Aug. 30, 1949. J. BOUCHER 2,480,284

APPARATUS FOR MAKING PIPES OF SMALL DIAMETER BY CENTRIFUGAL CASTING

Filed Feb. 28, 1946

2 Sheets-Sheet 1

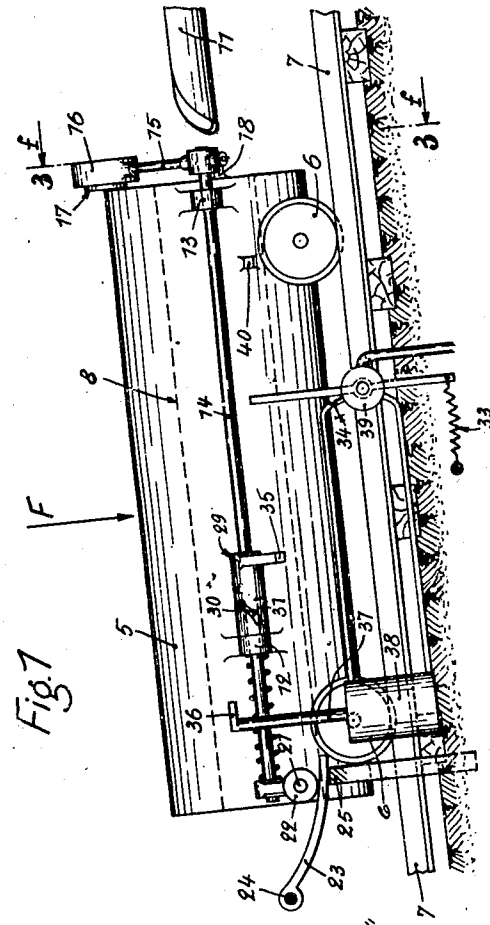

Fig. 1

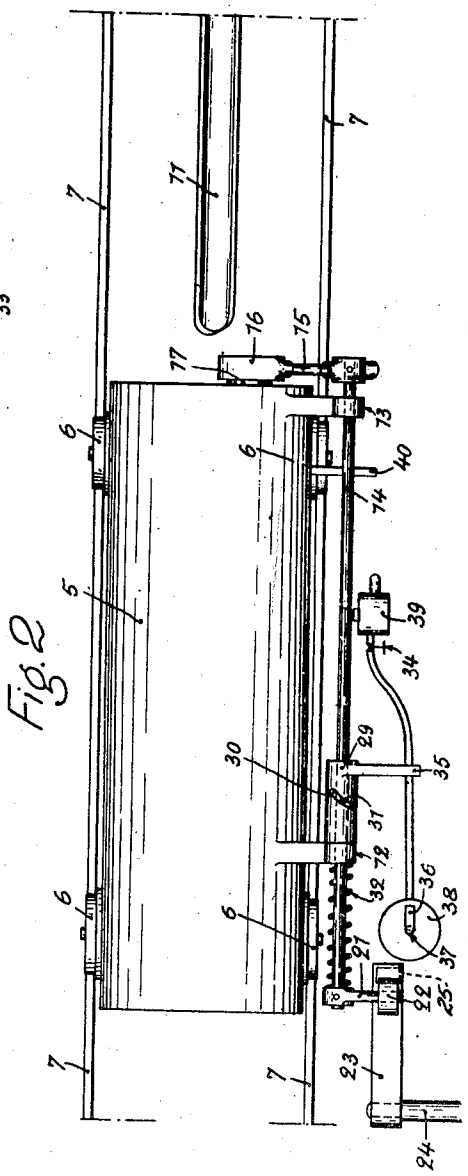

Fig. 2

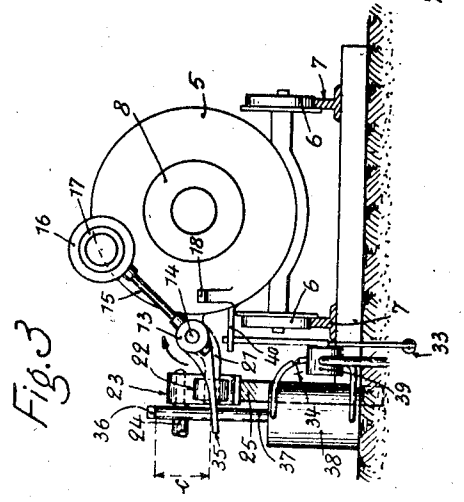

Fig. 3

INVENTOR
JACQUES BOUCHER
By
his ATTY.

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2 Sheets-Sheet 2

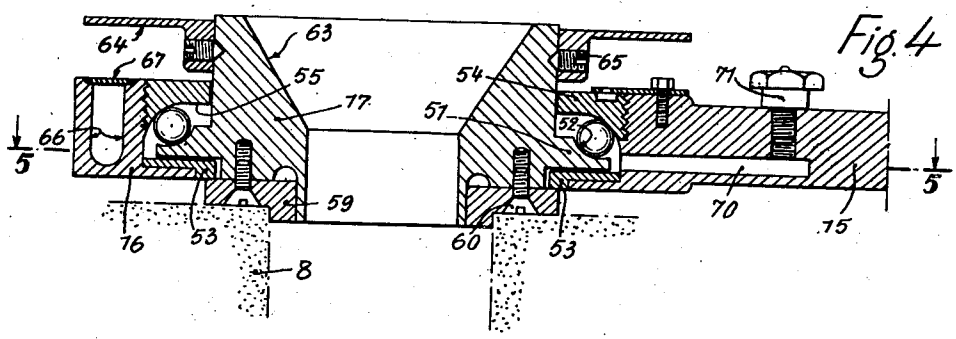

Fig. 4

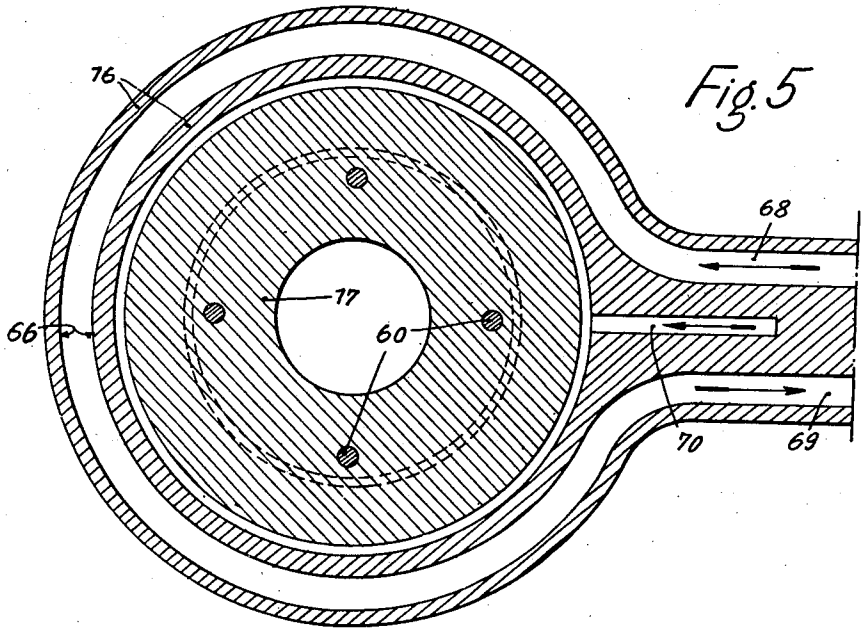

Fig. 5

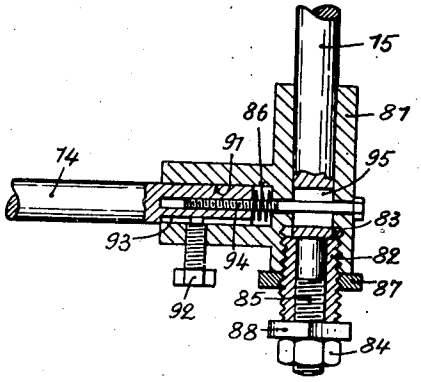

Fig. 6

INVENTOR
JACQUES BOUCHER
By Otto Munk
his ATTY.

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UNITED STATES PATENT OFFICE

2,480,284

APPARATUS FOR MAKING PIPES OF SMALL DIAMETER BY CENTRIFUGAL CASTING

Jacques Boucher, Paris, France, assignor to Compagnie de Pont a Mousson

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5 Claims. (Cl. 22—65)

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In the centrifugal casting of pipes by means of apparatus comprising a channel for introducing liquid metal into a rotating mould the channel being displaceable within the mould, it is necessary, according to known methods, for this channel to be overhung in such a way that at no instant can any point of its external surface come into contact with the internal surface of the mould. In view of the considerable length of the channel any accidental contact would in fact give rise to oscillations of great amplitude of the channel, whereby the liquid metal in the latter would overflow and, because of premature solidification of metal between the mould and the channel, the channel would be twisted round and damaged. This cantilever arrangement however becomes more and more difficult to design as the diameter of the pipe to be made becomes smaller. Indeed, it is not possible to reduce the useful cross section of the channel indefinitely, for the liquid iron flowing in the channel is cooled by the channel walls in contact therewith, and it is necessary for this iron to conserve sufficient fluidity as far as the end of the said channel. To this useful channel cross section must be added the thickness of its own walls, which must be sufficiently thick to allow for the considerable overhung length of the channel, which in practice is likely to amount to 6 metres, as well as for its sudden temperature variations due to the discontinuity of the flow of molten metal. In connection therewith it may be stated that at the moment of casting there is established a very considerable temperature difference between the upper part of the channel wall, which is not in contact with the molten iron, and the lower part of the wall, which is in contact therewith. This causes the channel to bend slightly. This phenomenon calls for a further decrease in the internal channel cross section as conditioned by the preceding requirements, if it is desired to ensure that between the channel and the mould there is sufficient clearance to prevent these elements from coming into contact at any time.

This difficulty is of course further increased by vibrations due to the rotation of the mould, such vibrations being transmitted to the channel by the frame of the machine, and being liable to cause the molten metal to overflow, if the vertical walls of the channel are not sufficiently high.

In making cast iron pipes by centrifugal action it is generally necessary to provide, on the mould end at which the molten metal is introduced, a circular rib protruding radially into the mould to an extent equal to the thickness of the pipe

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wall, such rib having for its purpose to prevent the molten iron escaping from the mould by the centrifugal action, thus enabling a pipe of constant thickness throughout its length to be cast.

This necessity further reduces the possibilities of known methods of manufacture and for these various reasons it has been found practically impossible to industrially cast pipes of an internal diameter smaller than 40 millimeters by centrifugal action.

Attempts have been made to provide the channel end with a roller or a ball adapted to roll within the mould, but this arrangement had the disadvantage of necessitating a supplementary clearance for mounting the roller or ball between the channel and the mould.

According to the invention, the mould is provided with a support carrying a movable ring the external diameter of which is equal to the internal diameter of the mould, while its internal diameter is equal to the internal diameter of the pipe to be made, the arrangement of this support being such that at the moment of removal of the channel from the mould this ring is introduced into the upper end of the mould, the jet of liquid metal, momentarily interrupted by the introduction of the ring, continuing through the ring after the latter has been put in, for the purpose of finishing the casting of the pipe.

In this manner, the pipe may have a constant thickness throughout its length, since the ring prevents the liquid iron from breaking out of the mould.

According to a further feature of the invention, the ring is removed after solidification of the metal but before the said ring is imprisoned by contraction of the mould.

Other features of the invention will be apparent from the following description with reference to the accompanying drawings, which show by way of example several embodiments of the invention, and in which:

Figure 1 is a general view in elevation showing casting apparatus according to the invention;

Figure 2 is a plan view corresponding to Figure 1, looking in the direction indicated by the arrow F in Figure 1;

Figure 3 is an end view looking in the direction indicated by the arrow *f* in Figure 1, the feed-channel being assumed to be removed;

Figure 4 is a detail view in sectional elevation showing the ring mounted in its cage;

Figure 5 is a corresponding plan view on the line 5—5 in Figure 4;

Figure 6 is a detail view in longitudinal section

showing the device for adjusting the cage-carrying lever.

Referring to Figures 1 to 3, 5 denotes the drum of a centrifugal casting machine. It can travel by means for rollers 6 on inclined rails 7, the means for controlling displacements of the drum along the rails not being shown. Within the drum 5 is located a chill mould 8 adapted to rotate about its longitudinal axis and provided with cooling means, also not shown. 11 denotes the end of a channel for introducing liquid metal into the mould 8.

To the drum 5 are secured two bearings 12 and 13, which support a longitudinal shaft 14, to the upper end of which is secured a lever 15 supporting a cage 16, in which is mounted, through the medium of a ball bearing, a ring 17. The downward displacement of the lever 15 is limited by an abutment 18, so disposed that the cage 16 in its lower position is in alignment with the axis of the mould 8. The details of the mounting of the lever 15 on the shaft 14 and of the ring 17 in the cage 16 will be described hereinafter. The lower end of the longitudinal shaft 14 carries a lever 21 provided with a roller 22 adapted to roll on a cam 23. This cam 23 may oscillate about an axis 24 and rests upon an abutment 25 during the operative stroke of the roller 22, the abutment being fixed to the base of the apparatus or it may comprise a post fixed in the ground. The longitudinal shaft 14 further carries a sleeve 29 loose thereon and provided with a helical slot 30, in which a pin 31 fitted into the shaft 14 can slide. The lower face of this sleeve is maintained in contact with the upper face of the bearing 12 by a helical spring 32, which is adapted to press at one end against the lower face of the bearing 12 and at the other end against the upper face of the lever 21, and to pull the shaft 14 downwards while displacing the pin 31 and the sleeve 29. To the sleeve 29 is secured an arm 35 adapted to oscillate together with the sleeve 29 about the shaft 14 under the action of a projection or tappet 36 secured to a rod 37 rigidly connected with a piston acted upon by a fluid under pressure in a stationary device 38 not shown in detail. This device is set in motion with the aid of a multi-way cock 39 provided with a return spring 33 and controlled by a peg 40 fixed to the drum of the machine as it moves along the rails 7.

The operation of the apparatus is as follows: The drum 5 of the machine being at the highest point of its stroke on the runway 7, and the feed channel 11 being therefore entirely engaged in the mould 8, the latter is set in rotation (about 1000 revolutions per minute) and the casting operation is started. The mould descends along the runway while the liquid metal is progressively deposited within the mould to form the pipe.

When the apparatus is idle, the clearance between the lower surface of the channel and the inner surface of the mould is about one millimeter so that in operation the lower face of the channel, which has a cylindrical profile, will rest upon the inner surface of the mould. The vibrations imparted to the mould in operation will thus be communicated to the channel, which facilitates the downward flow of the molten metal. The lateral walls of the channel are made sufficiently high in order to prevent any overflow of the metal.

When the mould reaches the lower end of its stroke, the roller 22 comes into contact with the cam 23 and rolls upwards thereon, actuating the lever 21, the shaft 14 and the lever 15 carrying

the cage 16, whereby the latter is caused to face the mould inlet opening, while interrupting for a very short time the jet of liquid metal escaping from the channel end until the lever 15 is stopped by the abutment 18 fixed on the drum 5. At this moment the ring 17 is slightly introduced into the interior of the mould by the spring 32 permanently pulling the longitudinal shaft 14. In its raised position the ring 17 bears against the end of the machine drum while keeping the spring 32 compressed, but as soon as the ring faces the mould inlet opening it is free to yield to the spring 32, and is thus caused to penetrate into the mould. The liquid metal is now still fed into the mould for a few moments, passing through the ring 17 and neatly finishing the upper end of the pipe as defined by this ring with respect both to the length and the internal diameter.

When the mould reaches the lower end of its stroke, the roller 22 having terminated its ascent of the cam 23 passes over the articulation 24, and being free to rotate, drops to its inoperative position. At the same time, the peg 40 of the machine opens the multi-way cock 39, which causes the fluid-pressure operated device 38 to lower its piston rod 37 and with it the tappet 36 which strikes against the lever 35 and rocks it, thus turning the sleeve 29, which, pressing against the bearing 12, impels the shaft 14 longitudinally towards the upper end of the machine, by virtue of the co-operation of its helical slot with the pin 31. This results in causing the ring 17 to move out of the mould, after which the end of the helical slot in the sleeve 29 presses against the pin 31, and the lever 35 now rotates the assembly comprising this lever 35, the sleeve 29, the shaft 14 and the lever 15, thereby raising the ring 17 and thus clearing the entrance into the mould.

The moulded pipe having been removed from the mould, the latter moves up to its starting point. The cam 23 oscillates about the pivot 24 to make way for the roller 22, which has passed over it and which in its return stroke now passes under it. The multi-way cock 39 is brought back to the proper place by the spring 33 in order that the rod 37 may return to its initial position.

It has been stated above that the liquid metal continues to flow a little while when the mould has arrived at the lower end of its stroke in order to finish the pipe in course of manufacture; but as the ring 17 is caused to rise by the displacement of the mould itself, and as the metal must be slightly cooled in its contact with the mould before the withdrawal of the ring 17, it is necessary that the withdrawal of this ring be effected with a certain time lag with respect to the moment of arrival of the mould at the lower end of its stroke. This is why the raising device 38 operates through the medium of a fluid under pressure. This retardation must be determined with the utmost accuracy; it must on the one hand be sufficiently great, in order that the metal of the pipe may be sufficiently solidified, and on the other hand, it must be sufficiently small in order that the ring 17 may not be jammed in through the contraction of the mould. This result is attained, according to the invention, by providing a valve 34 adapted to regulate the inflow of the fluid controlling the downward movements of the rod 37 and of the catch 36.

The catch 36 might alternatively be made adjustable on the rod 37, with a suitable adjustment of the idle space c that the tappet 36 has to travel before acting on the lever 35.

For a correct operation of the apparatus it

is indispensable that the ring 17 should follow the mould in its movement of rotation as soon as this ring is applied against it, and this is why the ring is mounted in the cage 16 through the medium of a ball bearing. Referring to Figure 4, there is shown an example of such mounting. The ring 17 has an intermediate collar 51 one face of which, the working face, is provided with a ball race 52 for a ball bearing, while the other face thereof is in contact with a friction piece 53 fixed to the cage 16 itself. A crown or ring 54 screwed into the cage 16 on its other face carries the outer race 55 of the ball bearing. A wear-resisting piece 59 is secured by screws 60 to the ring 17, and it is this piece 59 which is in direct contact with the mould 8. The ring 17 is provided with a flared enlargement 63 to facilitate the introduction of liquid metal through the ring. Furthermore, a collar 64 secured to the ring 17 by screws 65 protects the mechanism against splashes of liquid metal. Finally, there is housed in the cage 16 an annular water passage 66 for cooling purposes. This passage is laterally closed by a welded cover 67, and is adapted to communicate with a water inlet channel 68 and a water outlet channel 69 (Figure 5). Lubrication is effected by a central channel 70 and a grease box 71.

In order that the ring may present itself both in the plane of the end of the mould and exactly in front of the mould inlet orifice, the ring must be so mounted as to be adjustable on its support lever 15. Figure 6 shows an example of construction of such an arrangement with adjustable mounting. The end of the lever 15 supporting the ring cage is so inserted into a piece 81 as to be able to slide therein to a certain extent, while the end of the longitudinal shaft 14 is also inserted into the said piece 81 so as to slide therein to a certain extent. An externally threaded sleeve 82 is inserted in the end of the lever 15 between a shoulder 83 on this lever and a nut 84 screwed on at the end. This sleeve 82 is cylindrically bored throughout so as to turn on the likewise cylindrical end 85 of the lever 15. The sleeve 82 is screwed into the piece 81 and locked at the desired depth by means of a lock-nut 87, and is provided with a manipulating nut 88. On the other hand, the end of shaft 14 is slidably engaged in a cylindrical bore 91 in the piece 81, but it is prevented from turning therein by a screw 92 engaging in a longitudinal groove 93 provided in the end of the shaft 14. This screw 92 serves to lock the shaft 14 in the piece 81, while another screw 94, loose in the piece 81, is screwed into the end of shaft 14, and serves as adjustment means co-operating with a return spring 86 interposed between the shaft 14 and the piece 81. A slot 95 is provided in the lever 15 to make way for the screw 94 and at the same time to maintain the position of the lever 15 in the piece 81. It is evident that with this device it is easy to adjust the position of the ring 17 with respect to the mould in two perpendicular directions, namely: in a direction parallel to the mould axis by displacing the piece 81 along the shaft 14 with the aid of the screw 94, and in a direction perpendicular to the mould axis by shifting the lever 15 to a greater or less extent within the piece 81 with the aid of the nut 88. It is therefore easy to impart to the ring the exact position it must occupy in order to fall exactly in front of the inlet orifice of the mould at the moment of actuating the lever 15.

At various points on the outer surface of the metal-carrying channel there may be arranged plugs made from a very hard metal or alloy, for example tungsten carbide, which alone are in contact with the mould in rotation, with a view to reducing the wear to a minimum and localising it on the elements that can readily be replaced.

It will be understood that the invention is not limited to the particular embodiments described and shown, which have been set forth merely by way of example.

Thus, the ring may be positioned by any other kinematic means, for example by bodily movement perpendicular to the axis, followed by a movement parallel to the axis, as in the apparatus hereinbefore described, or else by pivoting about an axis at right angles to the mould axis and substantially in the plane of the mould end.

The motions necessary for putting in place and removing the ring may be produced by mechanical or hydraulic means as described, or by any other means, pneumatic or electric, which may have a time lag.

Still within the ambit of the invention, the ring may be merely applied against the mould head without penetrating into the mould. Such an arrangement simplifies the putting in place and the control of the ring, but does not ensure such a good alignment of the ring with the mould axis, and consequently may lead to a risk of inequalities in the thickness of the pipes to be made.

It will be understood that the invention is also applicable to centrifugal casting machines in which the mould is longitudinally immovable, while the iron feed channel is movable in the longitudinal direction.

Having now described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a centrifugal pipe casting machine having a feed trough and a carrier reciprocable with respect to said trough, and a mold rotatably mounted on said carrier, the trough entering said mold to pour molten metal and being withdrawn therefrom during such reciprocation; the combination with said trough, carrier and mold of an end dam for said mold pivoted on said carrier adjacent the pouring end of the mold for swinging movement into and out of the path of said feed trough, means actuated by the movement of the carrier and mold in one direction to swing said dam into operative position in front of the mold as the carrier and mold draw away from the feed trough, and additional control means for reversing the direction of swing of said dam upon completion of said withdrawal movement.

2. In a centrifugal pipe casting machine having a supporting structure including a guideway, a carrier reciprocable along said guideway, a mold rotatably mounted on said carrier, and reciprocating with said carrier along said guideway, a feed trough parallel with said guideway and disposed so as to enter the mold and be withdrawn therefrom as the carrier reciprocates; the combination with said structure, carrier, mold and trough of a shaft disposed on said carrier and means on the carrier for supporting the shaft, a dam fixed on said shaft adjacent the pouring end of said mold, said dam being rotatable into and out of operative position in front of said mold, a lever secured to the other end of said shaft and a follower on said lever, a cam on said supporting structure forming a trackway for said fol-

lower; said lever, cam and follower cooperating to rotate said shaft and swing said dam to its operative position between the mold and trough as the carrier leaves the trough, control means for reversing the direction of rotation of said shaft, and means on said carrier for actuating said control means to swing the dam to inoperative position at the completion of the pouring cycle.

3. In a centrifugal pipe casting machine having a supporting structure including a guideway- a carrier reciprocable along said guideway, a mold rotatably mounted on said carrier and reciprocating with said carrier along said guideway, a feed trough parallel with said guideway and disposed so as to enter the mold and be withdrawn therefrom as the carrier reciprocates; the combination with said structure, carrier, mold and trough of a shaft disposed on said carrier and means on the carrier for supporting the shaft, the shaft being longitudinally slidable in said supporting means, a dam fixed on said shaft adjacent the pouring end of said mold, said dam being rotatable into and out of operative position in front of said mold, said dam having an annular shoulder on its face of a diameter less than that of the mold opening so as to fit thereinto, a lever secured to the other end of said shaft and a follower on said lever, a compression spring on said shaft between said lever and the adjacent shaft supporting means, a cam on said supporting structure forming a trackway for said follower; said lever, cam and follower cooperating to rotate said shaft and swing said dam to its operative position between the mold and trough as the carrier leaves the trough, said spring acting on said lever to pull said shoulder into the mold when it is rotated into registry with said mold opening; control means for reversing the direction of rotation of said shaft, and means on said carrier for actuating said control means to swing the dam to inoperative position at the completion of the pouring cycle.

4. In a centrifugal pipe casting machine having a supporting structure including a guideway, a carrier reciprocable along said guideway, a mold rotatable on said carrier and reciprocating with said carrier along said guideway, a feed trough parallel with said guideway and disposed so as to enter the mold and be withdrawn therefrom as the carrier reciprocates; the combination with said structure, carrier, mold and trough of a shaft disposed on said carrier and means on the carrier for supporting the shaft, a dam fixed on said shaft adjacent the pouring end of said mold, said dam being rotatable into and out of operative position in front of said mold, a lever secured to the other end of said shaft and a follower on said lever, a cam on said supporting structure forming a trackway for said follower; said lever, cam and follower cooperating to rotate said shaft and swing said dam to its operative position between the mold and trough as the carrier leaves the trough; control means including a sleeve on said shaft abutting one of said shaft supporting means, said sleeve having a helical slot, and a pin in said shaft projecting through said slot; a lever on said sleeve projecting outwardly of said carrier; a fluid operated piston and a control valve therefor associated with said carrier, said piston having an arm engageable with said sleeve lever, and a lug on said carrier adjacent the pouring end of the mold; said valve having a handle projecting into the path of said lug, and being actuated thereby on the return movement of the carrier to release the fluid controlled piston, whereby the piston arm is operated to swing the sleeve lever and rotate the shaft and dam to inoperative position at the end of the pouring cycle.

5. In a centrifugal pipe casting machine having a supporting structure including a guideway, a carrier reciprocable along said guideway, a mold rotatably mounted on said carrier and reciprocating with said carrier along said guideway, a feed trough parallel with said guideway and disposed so as to enter the mold and be withdrawn therefrom as the carrier reciprocates; the combination with said structure, carrier, mold and trough of a shaft disposed on said carrier and means on the carrier for supporting the shaft, the shaft being longitudinally slidable in said supporting means, a dam fixed on said shaft adjacent the pouring end of said mold, said dam being rotatable into and out of operative position in front of said mold, said dam having an annular shoulder on its face of a diameter less than that of the mold opening so as to fit thereinto, a lever secured to the other end of said shaft and a follower on said lever, a compression spring on said shaft between said lever and the adjacent shaft supporting means, a cam on said supporting structure forming a trackway for said follower; said lever, cam and follower cooperating to rotate said shaft and swing said dam to its operative position between the mold and trough as the carrier leaves the trough, said spring acting on said lever to pull said shoulder into the mold when it is rotated into registry with said mold opening; control means for reversing the direction of rotation of said shaft including a sleeve on said shaft abutting one of said shaft supporting means, said sleeve having a helical slot, and a pin in said shaft projecting through said slot; a lever on said sleeve projecting outwardly of said carrier; a fluid operated piston and a control valve therefor associated with said carrier, said piston having an arm engageable with said sleeve lever, and a lug on said carrier adjacent the pouring end of the mold; said valve having a handle projecting into the path of said lug, and being actuated thereby on the return movement of the carrier to release the fluid controlled piston, whereby the piston arm is operated to swing the sleeve lever and rotate the shaft and dam to inoperative position at the end of the pouring cycle.

JACQUES BOUCHER.

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