July 5, 1960 V. A. SZWED 2,943,369

APPARATUS FOR CENTRIFUGAL CASTING OF PIPE

Filed June 1, 1959 4 Sheets-Sheet 1

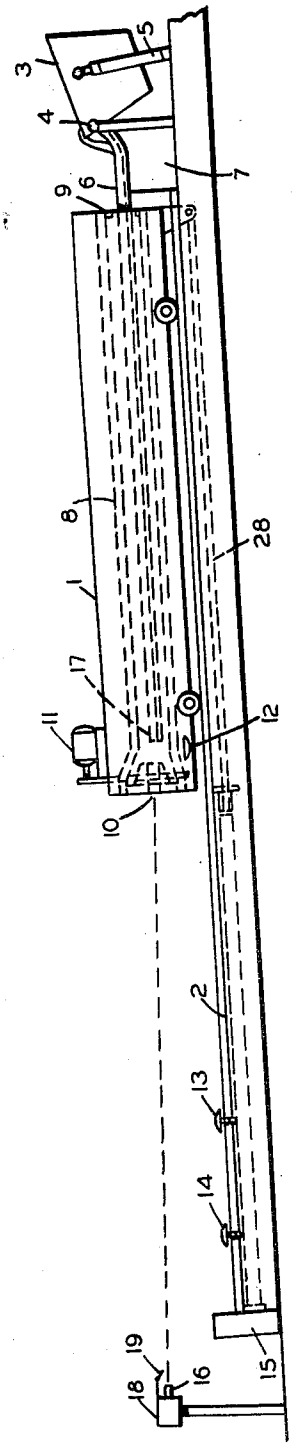


FIG.1

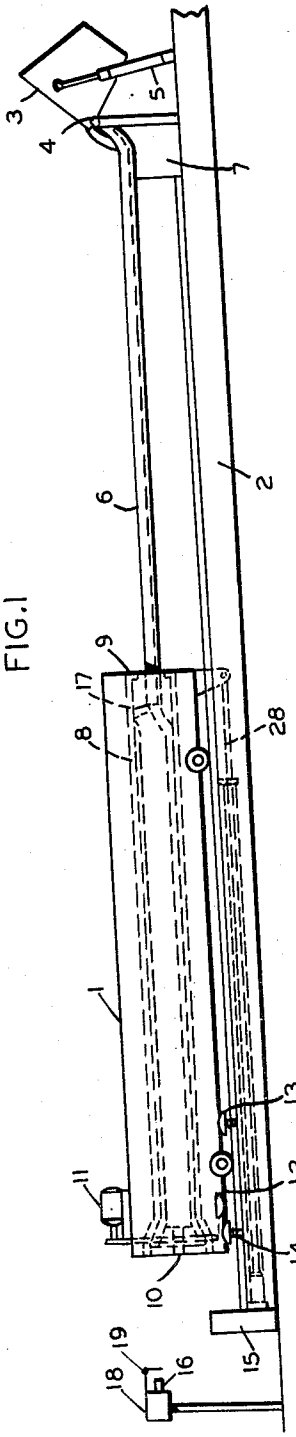


FIG.2

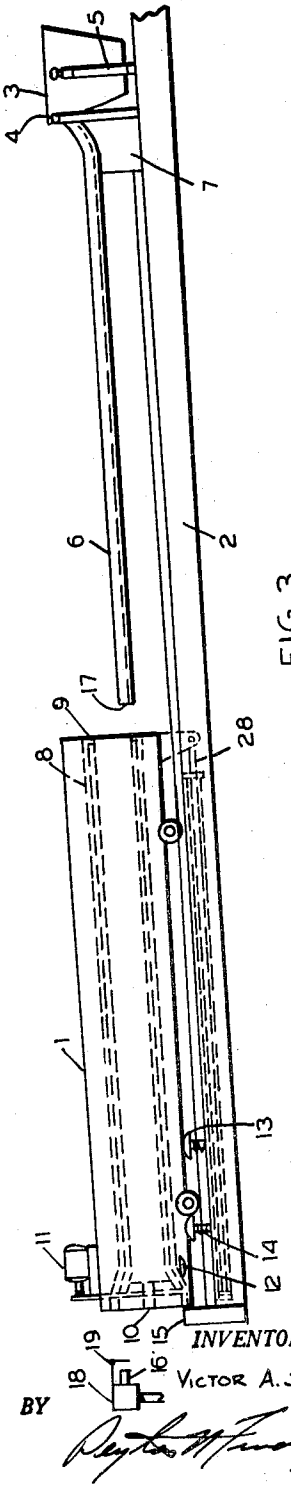


FIG.3

INVENTOR.
VICTOR A. SZWED
BY

July 5, 1960 V. A. SZWED 2,943,369

APPARATUS FOR CENTRIFUGAL CASTING OF PIPE

Filed June 1, 1959 4 Sheets-Sheet 2

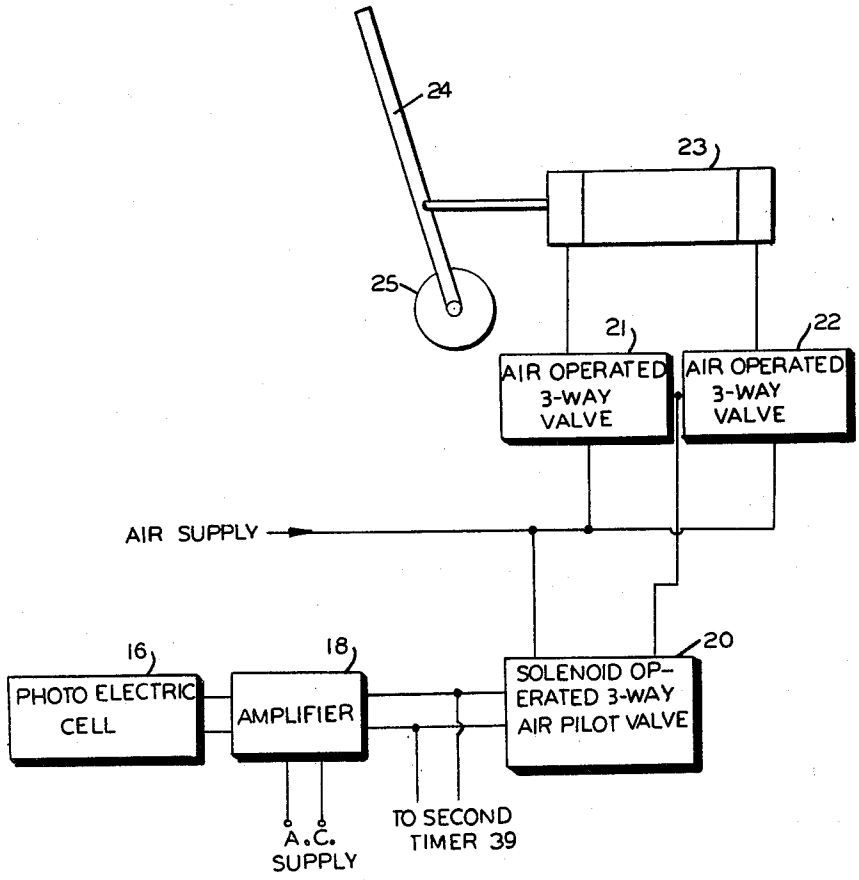


FIG. 4

INVENTOR.

BY VICTOR A. SZWED

July 5, 1960 V. A. SZWED 2,943,369

APPARATUS FOR CENTRIFUGAL CASTING OF PIPE

Filed June 1, 1959 4 Sheets-Sheet 3

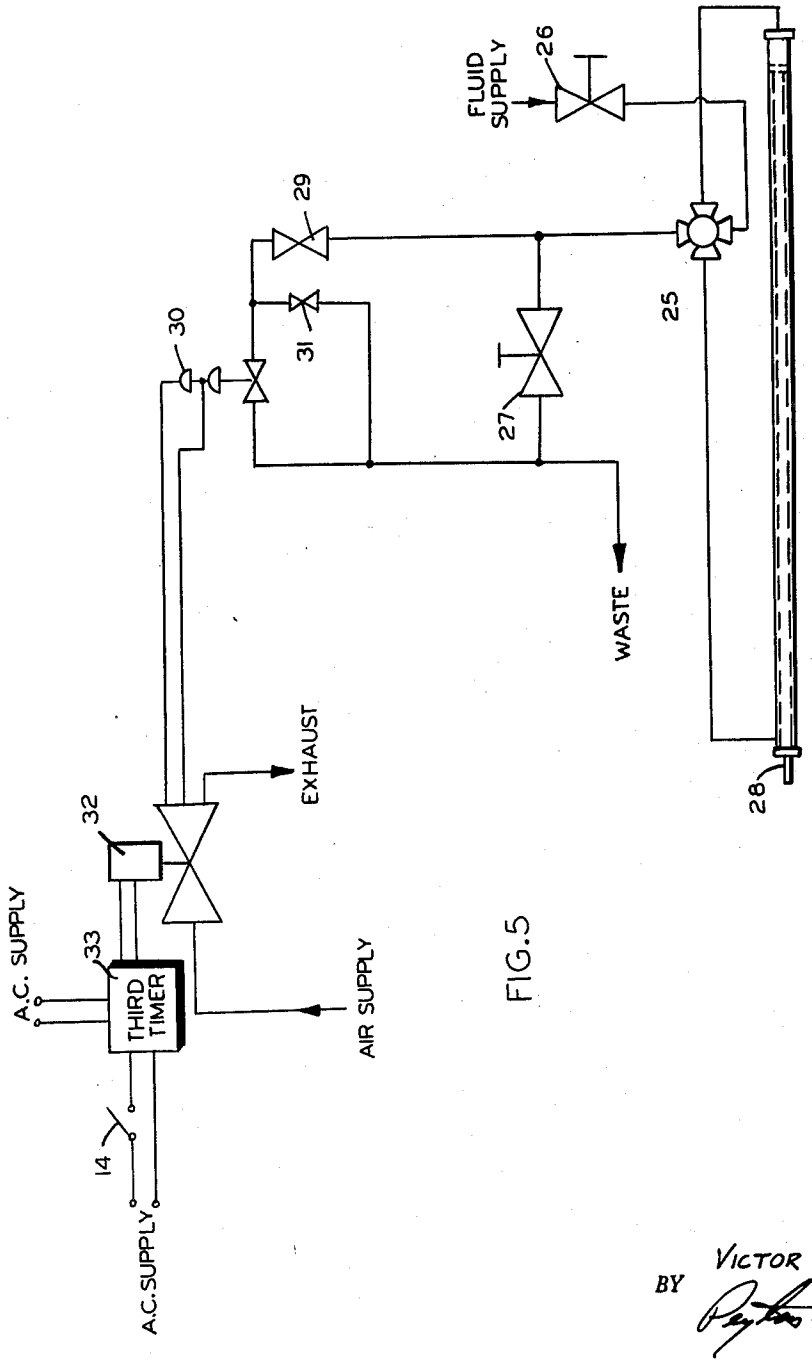


FIG. 5

INVENTOR.
VICTOR A. SZWED
BY

July 5, 1960 V. A. SZWED 2,943,369

APPARATUS FOR CENTRIFUGAL CASTING OF PIPE

Filed June 1, 1959 4 Sheets-Sheet 4

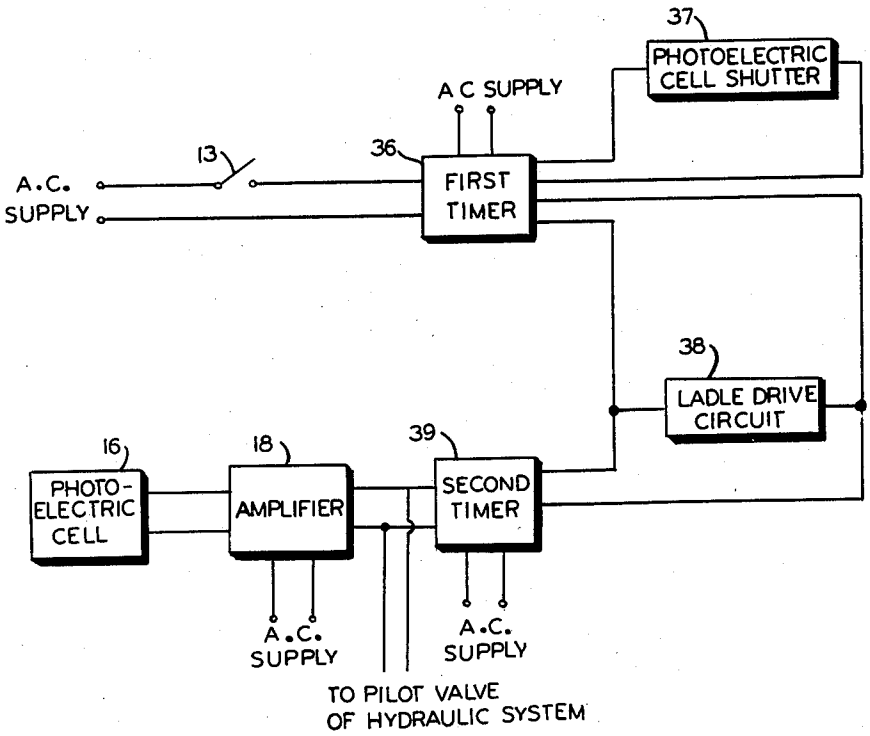


FIG.6

INVENTOR.

VICTOR A. SZWED

BY

United States Patent Office

2,943,369

Patented July 5, 1960

2,943,369

APPARATUS FOR CENTRIFUGAL CASTING OF PIPE

Victor A. Szwed, Burlington, N.J., assignor to United States Pipe and Foundry Company, Birmingham, Ala., a corporation of New Jersey

Filed June 1, 1959, Ser. No. 817,202

4 Claims. (Cl. 22—65)

The present invention relates to the manufacture of tubular metal castings, and more particularly is concerned with improvements in the apparatus used in manufacture of cast iron pipe by the De Lavaud process.

The De Lavaud process of casting pipe in permanent metal molds has been extensively practiced in this country for many years. Present methods comprise the use of cylindrical metal molds mounted on rollers in a water jacket and adapted to be rotated at suitable speeds. The water jacket is mounted on wheels so that the entire assembly can be moved by means of a hydraulic cylinder in the direction of the longitudinal axis of the mold. This movement is along a fixed bed inclined slightly from the horizontal. The molten metal is fed into the mold through a similarly inclined trough which is mounted at the upper end of the fixed bed and extends like a cantilever beam almost the full length of the mold when it is at the extreme upper position. When the mold is in this position, it is ready for casting. After the casting machine ladle has been filled, the machine operator brings the mold up to speed and actuates the mechanism controlling the tilting of the ladle. In a few seconds the iron has filled the bell space at which time the operator starts the mold carriage longitudinally down the inclined bed. The stream of iron discharged from the trough is distributed along the surface of the mold where it is held in place by centrifugal force and forms the pipe upon cooling. After the metal has solidified, mold rotation is stopped and the pipe is extracted from the mold by moving the mold carriage longitudinally up the inclined bed while holding the pipe stationary. The mold carriage is then moved back down the inclined bed to place the mold in a convenient position for setting the bell core, and if a mold coating is used, it may be applied during this stroke of the machine. The bell core is then set and the mold carriage moved to the extreme upper end of the inclined bed to begin another casting cycle.

The distribution of the metal along the mold length is controlled by the operator who must start the machine retracting from the trough at the correct moment or else the metal delivered to the bell end will not give the proper bell end thickness. For instance, if the carriage movement is started too soon the bell end will be too thin and if it is started late the bell end will be thick. Since it is usually impractical to place the machine operator in a position which commands a good view of the bell end of the mold, it is usually necessary to have the bell core setter, who is in a position which affords the best view of the bell end of the mold, signal the operator to start the mold carriage retracting from the trough. This is called flagging and is accomplished by throwing a switch which turns on a light or other suitable signal on the operator's panel.

In addition to starting the mold attraction at the proper instant, the operator must also judge the proper position in which to stop the mold carriage momentarily while the spigot end of the pipe is being cast, after which retraction of the mold carriage is completed, and the ladle pour is stopped. This is known as hand-checking and is necessary to build up the proper metal thickness at the spigot end of the mold. It is apparent that it is completely within the control of the operator who determines both the position and time stopped. When the mold movement is stopped in the wrong position or for too short a time, the spigot end is made thin, and if it is stopped for too long a time the spigot end is cast thick.

From the above it is obvious that the quality of the pipe cast depends to a large measure on the skill and judgment of the casting crew operating the machine. With the human element involved in flagging the machine, the possibility of casting consecutive pipe with the same thickness at the bell is remote, and in practice the metal thickness at the bell varies considerably. Again, during the hand-check, the carriage position and the time the carriage is stopped are dependent upon the judgment of the operator and for this reason the metal thickness of the spigot end varies from pipe to pipe. Since the period of time during which the ladle is tilting in pouring position depends upon both the time which elapses before the machine is flagged and the period of time in which the machine is stopped during the hand-checking, the total amount of metal poured will vary from pipe to pipe so that not only are pipe non-uniform in thickness from part to part of the same pipe, but they are also non-uniform in thickness and weight from one pipe to another.

Accordingly, the object of this invention is the provision of a procedure wherein improved uniformity in pipe thickness and weight is obtained.

A further object of this invention is the provision of a casting machine for casting pipe which requires a minimum of human judgment to operate.

A still further object of this invention is the provision of a casting machine with automatic flagging means.

Another object of the invention is the provision of a casting machine with automatic hand-checking means capable of slowing down the machine movement at a set position for a set time.

Another object of the invention is the provision of a casting machine with means for actuating ladle dump reversal after a set time to cut off metal flow.

An important object of the invention is the provision of an apparatus incorporating all the features named above.

Other objects and advantages of the present invention will be apparent to those skilled in the art from the following description taken in conjunction with the drawings in which:

Figure 1 shows a De Lavaud casting machine modified in accordance with this invention at the start of the casting stroke.

Figure 2 shows a De Lavaud casting machine modified in accordance with this invention near the end of the casting stroke.

Figure 3 shows a De Lavaud casting machine modified in accordance with this invention in the end position of the casting stroke.

Figure 4 is a block schematic of the automatic flagging circuits.

Figure 5 is a block schematic of the hydraulic system and the automatic hand-check control.

Figure 6 is a block schematic of the ladle drive and timing circuit.

This invention provides a control mechanism for a casting machine whereby the machine may be operated semi-automatically in such a manner as to minimize human judgment thereby obtaining pipe of more uniform thickness and weight. The principal features of the invention are automatic flagging, hand-checking and ladle cut back which are the three areas in which the human element plays such an important part in the control of pipe thickness and weight.

Referring now to Figures 1–3 which show a casting machine in various positions of the casting stroke, the general structure of the machine is seen to comprise a mold carriage **1** which is adapted to move up and down an inclined bed **2**. At the upper extreme of the inclined bed the machine casting ladle **3** is mounted so that it may be pivoted about trunnions **4** by hydraulic cylinder **5**. The machine ladle **3** is adapted to empty into trough **6** which is firmly mounted on base **7** and extends substantially parallel to the inclined bed for about the length of the mold **8** which is mounted in mold carriage **1** with its spigot end **9** toward the machine ladle **3**. The opposite end of the mold is adapted to receive a bell core **10**, and the mold is mounted so that it may be rotated about its longitudinal axis by electric motor **11**. Along the side of the mold carriage there is provided a shoe **12** which is positioned in line with 1st limit switch **13** and 2nd limit switch **14** so that it will depress the switches during the retraction of the mold carriage. If desired separate limit switches **13** and **14** may be replaced with a single double acting limit switch. At the lower end of the inclined bed a bumping block **15** is provided, and to the rear of the bumping block a photoelectric cell **16** in an aiming tube is mounted so as to aim at the extreme lower end **17** of the trough. The photoelectric cell **16** is mounted on an amplifier containing box **18** which is also provided with a shield or shutter **19** which can be raised or lowered by electrical means to provide a shield for the photoelectric cell after it has served its function in the casting cycle.

The block diagram in Figure 4 shows the automatic flagging mechanism. The photoelectric cell **20** which is aimed at the end of the casting machine pouring trough, detects the flow of molten metal from the end of the trough. The signal is amplified by amplifier **18** to provide a signal for actuating the second timer shown in Figure 6 and to actuate the solenoid operated 3-way pilot valve **20** which in turn controls the flow of air in the pneumatic circuit composed of two 3-way air operated valves **21** and **22** and a pneumatic cylinder **23** which is connected to machine operating lever **24** which actuates a 4-way valve **25** in the casting machine hydraulic system (also shown in Figure 5). The operation of the machine operating lever retracts the mold carriage from the pouring spout.

The 4-way valve **25** is also shown in Figure 5 which is a block diagram of the mold carriage hydraulic system. The 4-way operating valve **25** provides for movement of the machine travel hydraulic cylinder **28** in either direction and the fluid supply may be cut off by gate valve **26**. When the machine is in a non-casting portion of the casting cycle, by-pass valve **27** is opened by the operator to provide for rapid movement of the mold carriage. At the beginning of the casting stroke by-pass valve **27** is closed so that fluid flow in the hydraulic system is controlled by adjustable valve **29** which has been adjusted to provide the proper casting machine traverse rate. Reduction of the traverse speed is accomplished by closing air operated valve **30** so that fluid flow in the hydraulic system is controlled by needle valve **31** which has been set for a predetermined fluid flow rate. The opening and closing of air operated hydraulic valve **30** is controlled by solenoid operated air pilot valve **32** which is controlled, in turn, by timer **33**. The actuation of the timer **33** is accomplished by the closing of the second limit switch **14** at the correct instant by the shoe **12** on the side of the mold carriage. Slow down, which is necessary for hand-checking or casting of the spigot, is maintained for the time pre-set on timer **33**.

The block diagram in Figure 6 represents the electrical circuits which accomplish automatic cut back of the ladle after a predetermined time from the flagging of the machine. The first limit switch **13**, which is tripped as the mold carriage moves up the inclined bed, actuates the first timer **36**. This timer energizes a circuit **37** that opens the shutter over the photoelectric cell **16**, and also actuates the ladle drive circuit **38** which starts the ladle tipping.

When molten metal reaches the end of the trough, the photoelectric cell **16** detects it. The signal from the photoelectric cell **16** is sent to amplifier **18** which provides signal to the solenoid operated pilot valve **20** (shown in Fig. 4) and actuates second timer **39** which is set for a predetermined time necessary to pour enough metal for the pipe being cast. The second timer **39** is connected in parallel with the first timer **36** so that upon the expiration of the time set on the first timer the second timer will continue to provide power to the ladle drive circuit. The time for which first timer **36** is set is not precise and any setting which will run out after the second timer is energized but before it de-energizes is satisfactory. At the end of the predetermined time set on the second timer power to the ladle pour circuit **38** is cut off and the ladle reverses cutting off the metal pour. This scheme provides for pouring only for a fixed time after molten metal reaches the bell end of the trough, so that if the pour rate is constant the amount of metal poured will be known.

Referring now to Figures 1–6, a description of an operating cycle of the casting machine will be given. At the end of a previous casting cycle, the mold carriage **1** is at the extreme upper end of the inclined bed **2**. Hydraulic by-pass valve **27** is open to permit rapid movement of the mold carriage up and down the inclined bed. The mold carriage is retracted to the lower end of the inclined bed to the bell core setting position. The mold is preferably coated, during this retraction, with a slurry of refractory, insulating material in accordance with the invention disclosed and claimed in the Schuh et al. Patent No. 2,399,602 by means of spray nozzles, not shown, in the spout end **17** of trough **6**. The bell core **10** is set in place and the machine is now ready for casting. Since the machine is at the lower end of the inclined bed, the operator throws the manual machine operating lever **24** to the proper position to move the mold carriage to the extreme upper end of the inclined bed.

As the mold carriage **1** moves up the inclined bed **2**, shoe **12** on the side of the mold carriage trips first limit switch **13** actuating first timer **36** which energizes both the photoelectric cell shutter circuit **37** and the ladle drive circuit **38**. The shutter **19** which shields the photoelectric cell to prevent untimely triggering of the second timer **39** is lifted from in front of the photoelectric cell, and the ladle **3** starts to tilt and pour. When the machine reaches the position shown in Figure 1 the operator closes the hydraulic by-pass valve **27** so that the rate of carriage movement is controlled by adjustable valve **29** that has been set to give proper casting speed, and the mold is brought up to centrifugal speed. By this time molten metal is running down the trough **6** as a result of tilting of the ladle **3**. When this molten metal reaches the spout end **17** of the trough, the photoelectric cell **16** being focused at that point detects the molten metal and sends a weak signal to the amplifier **18** which provides amplified signal to the solenoid operated 3-way pilot valve **20** in the pneumatic circuit. The piston in pneumatic cylinder **23** moves with the result that the 4-way operating valve **25** is moved to casting position and the mold carriage starts to retract from the pouring trough.

At the same time second timer **39** is actuated, and as the mold carriage moves down the inclined bed, the time on first timer **36** expires, but the ladle drive circuit **38** remains operative since the second timer **39** is connected in parallel with the first timer **36**. When the first timer runs out, the shutter **19** drops over the photoelectric cell due to the de-energizing of the shutter circuit **37**.

When the mold carriage **1** reaches the position shown in Figure 2, the shoe **12** on the side of the carriage depresses second limit switch **14** and the mold carriage slow down for spigot pouring is initiated. The second limit switch **14** actuates timer **33** (see Figure 5) providing power to 4-way solenoid operated air pilot valve **32** which in turn controls air operated hydraulic valve **30** in the hydraulic system. When the solenoid of pilot valve **32**

is energized, hydraulic valve 30 is closed so that all the fluid passing through the hydraulic system passes through needle valve 31 which has been adjusted in advance to give the desired mold carriage speed during hand-checking. At the expiration of the time set on timer 33, power to solenoid operated pilot valve 32 is cut off and air operated hydraulic valve 30 automatically opens. The fluid flow in the hydraulic system is again controlled by adjustable valve 29, and the mold carriage actuated by hydraulic cylinder 28 resumes normal casting speed until the stroke is completed. As the mold carriage 1 approaches the spout end 17 of the trough, the time set on second timer 39 elapses and power to the ladle drive circuit 38 is cut off and the ladle stops tilting and drops back to its original position thus cutting off pouring after a preset time. Since the rate of movement of the mold carriage is precise, ladle cut back will occur during hand checking. After the mold carriage clears the spout end of the trough, it comes to a stop in the position shown in Figure 3. By-pass valve 27 in the hydraulic system is now opened by the operator and mold rotation is stopped as soon as the metal has solidified. The mold carriage is then bumped against bumping block 15 to break the pipe loose from the mold wall if required, and the pipe is extracted by holding the pipe stationary and moving the mold carriage up the inclined bed, and the machine is now ready to go through another cycle.

The valves and timers which are necessary only to the casting stroke do not operate during the extraction and mold coating strokes, so it is necessary for the operator to press a reset button to activate these circuits after the coating stroke is completed. It is necessary to wire these circuits in this manner to prevent ladle dumping and to permit rapid mold carriage movement during these operations.

It will be understood, of course, it is not intended that the invention be limited to the particular embodiments described above or shown in the drawings which have been set forth merely by way of example. The photoelectric cell could be replaced with any other means, either electrical or mechanical, capable of detecting the flow of molten metal and providing a reliable signal to initiate withdrawal of the casting machine. In the embodiment shown and described, the amplifier is utilized to assure a signal of intensity capable of triggering the various circuits; however, if the detection device used provides enough power to do this then the amplifier need not be used. In addition the hand-checking operation can be varied considerably with the same result. For example, instead of holding ladle dump constant while reducing mold carriage speed, the same results could be obtained by increasing ladle dump and holding mold carriage speed constant. Also, mold carriage slow down and ladle dump increase could be combined, and of course, mold carriage slow down also includes complete stopping of the mold carriage.

In order to realize the full benefits of the casting method of this invention, it is necessary that the ladle dump and mold carriage speed be capable of substantially constant rates both during a single cycle and from one cycle to another. Of course, the particular timer settings will vary from machine to machine, and the proper settings can easily be determined by simple experimentation with the machine being used. Thus it is obvious that through the elimination of human judgment it is possible to obtain from any given machine the maximum quality in pipe which it is capable of producing.

I claim:

1. In a centrifugal pipe casting machine having a pouring trough and a mold rotatably mounted on a carriage reciprocable with respect to said trough, the mold surrounding the trough into which molten metal is poured from a ladle and being retracted therefrom during reciprocation of the carriage, in combination therewith, a first limit switch positioned to be tripped by the mold carriage as it moves over the pouring trough, ladle tilting means responsive to the closing of said first limit switch, a photoelectric cell aimed at the spout end of the pouring trough for detection of molten metal pouring therefrom, means responsive to the signal from the photoelectric cell for starting retraction of the mold from the pouring trough, a ladle reverse mechanism controlled by a timer actuated by the signal from the photoelectric cell, a second limit switch positioned to be tripped by the mold carriage at a predetermined position near the end of the retraction step, retraction slow down means adapted to operate in response to the second limit switch and controlled by a timer which is actuated by said second limit switch and which is adjusted to maintain retraction slow down for a predetermined time.

2. In a centrifugal pipe casting machine having a pouring trough and a mold rotatably mounted on a carriage reciprocable with respect to said pouring trough, the mold surrounding the trough into which molten metal is poured and being retracted therefrom during reciprocation of the carriage, in combination therewith, a photoelectric cell aimed at the spout end of the pouring trough for detection of molten metal pouring therefrom and means responsive to the signal from the photoelectric cell for starting retraction of the mold from the pouring trough, a ladle reverse mechanism controlled by a timer actuated by the signal from the photoelectric cell, a limit switch positioned to be tripped by the mold carriage at a predetermined position near the end of mold retraction, retraction slow down means adapted to operate in response to the limit switch and controlled by a timer which is actuated by said limit switch and which is pre-set to maintain retraction slow down for a predetermined time.

3. In a centrifugal pipe casting machine having a pouring trough and a mold rotatably mounted on a carriage reciprocable with respect to said trough, the mold surrounding the trough into which molten metal is poured and being retracted therefrom during reciprocation of the carriage, in combination therewith, a photoelectric cell aimed at the spout end of the pouring trough for detection of molten metal pouring therefrom and means responsive to the signal from the photoelectric cell for starting retraction of the mold from the pouring trough comprising a solenoid operated air valve and a pneumatic cylinder adapted to operate the carriage control mechanism, a limit switch positioned to be tripped at a predetermined position near the end of mold retraction and a timer which is energized by said limit switch and which actuates and controls for a preset time the retraction slow down means comprising a solenoid operated air pilot valve connected in circuit with an air operated hydraulic valve in the mold carriage hydraulic system.

4. In a centrifugal pipe casting machine having a pouring trough and a mold rotatably mounted on a carriage which may be moved up and down an inclined bed with respect to said trough so that the mold surrounds the trough into which molten metal is poured when the carriage is moved up the inclined bed and is retracted from said trough when said carriage is moved down the inclined bed, in combination therewith, a limit switch positioned to be tripped at a predetermined position near the end of mold retraction, a timer connected so as to be energized by said limit switch, a solenoid operated air pilot valve actuated by said timer, and an air operated hydraulic valve which controls the flow of fluid in the mold carriage hydraulic system and which closes and opens in response to said air pilot valve, the closing of said hydraulic valve reduces the fluid flow in the mold carriage system with the result that the retraction speed is reduced for the time set on the timer.

References Cited in the file of this patent

UNITED STATES PATENTS

1,897,631	Clark	Feb. 14, 1933
2,246,907	Webster	June 24, 1941