather diverge, by perhaps 30°, as they extend inwardly. The approximated collar 24 has an interior diameter somewhat greater than the exterior diameter of the projection 12, and, as best shown in FIGURE 1, the thickness of the approximated collar 24, that is to say its axial length, is approximately equal to the difference between the length of the projection 12 and the depth, i.e., axial length, of the socket 14. It will therefore be seen that when identical mandrel cores 10, each fitted with an enclosing sleeve formed by the slips 27, 28, 29 and 30, are tandemly aligned, and then moved into axial abutment, the several mandrel assemblies 9 will form an essentially continuous mandrel having a substantially smooth and unbroken cylindrical exterior.

While in the illustrated preferred embodiment there are four slips 27, 28, 29 and 30, it is within the contemplation of this invention that there may be more or less. In any event, one of the slips 27, which is preferably small, i.e., narrow, is permanently affixed, as by screws 36 (FIGURE 1), to the mandrel core 10. The other slips are held in position by a circumferential tension spring 38, one or more of which may circumscribe the entire mandrel assembly 9.

Referring to FIGURE 1, it will be seen that each shoulder 32 has a small pin 39 on the inner surface thereof, that is on the surface abutting the end surfaces of the mandrel core 10, and that the end surface of the core has a complementary socket to snugly receive this pin.

The Braiding and Cleaning Apparatus

Referring to FIGURE 4, the tandemly aligned and axially abutting and interfitting mandrel assemblies 9 are fed, by hand or by any means, onto a power driven pinch roll stand 50, which urges them through a series of alternating braiding and heat cleaning devices, generally indicated at 52 and 54, respectively. The braiding machines 52, which may be of any standard form and design, and which are merely outlined in FIGURE 4, are equipped with a number of braider heads 56, and in a preferred embodiment with 96 braider heads, to weave glass filament threads 57 into a braided tube 58 about the mandrel assemblies 9. In some cases the braiding machines will include means to lay a plurality of separate strands on the surface of the mandrel assembly to extend longitudinally thereof in peripherally spaced relationship, the braiding means and the last mentioned means being co-operatively arranged to braid the woven strands about the longitudinally extending strands. The braiding machines 52 and the pinch roll stand 50 are all powered by a common drive shaft 59 so that there is a fixed relation between the speed of the rotation of the braider heads 56 about the lengths of mandrel assemblies 9 and the axial movement of these mandrel assemblies through the braiding machines. When, in accordance with this invention, successive layers or plies of the tubular reinforcement element, generally indicated at 60, are desired, several braiding machines 52 are arranged in alignment to form successive plies upon the substantially continuous mandrel assemblies 9 passing therethrough, one such machine being provided for each ply. The mandrel is supported by rollers 61, one being located on each axial side of each braiding machine.

Standard glass filament threads which are currently available are manufactured and supplied to the industry with a coating, such as starch or oil, on the filaments to

act as a lubricant during subsequent handling. It has been discovered that it is desirable to remove all such coatings from the filaments prior to the using of reinforcing elements formed therewith in the casting of fibrously reinforced plastic pipes with thermosetting resins, as such a coating serves to prevent, or at least retard, the forming of a satisfactory adhesion or bond between the resin and the glass fibers. For instance, it has been found that certain coatings will form air bubbles on the glass filaments during the curing of the resin. As has been explained in the copending application, Boggs application No. 459,092, filed September 29, 1954, a satisfactory bond between the resin and the individual fibers of the reinforcement element is essential if a sufficiently strong, non-weeping, and pressure resistant pipe is to be formed.

It is therefore within the contemplation of this invention to remove such a coating by the provision of a heat cleaning device, generally indicated at 54, between each of the braiding heads. Due to the fact that glass is a good insulator, it is preferable to remove this coating, when present after each ply is formed or braided on the mandrel and hence, to provide a separate cleaning oven 62 at the discharge side of each braiding machine. It has been found that due to the high heat conductivity of the metallic mandrel assembly 9, a higher oven temperature is required to remove the coating on the first layer or ply on the mandrel, than is required in the subsequent ovens because the second and subsequent plies are insulated from the mandrel by the first ply, or the inner plies. As a filament temperature of approximately 600°-850° F. is required to satisfactorily destroy the coating on the glass, it has been found that satisfactory results may be obtained when the temperature of the first oven, which heats the innermost ply, is in the range of 1500°-1800° F., and when the temperature of the successive ovens are in the range of 1500° F. All of the oven temperatures set forth are on the basis of the sleeve being braided, and hence, the continuous mandrel being moved, at a speed of 33 to 61 inches per minute, and it is believed that the oven temperature ranges may be varied to some degree, depending upon the speed of the mandrel, the length of the oven, the thickness of the braid, and the particular coating which is used upon the glass fibers being braided.

In a preferred embodiment of this invention, the heat-cleaning device 54 consists of an elongated cylindrical chamber or oven 62 surrounding the axially moving mandrel assemblies 9 which are covered with one or more layers of braided glass fiber tubing 58. Each oven is connected by suitable ducts with a small furnace, preferably a gas furnace 63, which is supplied with gas and an excess of combustion air by compressor-mixer 64. The combustion products and the heated excess air travel to the oven 62 and thence to a collection ring 65 and out through vent 66. It should be recognized that the specific design of the furnace and oven can be considerably varied within the scope of this invention and that any other similar arrangement may be utilized to bring the temperature of the filaments of the tube 58, or filaments of the outside tube if there are more than one, up to a temperature of a range of 600° to 850° F. so that the coating of starch and oil on the glass fibers will carbonize. It has been found that once the starch and oil coating on the fibers has been carbonized, it no longer affects the bond between the glass and the resin, and, further, that the carbon acts satisfactorily as a filler in the pipe body. It will now be understood that it may be desirable to coat the outer surface of the mandrel assembly 9, i.e., the outer surface of the slips 27, 28, 29 and 30, with a silicone release agent, such as a standard commercial high temperature silicone grease, by means of a felted brush 67, as it leaves the pinch roll 59, so that the innermost tube will not adhere to the mandrel assembly and thus hinder the subsequent removal thereof, in a manner which will be described in detail hereinafter.

It may be desirable to pre-clean the exterior of the

mandrel assembly by means of a circumferential wire brush 67a which is formed to receive a belt drive 67b which is, in turn, rove over a spindle 67c, fitted on power shaft 59, so that the wire brush will be positively actuated to revolve about the mandrel assembly.

It will now be understood that tension spring 38, which helps hold the slips 28, 29 and 30 on the mandrel core prior to the first braiding operation, must not be allowed to enter the braiding machines. A guard 67d is therefore fitted on the entry side of the pinch roll stand 50 to catch these springs.

After an individual mandrel has been passed through several braider heads and ovens, and has received the desired number of plies or layers of braided tubing, the continuous reinforcement element 60, consisting of the concentric fibrous tubes 58, is cut at the points of intersection of a given mandrel assembly 9 with its neighboring mandrel assemblies. The ends of the reinforcement element 60 are tied or taped to prevent the braid from unraveling and the mandrel assembly is then transported to the mold-feeding assembly.

The Mold-Feeding Assembly

Referring to FIGURES 5 and 6, it will be seen that a mold-feeding assembly, generally indicated at 68, includes an elongated base frame, generally indicated at 70, which is mounted on flanged wheels 72 for movement along relatively transversely extending fixed rails 74 so that the entire mold-feeding assembly can be transversely moved between a number of positions corresponding to a number of casting molds, generally indicated at 76. In a preferred embodiment, the transverse movement of the entire mold-feeding assembly 68 is selectively controlled by a hand operated sprocket wheel 78 which is connected by a chain drive 80 to a sprocket 82 on the shaft 84, upon which the wheels 72 are non-rotatably mounted. As will be evident hereinafter, it is quite important that the entire mold-feeding assembly 68 be properly aligned with the axis of the particular mold which it is to service and the means for attaining this exact alignment will now be described.

Depending from the mold-feeding assembly base frame 70 is an air lock assembly, generally indicated at 86 (FIGURES 5 and 7), consisting of a pneumatic cylinder 88 having a piston rod 90 extending therefrom, with the entire assembly being so located that when the piston rod 90 is being pneumatically urged outward, it bears against the web 92 of one of the fixed rails 74. The web 92 of this rail 74 has one aperture 94 drilled therein, or a recess formed therein, at the same level as the piston rod 90, for every mold 76 which is to be served. The aperture 94 is dimensioned to receive the piston rod 90, in a manner to lock the entire mold-feeding assembly 68 against further transverse movement, and is so transversely (of the mold-feeding assembly 68) located as to receive the piston rod when the entire mold-feeding assembly is properly aligned with a given mold. The air lock assembly 86 may be remotely controlled, by a valve 96 located near the sprocket wheel 78 (FIGURES 5 and 6), to urge the piston rod 90 outwardly, or towards an extended position, when it is intended to lock the mold-feeding assembly 68 in a desired position, that is to say in alignment with a particular mold, and also to urge the piston rod to a retracted position, clear of the apertures 94, when it is desired to unlock the mold-feeding assembly before moving it to a new position.

Referring again to FIGURES 5 and 6, the transversely movable base frame 70, which consists essentially of a pair of suitably braced, longitudinally extending, spaced parallel rails 100, which may be formed of I-beams or the like, has a second frame, generally indicated at 102, which consists essentially of a pair of suitably braced, longitudinally extending, spaced parallel rails 104, which may be formed of I-beams or the like, mounted thereon. The second frame 102 is supported on flange wheels 106 which are arranged to roll along rails 100 when the

second frame is moved longitudinally of the base frame 70. Such movement is obtained by a pneumatic cylinder 108, depending from the second frame 102, having the free end of its piston rod 110 fixed to a fixed upstanding member 112 on the base frame 70. The pneumatic cylinder 108 is double acting and is coupled, by suitable lines, to a three-way control valve 114 located on the operated panel 115.

A mold-feeding carriage, generally indicated at 116, is disposed upon the rails 104 to move longitudinally thereof on wheels 118. The mold-feeding carriage 116 is positively actuated to move longitudinally of second frame 102 by a chain drive 120 extending longitudinally of the rails 104, and approximately midway therebetween, at a level slightly below their upper surface. The chain drive 120 is secured, at each end, to the mold-feeding carriage 116, as by draw bolts 122 (FIGURE 8), and extends around an idler sprocket 124 mounted at the mold end of the rails 104 and around a power sprocket 125 mounted at the opposite end of these rails. The power sprocket 125 is non-rotatably fixed to a coaxial drive sprocket 126 which is, in turn, engaged by chain drive 128 to a sprocket 130 fixed on the shaft of reversible air motor 132, the latter being remotely controlled by a three-way valve 134 located on the operating panel 115.

As the mold-feeding carriage 116 serves to convey an individual mandrel assembly 9, circumscribed by a reinforcement element 60, consisting of one or more layers or plies of braided tubing, into a waiting casing mold 76 and, further, to withdraw a mandrel core 10 from a mold, there are provided several mandrel supporting rollers 136 to bear the weight of the mandrel during the periods when it is on, or partially on, the mold-feeding assembly 68.

Referring more particularly to FIGURE 8, cantilevered from the mold-feeding carriage 116 is a tube 133 of heavy stock extending toward the mold end of the rails 104. The tube 133 has an exterior diameter substantially equal to the exterior diameter of the mandrel core 10, and the free end thereof is formed with a projection 140 of reduced exterior diameter which is dimensioned to fit into the socket 14 of the mandrel core. Loosely fitted within the tube 133 is a mandrel engaging shaft 142 having a threaded end 141 which normally extends outwardly from the reduced end 140 of the tube, that is, the end towards the casting molds 76. This threaded end 141 is so dimensioned that its threads will operatively engage the threaded aperture 18 in the bottom or end of socket 14. The opposite end of the mandrel engaging shaft 142 extends without the opposite end of tube 133 and has a hand wheel 143 fitted thereto.

A collar 144 having an internal diameter slightly greater than the exterior diameter of the mandrel core 10, and somewhat smaller than the exterior diameter of the assembled slips 27, 28, 29 and 30, is loosely fitted on the mold end of the tube 133. As shown in FIGURES 9 and 10, the collar 144 is formed with a longitudinally extending keyway 146 which has a width and depth slightly greater than the width and height of fixed slip 27. That is to say, the collar interior, including its keyway 146, is so dimensioned as to allow the mandrel core 10, together with the fixed slip 27, to move therethrough when the keyway is properly indexed with the fixed slip. The end of the collar located nearest the mold 76 has a short counterbore dimensioned to receive the entire mandrel assembly 9, the counterband defining a parannular abutment 145, the annulus defined by the abutment being broken by keyway 146. The exterior of the collar 144 has a few turns of raised heavy-duty threads 147 formed thereon on the end furthest from the mold 76 for reasons which will be apparent hereinbelow. The exterior of tube 133 has a key 148 mounted thereon to fit into keyway 146 to prevent relative rotation between the collar 144 and the tube 133.

In operation, the entire mold-feeding assembly 68 is aligned with the particular mold 76 to be supplied with a reinforcement element 60 and the second frame is correctly positioned, longitudinally of the base frame, in a manner which will become evident hereinafter. A mandrel assembly 9, which has been passed through the alternating braiding machines 52 and heat cleaning ovens 54, and which has reinforcement element 60, consisting of a number of concentric braided fibrous tubes, formed thereon, is placed upon the mandrel supporting rollers 136, with the end having the recess 14 facing the mold-feeding carriage 116, which is then disposed at the ends of the rails 104 which are furthest from the mold 76. The mandrel assembly is so indexed that the fixed slip 27 is angularly aligned with the keyway 146 of the collar 144. The mold-feeding carriage 116 is then moved, by air motor 132, toward the mold 76 to a position wherein the reduced end 140 of the tube 133 fits within the recess 14 of the mandrel core 10. The threaded end 141 of shaft 142 will then be abutting and engaging the first turn of the threads of aperture 18. The shaft 142 is then rotated, by means of hand wheel 143, to effect a firm threaded engagement between the shaft 142 and the mandrel core 10. The mold-feeding carriage 116, together with the mandrel assembly 9 affixed thereto, and the collar 144 mounted thereon, is then moved, by air motor 132, toward the mouth of the mold 76 until the mandrel assembly and its surrounding reinforcement element 60 are entirely within the mold 76.

Referring more particularly to FIGURE 11, as the mandrel assembly 9 moves toward the mold 76, the end thereof opposite from the mold-feeding carriage 116 passes through the aperture of a large nut 149 which is mounted for rotation about a fixed axis, corresponding to the axes of the mandrel assembly 9, the tube 133, the collar 144, and the mold 76, by the loose fit of its radially extending, circumferential flange 150 within a corresponding annular groove 152, formed by a flanged angular ring 154 and an apertured plate 156, the latter member being mounted on, and fixed to, the mold ends of rails 104. The nut 149 has a portion of its exterior periphery formed as a sprocket wheel 157 which is engaged, by a chain drive 158, with a drive sprocket 160 (FIGURE 6), the latter being operated by a coaxial hand wheel 161 which is located at the operating panel 115.

The threads of nut 149 are dimensioned for engagement with raised threads 147 of the collar 144. After the mandrel assembly 9 is completely within the mold 76, the collar 144 is moved axially, by hand, or other means, along the tube 133 until it extends through the nut 149 and its mold and almost touches the slips 27, 28, 29 and 30. It will now be understood that if the second frame 102 has been correctly longitudinally positioned along the rails 100 of the base frame 70, the distance between the mold end of the collar 144 and the slips will be the thickness, i.e., the axial length, of the threads 147 of the collar. Stated otherwise, the correct position of the second frame 102 will be determined by the length of the collar 144.

At this time the collar 144 is so indexed that its longitudinally extending interior keyway 146 is angularly aligned with the small slip 27 which is permanently secured to the mandrel core 10. Hand wheel 162 is then operated to rotate the nut 149 and threadably engage the collar 144 therewith. As the collar engages the nut, its mold end moves axially to bear against the slips 28, 29 and 30, but not against slip 27, as this member is aligned with the keyway 146. It will be readily seen that after this is done, the collar 144 is fixed against axial movement relative to the mold 76 and the rails 104.

In FIGURE 11 the collar 144 is illustrated as approaching, but not having yet reached, its final position of abutment with the slips 28, 29 and 30. It will be noticed that further appropriate rotation of the nut 149 will move the collar 144 closer to the mandrel assembly 9, that is,

until the para-annular abutment 145 is fast against the slips 28, 29 and 30. Then the collar will be unable to move further unless the second frame 102 is moved away from the mold assembly 76. It should be noted that when the collar is so abutting the mandrel assembly 10, the end of the collar, in the area of the counterbore, will extend a short distance into the space between the exterior of the mandrel assembly 10 and the interior of the mold 76. The reinforcement element formation 60 will necessarily be distorted and compressed by this, but only along the small portion immediately affected and, as will be evident hereinafter, this distortion is only temporary and the reinforcement element will usually spring back to its ordinary position after the collar 144 is removed from the area.

As has been described hereinabove, the interior diameter of the collar 144 is slightly greater than the exterior diameter of the mandrel core 10, and it will therefore be seen that when, in accordance with this invention, the mold-feeding carriage 116 is moved along rails 104, by air motor 132, away from the mold 76, the mandrel core 10, together with the fixed slip 27, will then be withdrawn from the immobile mold, through the lumen of the immobile collar, while the slips 28, 29 and 30 are held fast in their position within the mold because of their abutting relation with para-annular shoulder 145 of the collar.

The means for supporting the mandrel assembly 9 prior to its insertion within the mold 76 and the means for supporting the mandrel core 10 after its withdrawal from the mold will now be described. Referring to FIGURES 5 and 6, the mandrel support rollers 136 are, when in their operative position, located midway between rails 104 and at a level slightly below the upper surface thereof. Each set of rollers 136 consists of an opposed pair of spaced coaxial truncated-conical rollers having their minor ends facing one another. As is best shown in FIGURE 5, when the mandrel support rollers 136 are operatively positioned at a level to support a mandrel assembly, and particularly a mandrel assembly of relatively small diameter, they will necessarily be located within the longitudinal path of the mold-feeding carriage 116. It is therefore within the contemplation of this invention to provide means for moving the mandrel support rollers 136 from their usual position when the mold-feeding carriage passes by.

To effect this end, each of the rollers 136 are rotatably mounted at the free end of one of two rocker arms 169 which extend, in spaced parallel relation, radically outward from a rocker arm shaft 171 which is rotatably mounted in suitable bearings (not shown) to extend under, and transversely of, the rails 104.

An operating arm 175 is fixed to rocker arm shaft 171 and extends radially therefrom. In the preferred embodiment illustrated this operating arm is angularly displaced from the rocker arms 169, and is pivotally connected to a drive rod 179 which is, in turn, pivotally connected with a piston rod 181 of pneumatic cylinder 183. The pneumatic cylinders 183 may be selectively operated from the operating panel 115 at such times as the mold-feeding carriage 116 approaches a given set of mandrel supporting rollers 136, or, as in this preferred embodiment, this operation may be entirely automatic by the provision of suitable mechanically operated valves (not shown), such as are well known in the art and need not be defined or described in detail herein, which energize the pneumatic cylinders to lower a particular set of rollers 136 as the mold-feeding carriage approaches.

It should be noted that the opposed truncated ends of the mandrel support rollers 136 are spaced from one another a distance sufficient to allow clearance of the drive chain 120 when the opposed rollers move downward, as a unit, through an arc defined by the movement of the rocker arms 169. While the preferred embodiment illustrated in FIGURES 5 and 6 has two sets of mandrel support rollers 136 it should be understood that it may

be desirable to provide additional sets of rollers, particularly when the pipe to be cast, and hence the mandrel assemblies 9, are unusually long. In such a case, each set of mandrel support rollers would be provided with means for lowering the rollers below the path of the passing mold-feeding carriage 116 which are similar to the means which has just been described.

After the mandrel core 10 has been wholly withdrawn from the mold 76, hand wheel 143 is manipulated to release the thread 141 from the threaded aperture 18 of the mandrel core so that the latter can then be removed. At this time the second frame 102 is moved longitudinally, of the base frame 70, away from the mold 76 a sufficient distance to provide ample clearance between the end of the mold and the collar 144, and the latter is released from the nut 149 and placed in its original position on the tube 138. This may be done by hand or, in the alternative, the mold-feeding carriage 116 can be moved forwardly, or in the direction of the molds 76, so that the tube 138 extends through the collar 144, and is keyed thereto, before the latter is disengaged from the nut 149 by suitable manipulation of hand wheel 161.

When the mandrel core 10, together with the fixed slip 27, is removed from the mold 76, the pins 39 of the remaining slips, i.e., slips 28, 29 and 30, are, in effect, withdrawn from their respective sockets in the mandrel core. As they no longer form a complete tube or sleeve, they will then collapse and fall to the bottom of the interior of the mold. After the second frame 102 is longitudinally moved away from the mouth of the mold, and either before or after the collar 144 is disengaged from the nut 149, the entire mold-feeding assembly is moved transversely, by suitable manipulation of operating wheel 78, to a position where it is clear of the mouth of the mold. The slips 28, 29 and 30 are then removed, either by hand or suitable power machinery (not shown), from the mold.

As will be readily understood, in withdrawing the individual slips from the mold, care should be exercised lest the fibers of the reinforcement element 60 be disturbed and disarranged from their normal positions. As has been explained in the copending applications hereinabove mentioned, the quality and strength, and hence the end performance, of fibrously reinforced plastic pipe is quite dependent of the accuracy and precision of placement of the fibers of the reinforcing element. It will now be seen that the use of the mandrel assembly 9 in the particular manner described hereinabove constitutes a marked improvement over the previously known apparatus and methods of inserting woven tubular reinforcement elements within a mold, inasmuch as it makes it unnecessary to slide a mandrel against the interior of the close-fitting innermost ply or layer of the reinforcement element 60. It has been found that when an ordinary mandrel is used, it frequently occurs that the weight of the mandrel on the lower portion of the reinforcement element causes the latter to bunch, and thus reduces the inside diameter of the element until it finally seizes the mandrel, particularly when the mold is quite long. Even if the mandrel is not seized, the bunching of the reinforcement element distorts the arrangement of the fibers so that they are no longer disposed in the desired patterns, and a plastic impregnated pipe formed therewith may be materially weakened.

The Mold Assembly

It is within the contemplation of this invention that there be provided a number of molds, generally indicated at 76, arranged in aligned rows to be serviced by the mold-feeding assembly 68, which has been already described, and which will also be serviced by a single mold-ejecting assembly 263 (FIGURES 18, 19 and 20), which will be described in detail hereinafter.

Referring to FIGURE 12, in each mold assembly 76 there is an elongated tubular casting mold 162 rotatably supported by ball bearings 163, or other conventional low

friction means, within the lumen of a fixed tubular heating chamber 164. The end of the mold 162 opposite to the end which receives the mandrel assembly is counter-bored, at 165, and interiorly fitted with an annular collar 166, which is exteriorly dimensioned to fit into the counter-bore, and has an interior diameter equal to the bore of the mold. If the pipe to be cast is to have one end exteriorly threaded, the collar 166 may have a threaded interior so as to act as a thread mold. The ends of the mold 162 extend a short distance beyond the ends of the heating chamber 164 so that, during the casting operation, the mold can be partially closed by externally threaded caps 167, each having a centrally disposed aperture 168 therein. At or near the ends of the heating chamber 164, O-ring liquid seals 170 engage the outer periphery of the mold 162 and the inner periphery of the chamber so that the lumen of the heating chamber is liquid tight even when the mold is being rotated in a manner which will now be described.

At one end of the mold 162, and in a preferred embodiment at the mouth or the end which receives the loaded mandrel, a V-belt pulley 172 is non-rotatably fixed, by bolts 173, to the mold coaxially therewith. This V-belt pulley is engaged, by a number of V-belts 174, to a suitable drive wheel 176 on the shaft of a prime mover 178, which may be mounted above the heating chamber. A portion of the junction of the V-belt pulley 172 and the exterior of the mold 162 defines an annular recess 180 having its female arcuate surface threaded to engage the exteriorly threaded cap 166 which partially closes the mouth of the mold. The other cap 166, fitted at the other end of the mold 162, engages a similarly threaded recess 182 formed in the built-up end of the mold.

Each heating chamber 164 is provided with one or more heating fluid inlets 184 and outlets 186 so as to allow a carefully controlled circulation of heated fluid, which preferably is oil, from a fluid heat exchanger 188. The heat exchanger 188 may be of any conventional design and will not be described in detail, it being enough to say the heat exchanger is designed and arranged to retain a relatively large amount of heating fluid at a carefully controlled temperature level so that there is always a sufficient supply of heating fluid available at the exact temperature desired. In the centrifugal casting of reinforced plastic impregnated pipe, it has been found that exact temperature control is often critical and this end can only be achieved by maintaining an adequate supply of fluid, at the proper temperature, available at all times. While the fluid is hereinabove termed a heating fluid, it should be observed that during the time of the exothermic reaction of the plastic pipe being formed in the mold, the mold temperature may temporarily increase to a point whereby the fluid becomes a cooling fluid, i.e., the mold temperature may rise above that of the fluid.

The proper temperature of the heating fluid will vary from 150° to 350° F., depending on the character of the resin being used. When working with certain resins, it may be desirable to pump heating fluid out of the heating chamber 164 after the resin has begun its thermosetting reaction, and replace it with a cooling fluid, also preferably oil, to carry off the exothermic heat generated. Also, as certain epoxy resins must be cured at a fairly high temperature, i.e., approximately 320° F., it may be desirable to use other means than air cooling (which will be described hereinafter) to get the temperature of the formed plastic pipe down to a point where the pipe is strong enough to be removed from the mold 162.

To achieve this end there is provided a fluid-cooling heat exchanger 190, which is equipped with conventional cooling means (not shown) to control the temperature of the cooling fluid. While a preferred embodiment of this invention includes a row of transversely aligned mold assemblies 76, it is within the contemplation of this invention that the mold assemblies be paired, with

each pair having a common fluid-heating heat exchanger 188 and fluid-cooling heat exchanger 190. Each fluid temperature control system includes suitable valves, reversible pumps, sumps, meters, and temperature indicia means which may be of conventional design well known in the art and which, therefore, need not be illustrated or described in detail.

As the preferred heating and cooling fluids are oil, this fluid serves to lubricate, as well as control the temperature of, ball bearings 163, and, in such a case, no other lubrication is needed.

The Resin Impregnating Means

As shown in FIGURES 12 and 13, adjacent each end of the mold assembly 76 there is a resin reservoir 200 which is preferably large enough to contain sufficient resin for preparing a large number of plastic pipes. The reservoir 200 is mounted above the level of the mold assembly, so as not to interfere with other moving elements in the vicinity and, in a preferred embodiment, is suspended from the ceiling structure (not shown). The reservoir may be a vessel of any conventional design, although it should have a large removable cover 202 to allow easy access for cleaning and loading and should include heating coils 204 for maintaining the liquid resin at a predetermined temperature so as to control the viscosity thereof. Compressed air is supplied to the top of each reservoir by conduit 205, so that liquid resin may be forced out under pressure through flexible conduit 206 to nozzle 208. The nozzles may have selectively variable openings, but it is within the contemplation of this invention that they be given a constant fitting or opening for use with resin of a given viscosity and in conjunction with a mold 162 of a given length.

After the reinforcement element 60 has been properly placed in the mold by the apparatus and methods described hereinabove, the nozzles 208 are inserted into the apertures 168 in the mold caps 167 (FIGURES 12 and 13) and the resin is then injected into the mold, by the operation of an air conduit control valve 210. With the proper combination of air pressure, resin viscosity, and nozzle opening, some of the air-borne stream of resin from each nozzle will reach a point half way through the mold.

In a preferred embodiment of the invention, the resin is introduced into the mold 162 while the latter is rotating at a high rate of speed, derived from the energization from the prime mover 178 (FIGURE 12). For example, in the manufacture of 3 inch O.D. pipe, it has been found that the mold should be rotated at approximately 1800 r.p.m., although it will be understood that when the larger pipes are being cast, the same centrifugal forces may be obtained at a lower r.p.m. As the mold rotates, and the liquid plastic material is being centrifugally urged to distribute itself evenly along the internal periphery of the mold 162, and hence, within and about the fibrous formations of the reinforcement element 60, the heat of the heating fluid within the chamber 164 (FIGURE 12), which surrounds the major part of the mold 162, causes a thermosetting reaction of the resin. It is well known that this thermosetting reaction will, in due course, be accompanied by a certain exothermic reaction on the part of the resin as it becomes set in its final physical form. While the heating fluid will serve to carry off a certain amount of this exothermic heat, it is within this contemplation to provide additional means for achieving this end, as it is not possible to remove the formed pipe from the mold until its temperature has been reduced to a vicinity of 120° F., and, further, as this exothermic heat may, in some circumstances, have a deleterious effect on the pipe being formed.

Air Blowing Assembly

It is within the contemplation of this invention to provide each mold assembly 76 with an air blowing assembly, generally indicated at 220 (FIGURES 14, 15 and 16),

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which is arranged to blow air alternately through one end of mold 162 and then through the other. It has been found that a greater uniformity of product is effected by alternating the direction of air flow so that all areas of the newly formed, fibrously reinforced plastic piping are more uniformly treated.

Each air blowing assembly includes a blower 222 operated by a prime mover 224 through a variable speed belt and pulley apparatus, generally indicated at 226. The blower 222 discharges into an upwardly extending duct 228 which splits, at a Y connection 230 into two branches, each of which extend to the respective ends of the mold assembly (shown in phantom) at 76.

As each branch is substantially identical, only one will be described in detail. The ends of each of the arms of the Y ducts 230 are fitted with a disc valve 232 which discharges into a horizontally extending duct 234. Duct 234 is fitted to the disc valve 232 by a suitable sleeve connection which allows this duct to rotate freely, about its own axis, while the valve remains immobile, and is also supported by a bearing 236 located in spaced relation to the valve. Another duct 238 is connected to the free end of duct 234 to extend generally downward and thence back towards the center of the air blowing assembly, and terminates in a mouth 240 which is dimensioned to approximate the aperture in the cap 167 of the molding assembly 76, the last mentioned elements being shown in the phantom. The entire air blowing assembly 220 is so dimensioned that the mouths 240 of each branch are spaced apart a distance only slightly greater than that of the overall length of the mold assembly 76.

As best shown in FIGURE 14, the air blowing assembly is placed to one side of the mold assembly 76, and when the downwardly extending duct 238 hangs in a plumb line, its mouth 240 is well clear of the mouth of the mold, so as not to interfere with the loading or unloading thereof.

The rotatably mounted duct 234 has a radially extending operating arm 241 fixed thereto, and the free end of this arm is connected to the vertically extending piston rod 242 of pneumatic cylinder 244, the latter being pivotally mounted on the base of the air blowing assembly. As is evident in FIGURES 14, 15 and 16, extension and retraction of the piston rod 242 will cause duct 234 to oscillate about its own axis and, further, will cause the duct 238 to swing from a plumb position to an oblique position (illustrated in phantom in FIGURE 16) and then back to plumb. The various elements are so dimensioned and arranged that upon a full extension of piston rod 242, the mouth 240 of the duct 238 will be aligned with, and adjacent to, the aperture in mold cap 167.

The disc valve 232 is of conventional design and is operated by rotating an internal disc, having an off-center aperture 245 (in phantom, FIGURE 16), into and out of a position wherein the aperture is aligned with coaxial intake 246 and discharge 247 fittings (FIGURES 14 and 15). In the present apparatus, the disc is caused to rotate about its axis by the arcuate movement of a pin 248 extending outwardly from the valve 232 on the same side as the operating arm 241. The pin 248 extends into an elongated slot 250 formed in the operating arm 241 so that it moves therewith. It will therefore be seen that the swinging of the duct 234 into a position whereby its mouth 240 is aligned with the cap 167 of the mold assembly 76 will also effect an opening of the disc valve 232, and that when the duct 238 is moved back to a plumb position, the valve will close.

It is within the contemplation of this invention to arrange a system of timer-cam operated valves to supply pressurized air alternatively to one pneumatic cylinder 244 and then to the other in a timed cycle, of say one minute, so that each of the ducts 233 will alternatively swing into alignment with its end of the mold assembly 76 and then deliver a one minute blast of air while the other duct 238 is maintained in a position clear of the

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mouth of its end of the mold. It is further within the contemplation of this invention that there be provided a manually operated bleeding valve to allow both arms to swing to a plumb position, with each disc valve 232 being closed, when the mold assembly 76 is being loaded or unloaded, or is not in use.

Such a system is shown schematically in FIGURE 15, in which timer 252 alternatively opens valves 254 leading to the respective pneumatic cylinders 244. The manually operated bleeding valves 256 are interposed in the pressure lines intermediate the valves 254 and the pneumatic cylinders 244. It should, of course, be understood that the overriding valves 256 could also be connected with timing apparatus if the loading and unloading operations are to be part of a timed cycle.

While the thermosetting reaction of the material within the mold has been heretofore described as occurring as a result of the temperature of the heating fluid in the heating chamber 164, it is within the contemplation of this invention that the air blown through the mold 162 may be heated when certain resins are being used in the casting operation. Accordingly, electric heating coils 260 (FIGURE 16), or other air heating means, may be installed at the intake of the blower 222 so that the air supplied to the interior of the mold 162 will be warm.

The Pipe Ejecting Assembly

Referring to FIGURES 18, 19 and 20, it will be seen that the pipe ejecting assembly, generally indicated at 268, includes an elongated base frame, generally indicated at 270, which is mounted on flanged wheels 272 for movement along relatively transversely extending fixed rails 274, so that the entire pipe ejecting assembly can be transversely moved between a number of positions corresponding to a number of the casting molds generally indicated at 76.

In a preferred embodiment, the transverse movement of the entire pipe ejecting assembly 268 is selectively controlled by hand operated sprocket wheel 278 which is connected by chain drive 280 to a sprocket 282 on the shaft 284, upon which the wheels 272 are non-rotatably mounted. As will be evident, hereinafter, it is quite important that the entire pipe ejecting assembly 268 be properly aligned with the axis of the particular mold which it is to service, and means for attaining this exact alignment include an air lock assembly generally indicated at 286 which is identical with the air lock assembly 86 described in detail hereinabove in the disclosure of the mold-feeding assembly 68. That is to say, the air lock assembly 286 includes a pneumatic cylinder 288 having a piston rod 290 maintained in a position to selectively engage an aperture in one of the rails 274 when the pneumatic cylinder is suitably energized by operation of valve 296 on operating panel 298.

The transversely movable base frame 270, which consists essentially of a pair of suitably braced, longitudinally extending, spaced parallel rails 300, which may be formed of I-beams or the like, has a second frame, generally indicated at 302, which consists essentially of a pair of suitably braced, longitudinally extending, spaced parallel rails 304, which may be formed of I-beams or the like, mounted thereon. The second frame 302 is supported on flange wheels 306 which are arranged to roll along rails 300 when the second frame is moved longitudinally of the base frame 270. Such movement is obtained by a pneumatic cylinder 308, depending from the second frame 302, having the free end of its piston rod 310 fixed to a fixed upstanding member 312 on the base frame 270. The pneumatic cylinder 308 is double acting and is coupled, by suitable lines, to a three-way control valve 314 located on the operating panel 298.

A pipe-ejecting carriage, generally indicated at 316, is disposed upon the rails 304 to move longitudinally thereof on wheels 318. The pipe-ejecting carriage 316 is positively actuated to move longitudinally of second

frame 302 by a chain drive 320 extending longitudinally of the rails 304, and approximately midway therebetween, at a level slightly below their upper surface. The chain drive 320 is secured, at each end, to the pipe-ejecting carriage 316, as by draw bolts 322 (FIGURE 20), and extends around an idler sprocket 324 mounted at the mold end of the rails 304 and around a power sprocket 326 mounted at the opposite end of these rails. The power sprocket 326 is non-rotatably fixed to the shaft of reversible air motor 332, which is remotely controlled by a four-way valve 334 located on the operating panel 298.

As the pipe-ejecting carriage 316 serves to convey a section of newly formed plastic pipe 335, there are provided several pipe-supporting rollers 336 to bear the weight of, and to support, the pipe during the periods when it is on, or partially on, the pipe ejecting assembly 263. These pipe-supporting rollers are substantially identical with the mandrel-supporting rollers 136 described in detail in the disclosure of the mold-feeding assembly 68, and each are, when in their operative position, located midway between the rails 304 and at a level slightly below the surface thereof.

Each set of rollers 336 consists of an opposed pair of spaced coaxial truncated conical rollers having their minor ends facing each other. As is best shown in FIGURE 18, when the pipe-supporting rollers 336 are operatively positioned at a level to support a newly formed pipe 335, and particularly a pipe of relatively small diameter, they will necessarily be located along the longitudinal path of the pipe-ejecting carriage 316. It is therefore within the contemplation of this invention to provide means for moving the pipe-supporting rollers 336 from their usual position when the pipe-ejecting carriage passes by.

To effect this end, each of the rollers 336 are rotatably mounted at the free end of one of two rocker arms 370 which extend, in spaced parallel relation, radially outward from a rocker arm shaft 372 which is rotatably mounted in suitable bearings (not shown) to extend under, and transversely of, the rails 304. An operating arm 376 is fixed to the rocker arm 372 and extends radially thereof. In the preferred embodiment illustrated, this rocker arm is angularly displaced from the rocker arm 370 and is pivotally connected to a drive rod 380 which is, in turn, connected with a piston rod 382 of pneumatic cylinder 384. The pneumatic cylinders 384 may be selectively operated from the operating panel 298 at such times as the pipe-ejecting carriage 316 approaches a given set of pipe-supporting rollers 336, or, as in this preferred embodiment, this operation may be entirely automatic by the provision of suitable mechanically operated valves, such as are well known in the art and need not be described in detail herein, which operate the pneumatic cylinders to lower the rollers 336 as the pipe-ejecting carriage 316 approaches.

It should be noted that the opposed truncated ends of the pipe-supporting rollers 336 are spaced from one another a distance sufficient to allow clearance of the chain drive 320 when the opposed rollers move as a unit, through an arc defined by the movement of rocker arms 370. While the preferred embodiment illustrated in FIGURES 18 and 19 has two sets of pipe-supporting rollers 336, it should be understood that it may be desirable to provide additional sets of rollers, particularly when the pipe being ejected from the mold 76 is unusually long. In such a case, each set of pipe-supporting rollers would be provided with means for lowering the rollers below the path of the passing pipe-ejecting carriage 316 which are similar to the means which have just been described.

Referring more particularly to FIGURE 20, mounted upon the pipe-ejector carriage 316 is a pipe-ejector pullout. As has been described hereinbefore, the end of the pipe mold 162 nearest the pipe-ejecting assembly 263 is counterbored and loosely fitted with a reinforcing collar 166, usually having an internal diameter equal to that

of the rest of the mold, although it may have a threaded interior if threaded pipe is being cast. Generally speaking, the pipe-ejector pullout consists of an axially expanding circular wedge which is inserted within the lumen of the newly formed pipe 335 and then expanded to bear against the inner periphery thereof. The pipe is not distorted or injured as it has been cast in a closely fitted relation to the reinforcing collar 166. A hydraulic jack mounted on the pipe-ejecting carriage is then energized to urge the expanded wedge, and the pipe and reinforcing collar grasped thereby, toward the mold-ejecting carriage. The movement imparted by the hydraulic jack is relatively short, it being sufficient that the entire length of newly cast pipe be moved a short distance so as to break the typical initial bond or adhesion between the pipe and the mold 162. The pipe is then completely withdrawn from the mold by the use of a powerful winch to draw the pipe-ejecting carriage along the rails 304. This apparatus will now be described in detail.

As shown in FIGURE 20, a cylindrical sleeve 400 mounted upon carriage 316 has a snugly fitting operating rod 402 extending therethrough. A tube 404 is coaxially cantilevered from the sleeve 400, and extends toward the mold assembly 76. The tube 404 has a longitudinally extending keyway 406 therein and has an interior diameter somewhat greater than the exterior diameter of operating rod 402. Slidably mounted and keyed (by key 407 fitting in keyway 406) within the tube 404 is a sleeve 408 which is interiorly dimensioned to receive the operating rod 402 and has at least a portion of its lumen interiorly threaded to engage raised threads 410 formed upon a portion of the operating rod. The free end of the operating rod nearest the mold assembly 76 is reduced and formed with a truncated conical projection 412 which flares outwardly toward the free end thereof. The opposite end of the operating rod extends through a hollow hydraulic jack, generally indicated at 414, and has an operating wheel 416 fixed on the extreme end.

The conical projection 412 is provided with a segmental collar ring composed of four chordal elements 418 (FIGURE 21) held together, and about the conical projection, by a tension spring member 420 disposed in a peripheral groove 422. The segmental collar ring is formed with an interior taper complimentary with that of the conical projection 412 and has an exterior peripheral surface defining a right cylinder. In a preferred embodiment, the exterior or peripheral surface of each chordal element is formed with a number of fine serrations thereon so as to give it a better grip on the interior periphery of the pipe 335, as will be explained. In operation, the conical projection 412, circumscribed by the segmental ring 418, is inserted within the end of the mold 162 and so located that the segmental ring is within the area thereof which is fitted with the reinforcing collar 166. Rotation of operating rod 402, by suitable manipulation of wheel 416, causes an axial movement thereof, away from the mold 162, due to the engagement of the thread 410 with the threaded interior of keyed, and hence non-rotatable, sleeve 408. The segmental collar 418, which is biased by tension spring 420 to snugly fit on the conical projection 412, moves towards the sleeve 408 until its end abuts the planar end surfaces of the sleeve. Further axial movement of the operating rod 402, and the conical projection 412, in the same direction, will cause the respective elements of the segmental ring to ride up the conical element until its peripheral surface contacts the interior of the pipe 335. It will now be seen that once such contact is made, further axial movement of the operating rod 402 will serve to wedge the serrations on the peripheral surfaces of the segmental ring 418 tightly against the interior of the of the sleeve 408, so that the end of the segmental ring above, the strong reinforcing collar 166 snugly circumscribes this portion of the pipe 335 so there is no danger

of distorting or injuring the pipe as long as reasonable forces are used. It will now be understood that the minor interior diameter of the conical projection 412 must be less than the interior diameter of the free end of the sleeve 408, so that the end of the segmental ring will properly abut the latter.

At this time the hollow hydraulic jack 414 is energized to urge the hub 420 of the operating wheel 416 away from the pipe-ejecting carriage 316. This movement will be experienced by the conical projection 412 and the segmental ring 418 and will tend to pull the pipe 335 out of the mold 162. As has been stated hereinbefore, this movement is only for a very limited distance, it being quite sufficient that the pipe be moved enough to break the bond or adhesion between the newly cast pipe 335 and the mold 162.

As shown in FIGURES 18 and 19, a winch 430, powered by a prime mover 432, is mounted at the end of second frame 302 furthest from the mold assembly 76, and a cable 436 is rove about the winch. The free end of the cable 436 is fitted on pipe-ejecting carriage 316 and is utilized to draw the latter along rails 304, and, hence withdraw the newly cast pipe 335 from the mold 162 after the hydraulic jack 414 has been operated to break the initial bond or adhesion between the pipe and the mold. When the winch is being operated, the reversible air motor 332 is vented by the operation of valve 334 so that the motor offers no resistance to the winch. In a preferred embodiment, the operating controls 438 for the winch may be located on the operating panel 298 alongside the valve 334. As the pipe-ejecting carriage moves away from the mold, the pipe-supporting rollers 336 will rise to their operative position to provide suitable support for the length of the pipe 335 being withdrawn from the mold in a manner similar to the action of the mandrel support rollers 136 described hereinabove.

After the pipe has been completely withdrawn from the mold, the operating wheel 416 is rotated to relax the grip of the segmental collar ring 418 on the inner periphery of the pipe, in a manner that will now be understood, and then the pipe-ejecting carriage is moved away from the pipe a distance sufficient to clear the conical projection 412 and the segmental ring 418 from the interior of the pipe. The pipe is then removed from the pipe-ejecting assembly 268, by any suitable means, and the pipe-ejecting carriage is moved back to the mold end of the second frame 302 by the air motor 332 and the chain 320 so as to be ready to begin a new pipe-ejecting operation.

In FIGURES 18 and 19, the second frame 302 is illustrated as being so positioned as to be spaced from the mold assembly 76, when the pipe 335 is being withdrawn from the mold 162. It should be understood, however, that when the hydraulic jack 414 is being operated to break the bond between the mold and the pipe, the mold end of the second frame 302 is positioned to abut the end of the mold 162; otherwise the pulling force of the jack would have a tendency to pull the mold 162 out of the mold assembly 76.

This application is a division of co-pending application Serial No. 594,565, filed June 28, 1956, now Patent No. 2,997,737.

Having described only a typical preferred form and application of our invention, we do not wish to be limited or restricted to specific details herein set forth but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art and falling within the scope of the following claims:

We claim:

1. Apparatus for the insertion of a fibrous elongated hollow reinforcement element formed about a mandrel into a mold so dimensioned as to closely fit the reinforcement and for subsequently withdrawing at least a portion of the mandrel from the mold to leave the reinforcement element therein comprising: a first frame mounted for

selective movement transversely of the mold on a path adjacent the mouth thereof; a second frame mounted for selective movement longitudinally of said first frame in a direction parallel to the axis of the mold; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axis of the mold; selectively operable mandrel engaging means mounted on said carriage, and means for maintaining the reinforcement element within the mold when the mandrel engaging means is operated to withdraw at least a portion of the mandrel therefrom.

2. Apparatus for the insertion of a fibrous tubular reinforcement element formed about a mandrel assembly consisting of a mandrel core surrounded by a plurality of slips into a mold so dimensioned as to closely fit the reinforcement element and for subsequently withdrawing the mandrel core from the mold to leave the reinforcement element therein comprising: a first frame mounted for selective movement transversely of the mold on a path adjacent the mouth thereof; a second frame mounted for selective movement longitudinally of the first frame in a direction parallel to the axis of the mold; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axis of the mold when the second frame is axially aligned with the mold; selectively operable mandrel engaging means mounted on said carriage; and slip abutting means engageable with said second frame in a position to abut the slips of a mandrel assembly disposed within the mold when the mandrel core is being withdrawn from the mold by the mandrel engaging means, the arrangement being such that the axial movement of the mandrel engaging means is independent of the slip abutting means when the latter is engaged with second frame.

3. Apparatus for the insertion of a fibrous tubular reinforcement element formed about a cylindrical mandrel assembly consisting of a cylindrical mandrel core surrounded by a plurality of slips into a mold so dimensioned as to closely fit the reinforcement element and for subsequently withdrawing the mandrel core from the mold to leave the reinforcement element therein comprising: a first frame mounted for selective movement transversely of the mold on a path adjacent the mouth thereof; a second frame mounted for selective movement longitudinally of the first frame in a direction parallel to the axis of the mold; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axis of the mold when the second frame is axially aligned with the mold; cylindrical selectively operable mandrel engaging means mounted on said carriage; a tubular slip abutting means engageable with said second frame in a position to abut the slips of a mandrel assembly disposed within the mold when the mandrel core is being withdrawn from the mold by the mandrel engaging means, the arrangement being such that the mandrel engaging means can move axially through the lumen of the slip abutting means when the latter is engaged with said second frame.

4. Apparatus for the insertion of a fibrous tubular reinforcement element formed about a cylindrical mandrel assembly consisting of a cylindrical mandrel core surrounded by a plurality of slips into a mold so dimensioned as to closely fit the reinforcement element and for subsequently withdrawing the mandrel core from the mold to leave the reinforcement element therein comprising: a first frame mounted for selective movement transversely of the mold on a path adjacent the mouth thereof; a second frame mounted for selective movement longitudinally of the first frame in a direction parallel to the axis of the mold; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axis of the mold when the second frame is axially aligned with the mold; cylindrical selectively operable mandrel engaging means mounted on said carriage; a tubular slip abutting collar dimensioned to be axially slid-

ably mounted on said mandrel engaging means and having an interior diameter less than the exterior diameter of the mandrel assembly and at least as great as the exterior diameter of the mandrel core; and means for engaging said collar against axial movement relative to said second frame, whereby said collar may be held immobile against at least some of the slips of the mandrel assembly within the mold when the mandrel core is being withdrawn from said mold and through said collar by movement of the carriage means and the mandrel engaging means away from the mold.

5. Apparatus for the insertion of a fibrous tubular reinforcement element formed about a cylindrical keyed mandrel assembly consisting of a cylindrical mandrel core surrounded by a plurality of slips into a mold so dimensioned as to closely fit the reinforcement element and for subsequently withdrawing the mandrel core from the mold to leave the reinforcement element therein comprising: a first frame mounted for selective movement transversely of the mold on a path adjacent the mouth thereof; a second frame mounted for selective movement longitudinally of the first frame in a direction parallel to the axis of the mold; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axis of the mold when the second frame is axially aligned with the mold; cylindrical selectively operable mandrel engaging means mounted on said carriage; a tubular slip abutting collar dimensioned to be axially slidably mounted on said mandrel engaging means and having an interior diameter less than the exterior diameter of the mandrel assembly and at least as great as the exterior diameter of the mandrel core; a key on the exterior of said mandrel engaging means; and a complementary longitudinally extending keyway formed in the interior of said collar, said keyway being of a width and height to receive said key and also to receive the key on the mandrel core.

6. The apparatus defined in claim 5 and further including means for supporting a mandrel assembly being inserted into the mold and for supporting a mandrel core being withdrawn from the mold, said means being mounted on said second frame and being arranged to avoid interference with the selective movement of said carriage means and the means mounted thereon.

7. The apparatus defined in claim 5 and further including means for supporting a mandrel assembly being inserted into the mold and for supporting a mandrel core being withdrawn from the mold, said means being mounted on said second frame; means to maintain said when the mandrel assembly or the mandrel core are adjacent thereto and to maintain said last-mentioned means clear of the path of the carriage means when the latter is adjacent thereto.

8. The apparatus defined in claim 7 and further includ-

ing means for maintaining said first frame in a fixed position relative to a mold being serviced by the apparatus when the mandrel engaging means is being operated, the position being defined by the axial alignment of the mold and the mandrel engaging means.

9. Apparatus for inserting a fibrous tubular reinforcement element into any one of a plurality of parallel transversely aligned molds and depositing the same therein in peripheral close-fitting contact therewith including the combination comprising: a first frame mounted for selective movement transversely of the molds on a path adjacent the mouths thereof; a second frame mounted for selective movement longitudinally of said first frame in a direction parallel to the axes of the molds; carriage means mounted for selective movement longitudinally of said second frame in a direction parallel to the axes of the molds; a cylindrical mandrel assembly exteriorly diametrically dimensioned to closely fit the lumen of the reinforcement element, said mandrel assembly including an elongated mandrel core, a plurality of elongated slips disposed along the periphery of said mandrel core with their longitudinal axes parallel to the longitudinal axis of said mandrel core, each of said slips having an inner surface facing said mandrel core and an arcuate outer surface, the outer surfaces of the several said slips defining a cylinder constituting the peripheral exterior of the mandrel assembly, said slips being so formed and arranged that the cylinder defined thereby will collapse upon the withdrawal of the mandrel core therefrom; selectively operable mandrel core engaging means mounted on said carriage means to urge the mandrel core into and out of the mold upon appropriate movement of the carriage means longitudinally of said second frame; and means operable when the mandrel assembly, together with the reinforcement element are within the mold to maintain the reinforcement element therein when the mandrel core engaging means is operated to withdraw the mandrel core therefrom.

10. The apparatus defined in claim 9 in which the means to maintain the reinforcement element within the mold includes means to maintain at least some of the slips therein when the mandrel core is being withdrawn from the mold, the arrangement being such that the cylinder defined by the slips within the mold will collapse upon the substantial withdrawal of said mandrel core.

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