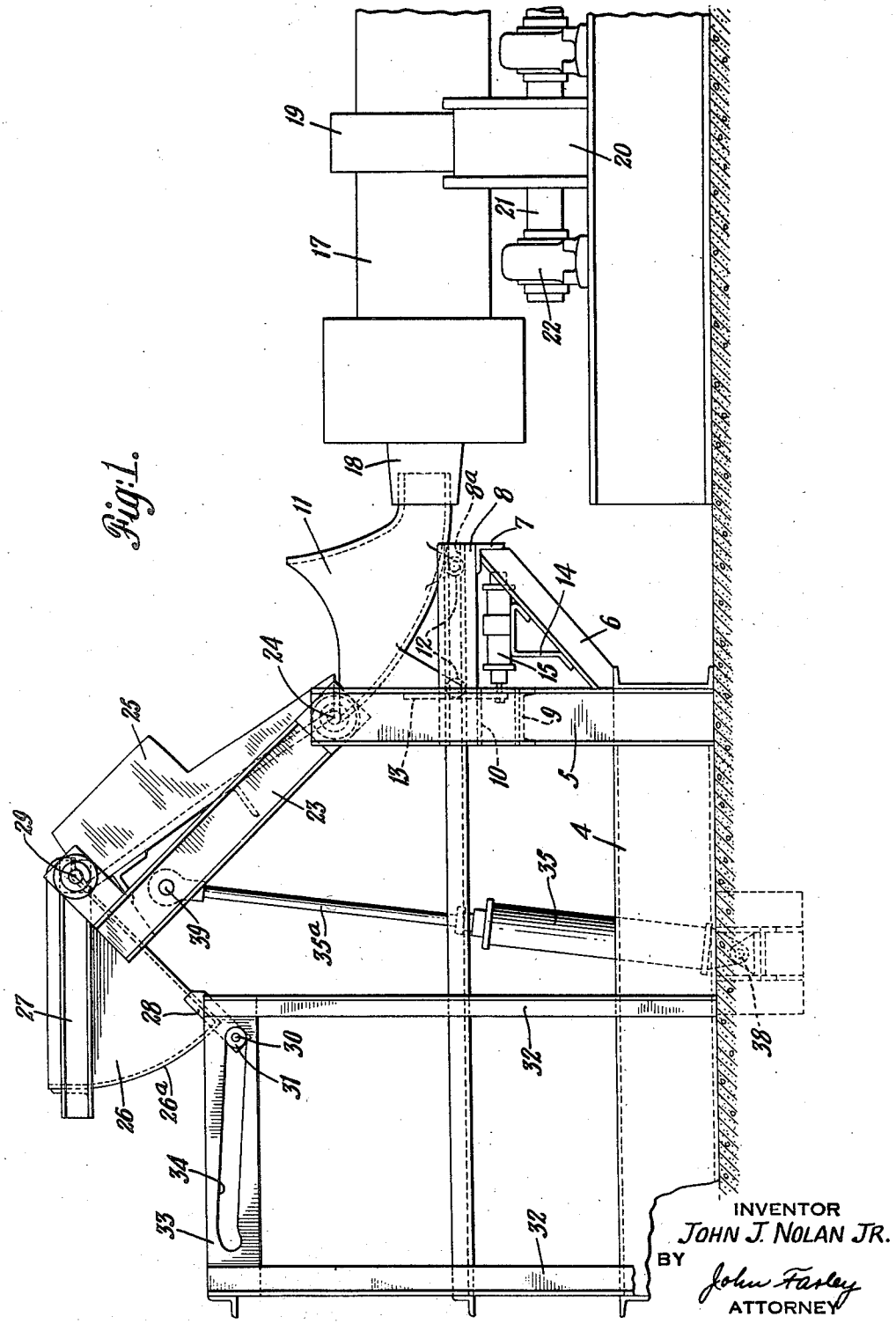
Jan. 24, 1950 J. J. NOLAN, JR 2,495,541

METAL POURING APPARATUS FOR CENTRIFUGAL CASTINGS

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Fig. 1.



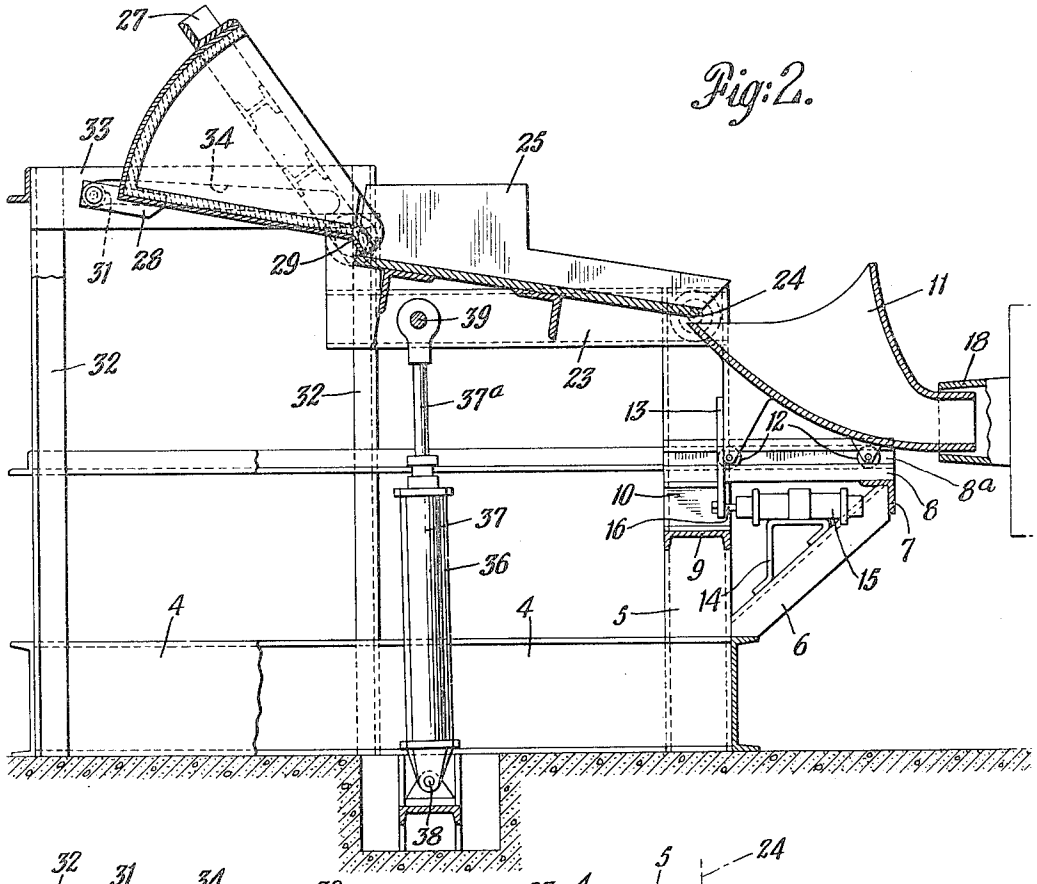
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Fig. 2.



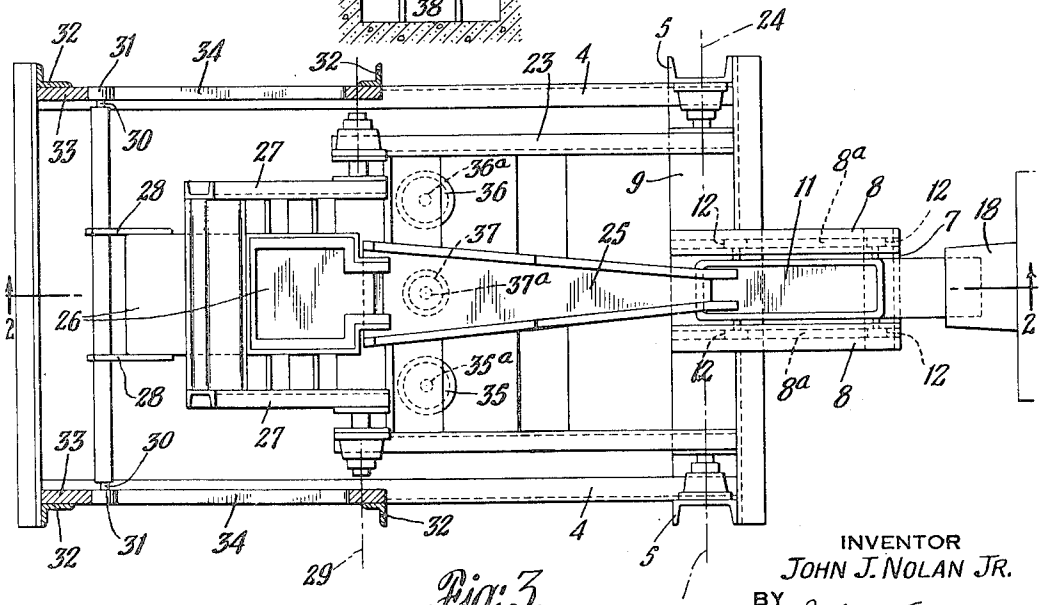


Fig. 3.

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METAL POURING APPARATUS FOR CENTRIFUGAL CASTINGS

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4 Claims. (Cl. 22—79)

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This invention relates to apparatus for the centrifugal casting of iron pipe and the like, and more particularly to improvements in pouring mechanisms for supplying molten metal to rotating molds.

In centrifugal casting of iron pipe, it is customary to use a rotating cylindrical mold, generally horizontally oriented, and the molten metal is fed into the mold from an end thereof. Difficulty has been encountered prior to the present invention as a result of the frictional resistance to the flow of molten metal from one end of the mold to the other, with a consequent tendency for the molten metal to be unevenly distributed.

An object of the present invention is to provide apparatus for supplying molten metal to the mold in such a way that it will be evenly distributed along the length of the mold.

In accomplishing this objective, an important feature of the invention is that molten metal is poured in such a manner that two conditions are satisfied concurrently: One of these conditions is that a constant volume of metal is delivered to the mold per unit time. The other condition is that the horizontal velocity of the molten metal moving into the mold is relatively high at the beginning of the pouring operation but diminishes progressively as the pouring operation proceeds.

A further feature of the present invention is that means for controlling the linear velocity of the molten metal are arranged to cooperate with means for controlling the volume of metal poured per unit time in such a way that the apparatus complies with the two above-mentioned conditions irrespective of the length of time required for the entire pouring operation. Hence the pouring operation can be accomplished as quickly or as slowly as is desired.

Other objects, features and advantages will appear as the description proceeds.

In the drawings, which illustrate a preferred embodiment of the invention:

Fig. 1 is a side elevational view showing the pouring mechanism in an up position;

Fig. 2 is a side view partly in elevation and partly in section showing the pouring mechanism in a down position, after completion of a pouring operation, the plane of the section being indicated in Fig. 3, at 2—2; and

Fig. 3 is a plan view of the apparatus, the cam-like members and their supporting standards being shown in section.

Referring to Figs. 1, 2 and 3, it may be seen that there is provided a frame having a base 4

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and a pair of upwardly extending standards 5. There is provided a pair of angle irons 6 secured to and extending slantingly upward from the base. An angle iron 7 is mounted on and extends transversely between the angle irons 6. There is provided a pair of horizontal members 8, supported at their right-hand end by the angle iron 7. Extending transversely between the standards 5 is a channel iron 9. Supporting the left-hand ends of the members 8 are a pair of vertical members 10, mounted on the channel iron 9. The members 8 are provided with a pair of tracks 8a, adapted to carry a trough or boot 11 provided with wheels 12 which run on said tracks. Secured to the boot 11 is a downwardly extending plate 13, by which the boot may be moved along the tracks. Supported by the frame, as by a member 14 resting on the angle irons 6, is a cylinder 15, carrying a piston (not shown), provided with a piston rod 16 connected to the plate 13. Means not shown are provided for supplying fluid to the cylinder 15 in order to move the boot 11 to the right or left as desired.

The mold 17 is mounted for rotation about a substantially horizontal axis. It may be provided with a plurality of spaced circumferential flanges, one of which is shown at 19, and may be supported and rotated by means of corresponding flanged friction rollers, such as that shown at 20, carried by a pair of shafts one of which is shown at 21. There is provided suitable supporting means carrying bearings 22 in which the shafts 21 are rotatably mounted. Means not shown are provided for rotating the shafts 21 in like directions in order to give the mold a rotary motion. Other types of horizontal rotary molds and means for rotating same may be used in connection with the present invention.

As shown in Fig. 1, the boot 11 may, at the beginning of the pouring operation, be rolled toward the right on the tracks 8a so that its lower or outlet end actually enters the tapered input end portion 18 of the mold. After the pouring operation is completed, the boot may be rolled to the left in order that the mold may be disengaged and moved transversely away from the pouring apparatus and another mold brought into position for the next pouring operation.

There is provided a chute frame 23, pivotally supported along an axis 24 by the standards 5. Supported by the chute frame is a chute 25, which is tapered to a narrower width toward the right and adapted to conduct molten metal into the boot 11.

The apparatus is provided with a ladle 26 for

holding molten metal, said ladle having as portions thereof a ladle frame 27 and a pair of extensions or arms 28. The ladle frame 27 is pivotally attached to the chute frame 23 toward the upper left-hand portion thereof at a horizontal axis 29. In the embodiment shown, the ladle proper may be generally wedge-shaped, having a generally apical edge at the axis 29, and having a rear wall 26a in the shape of a portion of a cylinder approximately concentric about the axis 29. The pouring lip of the ladle is located approximately at the axis 29, for pouring molten metal into the chute, which in turn delivers it to the boot. In the embodiment shown, the generally sector-shaped sidewalls of the ladle, seen in elevation in Fig. 1, are approximately vertical. It may be seen that with a ladle so shaped, if the ladle is tipped or rotated in a clockwise direction about the axis 29 at a constant angular velocity, fluid will be poured from the ladle at a constant volume per unit time, since at any stage of the pouring operation equal angular increments of rotation will cause equal volumes of fluid to be poured. In the present embodiment, during the pouring operation the axis 29 is translated along an arcuate path in a generally downward direction and the ladle 26 is simultaneously rotated, by means to be described, in a clockwise direction at uniform angular velocity about this axis. The flow of fluid from the pouring lip is consequently uniform.

The term "flow" as used herein will be understood to mean "quantity per unit time." In the present discussion it is used interchangeably with the expression "volume per unit time."

It is observed that in the present embodiment the chute means serves to constrain a portion of the ladle, namely that at the axis 29, to a predetermined path, that is, one concentric about the axis 24. Means are provided for constraining another portion of the ladle to another predetermined path so as to tip the ladle. The arms 28 of the ladle carry a shaft 30 on the ends of which are rotatably mounted a pair of rollers 31. Rising from the base 4 there is provided a series of standards 32, reinforced by suitable means. Mounted toward the upper ends of these standards are a pair of opposed horizontally extending frame members 33. The frame members 33 are respectively provided with corresponding cam-like slots or grooves 34 of predetermined shape, adapted to receive and guide the rollers 31, thereby defining the path of motion of the shaft 30 and the free ends of the arm portions 28 of the ladle 26. As will be explained in more detail subsequently, the cam-like slot is shaped, in the present embodiment, so as to cause the ladle to be tipped or rotated about the axis 29 at uniform angular velocity.

Suitable means are provided for lifting and lowering the chute 25 and its frame 23. In the illustrative apparatus there is provided a series of cylinders 35, 36 and 37, pivotally supported at their lower ends along an axis 38 by various frame or foundation members. The cylinders are provided with a series of corresponding piston rods 35a, 36a and 37a, each carrying a piston, not shown, within the respective cylinders. The upper ends of the respective piston rods are pivotally attached to a shaft 39 comprising a part of the chute frame.

The cylinders 35 and 36 are supplied with water or oil so as to actuate the pistons therein, and the cylinder 37 is supplied with air under pressure for this purpose. The air lift cylinder

is effective in lifting the chute rapidly during the recovery part of the cycle, and the hydraulic cylinders are convenient for accurately controlling the downward movement of the apparatus during the pouring part of the cycle. As the chute is lowered, the ladle is lowered, so that metal is poured from progressively lower elevations down a chute which is relatively steeply inclined early in the pouring operation but only slightly inclined later. As a result, metal entering the mold toward the end of the pouring operation has less kinetic energy, and therefore a lower horizontal velocity, than metal entering the mold toward the beginning of the pouring operation. It is recalled that this is one of the conditions desired. Since the horizontal velocity of the metal supplied to the mold diminishes progressively during the pouring operation, the metal initially flows relatively rapidly toward the far end of the mold, while later in the pouring operation it enters the mold more slowly, thereby producing a generally even distribution of metal along the mold.

Although various arrangements are possible, it may be assumed in the present illustration that during their downward movement, the pistons move at uniform speed within the cylinders. It is apparent that the resulting speed of the axis 29 along its arcuate path is not quite uniform. The shape of the cam-like slot 34 can be so designed that the ladle is tipped about the axis 29 at a uniform angular velocity. More particularly, assuming that the apparatus is set for a certain speed of motion of the pistons within the cylinders, the position of the axis 29 at any instant can be determined. If this position is plotted at a series of instants separated by equal time intervals, then the required positions which the rollers 31 must assume at corresponding instants in order to produce a series of equal increments of angular rotation of the ladle about the axis 29 can be determined. The cam-like slot 34 is designed to constrain the rollers 31 to a path passing through these required positions. By thus locating a sufficient number of points, the proper shape of the slot may be completely determined. Such a slot will cause the ladle to tip at uniform angular velocity about the pouring lip during any given pouring operation. With the ladle shaped as previously described and as illustrated in the drawings, the constant-speed tipping which results from the slot designed as indicated, will produce a constant flow of fluid from the ladle.

While the shape of the ladle previously described is an advantageous one, since with such a shape it follows that a tipping of the ladle about the pouring lip at constant angular velocity produces a constant flow of fluid from the ladle, with a ladle of different shape, a tipping motion of non-uniform angular velocity can be found which will likewise produce a constant flow of fluid from the ladle. The ladle may have a very irregular shape, and if it is used in an embodiment such as that shown in Fig. 1, for example, then the proper shape for the cam-like slot 34 may be found by some system such as the following. A series of positions of the axis 29 is determined, as previously described, at a series of instants in the pouring cycle separated by equal increments of time. The ladle is filled with fluid, and positions of the rollers 31 corresponding to the first-mentioned series are located such that as the ladle is moved from one pair of corresponding positions to the next,

equal volumes of fluid are poured from the ladle.

While it may be stated generally that the present invention includes means for limiting the possible path of motion of a first part of the ladle, such as that at the axis 29, to a first predetermined path, and means for limiting the possible path of motion of a second part of the ladle, such as that in the region of the shaft 30, to a second predetermined path, it is to be emphasized that embodiments other than that illustrated in the drawings and described above may satisfactorily be used for these ends. Thus the motion of the axis 29 might be limited by a cam-like arrangement instead of a linkage, and the motion of the axis 31 might be limited by a linkage instead of a cam. Furthermore, the parts of the ladle which are limited to predetermined paths of motion need not necessarily be located at the positions of the rollers 31 and the axis 29. It is, however, of considerable advantage from the standpoint of simplicity of design to locate one of the constrained parts of the ladle near the pouring lip, which is the position of the axis 29. The pouring lip may advantageously be given a purely translational, generally downwardly motion, and the remainder of the ladle may be caused to pivot about this lip.

It is to be emphasized that various actuating means may be employed to move the ladle in accordance with its constraints. Instead of using hydraulic and air cylinders to rotate the chute and chute frame about the axis 24, this rotation could be accomplished by other means. The chute frame may, in another embodiment, be rigidly mounted on a shaft positioned at the axis 24, and this shaft may carry a spur gear, driven by a worm or other type gear connected with a power source. The chute frame may thereby be caused to rotate uniformly or otherwise about the axis 24.

Regardless of the means employed for constraining the axis 29 to a predetermined path, regardless of the shape of said path, and regardless of the relative and absolute speeds of the axis in various portions of the path, once the precise path of motion for the axis 29 and its speed in various portions of the path have been determined, the cam-like slot 34 can be shaped in the manner previously described to produce such a tipping action that a constant volume of molten metal is poured from the ladle per unit time during all portions of a particular pouring operation. If now for a second pouring operation the motion of the axis 29 along its path is made faster or slower, but if its relative speed in various portions of the path remains unchanged, the same shape for the cam-like slot 34 will be satisfactory in producing a flow from the ladle which is constant throughout the pouring operation, but of course the magnitude of the flow in this second pouring operation will be different from that in the previously mentioned case. By way of more specific illustration, it may be pointed out that in the embodiment illustrated in the drawings, so long as the piston moves at constant velocity axially along the cylinders during a pouring operation, then regardless of what this velocity may be, the cam-like slot 34 will serve to produce a constant flow of molten metal from the ladle during that operation.

Thus the illustrative apparatus will operate satisfactorily regardless of whether the entire pouring operation is accomplished quickly or slowly. More generally stated, in the present

invention means for controlling the horizontal velocity of the molten metal are combined with and are arranged to cooperate with means for controlling the volume of metal poured per unit time in such a way that irrespective of the length of time required for the entire pouring operation, the flow of metal from the ladle is constant throughout the operation and the horizontal velocity of the metal entering the mold diminishes progressively during the operation.

Referring again to the embodiment illustrated in the attached drawings, it is noted that when the pouring operation is accomplished quickly, by causing the pistons to move at a rapid, uniform speed along the cylinders during the pouring operation, the flow from the ladle, while constant throughout the pouring operation, is greater than when the pistons are moved at a slow uniform speed. Because of the combination of and cooperation of the tipping means and the lowering means, the horizontal velocity of the metal entering the mold will decrease more rapidly when the apparatus is operated so as to deliver a large volume of metal per unit time than when it is operated so as to deliver less metal per unit time to the mold. This effect is advantageous in producing a more even distribution of the metal within the mold in varying operating circumstances.

It will be noted that in general one portion of the ladle will be driven along a path according to a predetermined displacement-versus-time function and another portion of the ladle will be constrained to such a path that the ladle is tipped through an angle which is a predetermined function of said displacement.

In the illustrative apparatus, the path along which the axis 29 is driven has a vertical component, and the angle through which the ladle is tipped as a result of the action of the cam-like slot 24 may be said to be a predetermined functiton of the vertical displacement of the ladle.

While it was initially assumed in the apparatus illustrated that the pistons in the cylinders move at a constant speed during any pouring operation, it is possible to modify the apparatus so that the pistons move at different speeds in different portions of their stroke. For this purpose, pumps or valves adapted to produce varying flow of fluid to the cylinders in different portions of the cycle may be used. Assuming that the paths to which portions of the ladle are to be constrained have been previously determined, it may be seen that the law of motion of the pistons should be so chosen as to produce a constant flow from the ladle.

In addition to the previously described means for moving the ladle in accordance with its constraints, it may be pointed out that instead of driving the axis 24, other parts of the ladle, such as the shaft 30, may be driven. Assuming that the hydraulic cylinder system is eliminated from the illustrative apparatus, there may be provided actuating means including a system of linkages connected to the shaft 30 and adapted to move it and the rollers 31 along the path defined by the slot 34.

The terms and expressions which I have employed are used in a descriptive and not a limiting sense, and I have no intention of excluding such equivalents of the invention described, or of portions thereof, as fall within the purview of the claims.

I claim:

1. A pouring mechanism for use in centrifugal casting of pipe, comprising a frame, an inclined

chute having its lower end pivotally attached to said frame, means including a pressure-operated lifting and lowering device having a cylinder and a movable piston therein, to decrease the angle of inclination of said chute continuously, a ladle having a pouring lip at its forward edge, said ladle being pivotally attached along an axis at said lip to an upper part of said chute, a follower member connected to said ladle at a rear, lower part thereof, and a cam mounted on said frame and engaging said follower member, said cam having a surface of varying curvature, extending generally horizontally, shaped to move said rear, lower part of said ladle generally backwardly along a path to rotate said ladle about its said lip with an angular motion proportional to motion of said piston with respect to said cylinder, said ladle being shaped in the general form of a wedge having its apex at its lip and having its rear surface in the shape of a portion of a circular cylinder approximately concentric about said lip.

2. A pouring mechanism for use in centrifugal casting of pipe, comprising a frame, an inclined chute having its lower end pivotally attached to said frame, means including a pressure-operated lifting and lowering device having a cylinder and a movable piston therein, to decrease the angle of inclination of said chute continuously, a ladle having a pouring lip at its forward edge, said ladle being pivotally attached along an axis at said lip to an upper part of said chute, a follower member connected to said ladle at a rear, lower part thereof, and a cam mounted on said frame and engaging said follower member, said cam having a surface of varying curvature, extending generally horziontally, shaped to move said rear, lower part of said ladle generally backwardly along a path to rotate said ladle about its said lip with an angular motion determined by the motion of said piston with respect to said cylinder.

3. A pouring mechanism for use in centrifugal casting of pipe in a horizontal rotary mold, comprising a frame, an inclined chute having its lower end pivotally attached to said frame, means including a lifting and lowering device having a movable member, to decrease the angle of inclination of said chute continuously, a ladle having a pouring lip at its forward edge, said ladle being pivotally attached along an axis at said lip to an upper part of said chute, whereby said lip is lowered toward the horizontal axis of said mold, a cam and a follower member engaging same, interconnecting a rear, lower part of said ladle and said frame, said cam having a surface of varying curvature, extending generally horizontally, shaped to move said rear, lower part of said ladle generally backwardly along a path to rotate said ladle about its said lip with an angular motion determined by the motion of said movable member.

4. Apparatus for pouring molten metal into a horizontal rotary mold, comprising a frame, an inclined chute having its lower end pivotally attached to said frame, a ladle having a pouring lip at its forward edge, said ladle being pivotally attached along an axis at said lip to an upper part of said chute, a lifting and lowering device including a member moving at constant speed, to decrease the angle of inclination of said chute continuously, and to lower the lip of said ladle toward said mold, a follower member connected to said ladle at a rear, lower part thereof, a cam mounted on said frame engaging said follower member, said cam having a surface of varying curvature, extending generally horizontally, shaped to move said rear, lower part of said ladle generally backwardly along a path to rotate said ladle about its said lip with an angular motion determined by the motion of said member to pour molten metal from said ladle at a constant volume per unit time.

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