March 3, 1964 D. H. NAFFZIGER 3,122,800

AUTOMATIC METAL POURING MACHINE

Filed May 1, 1961 3 Sheets-Sheet 1

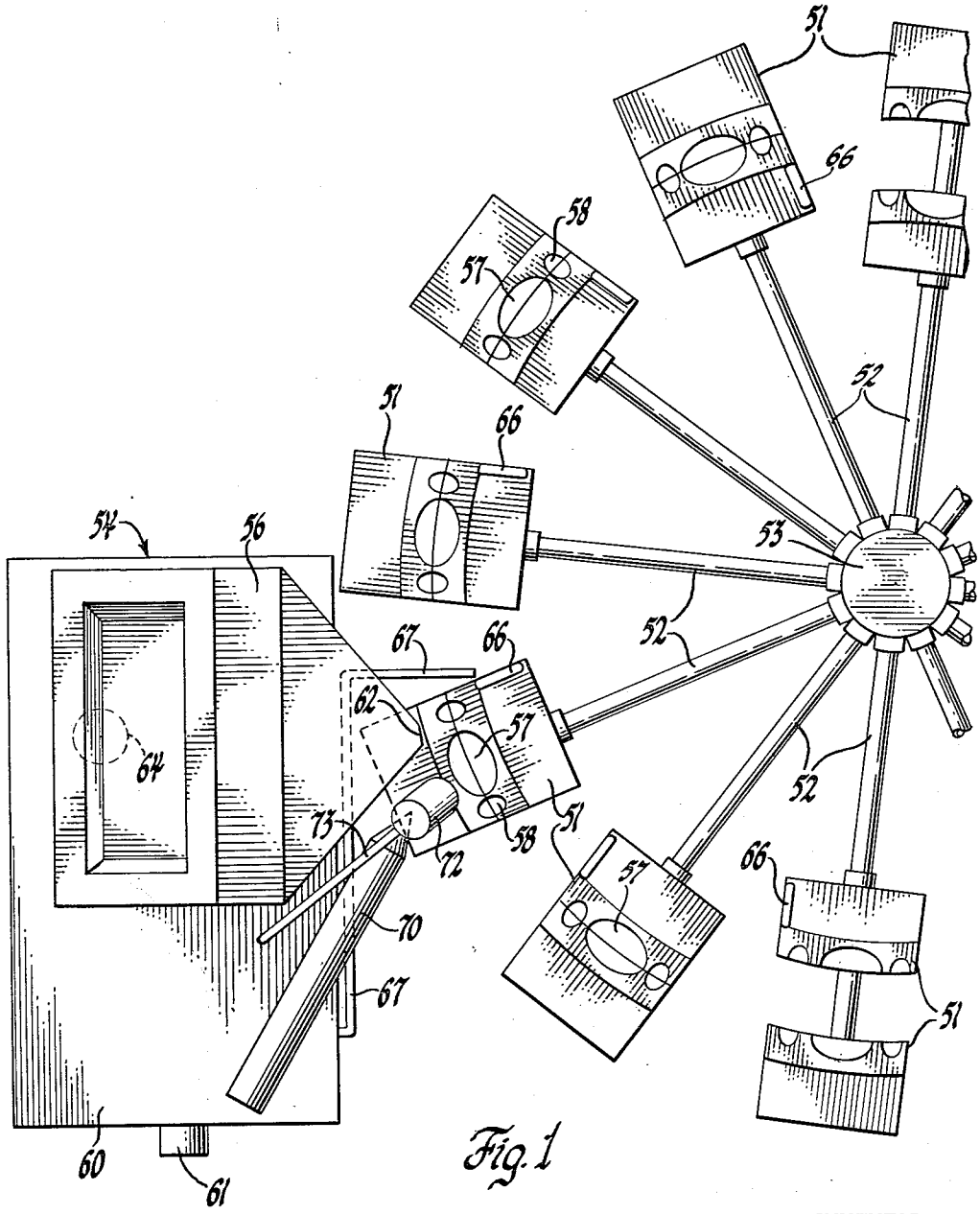


Fig. 1

INVENTOR.
Dewein H. Naffziger
BY
Paul Fitzpatrick
ATTORNEY

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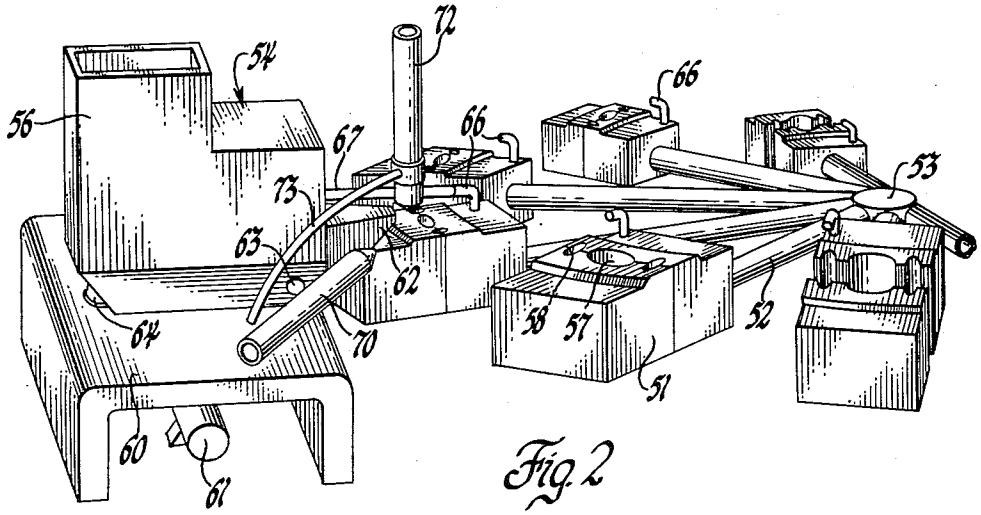


Fig. 2

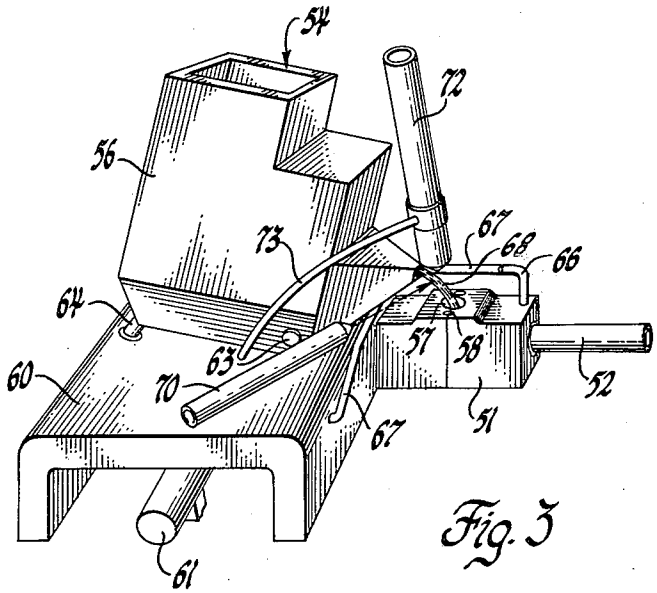


Fig. 3

INVENTOR.
Dewein H. Naffziger
BY
Paul Fitzpatrick
ATTORNEY

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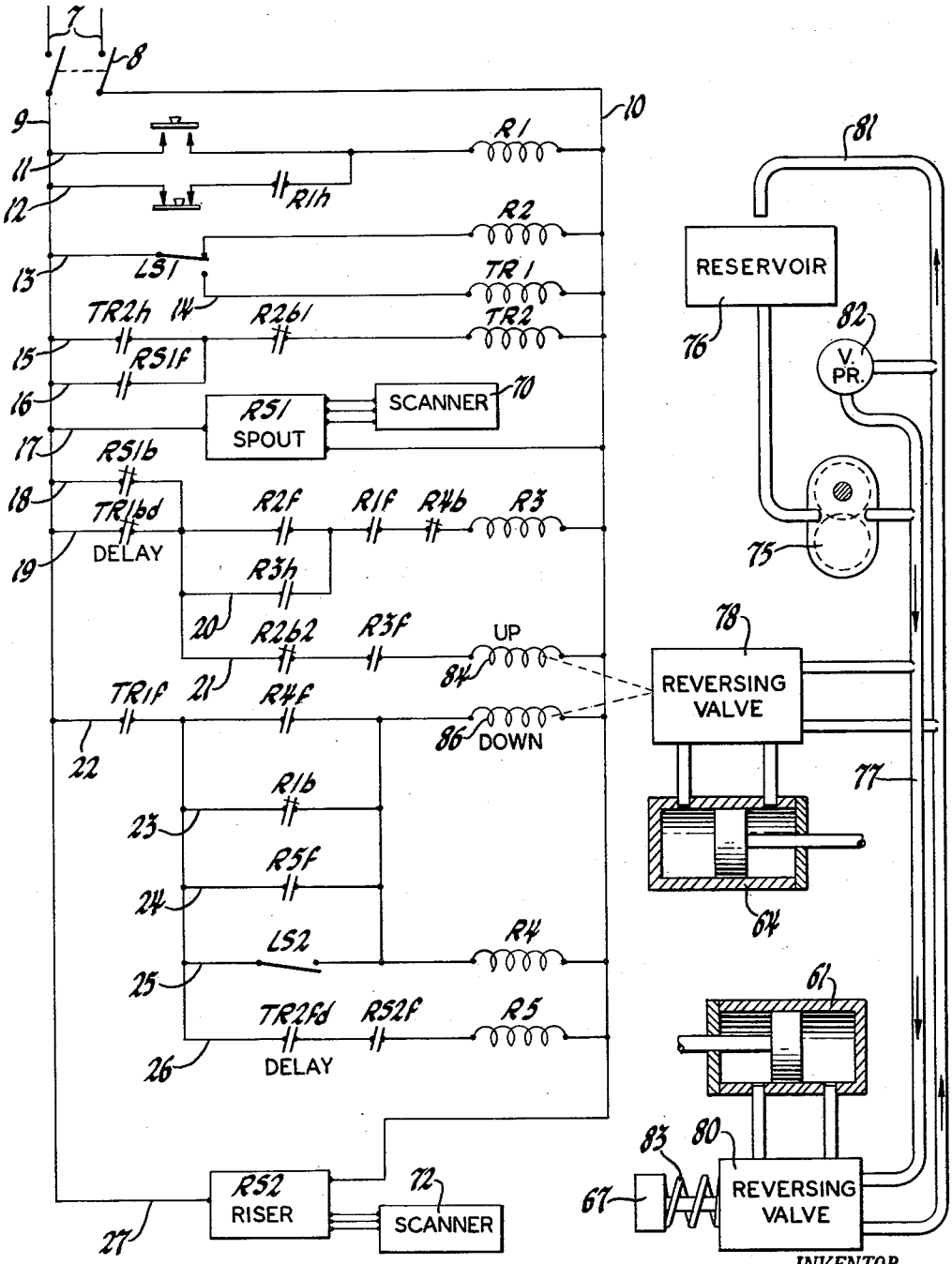


Fig. 4

INVENTOR.
Dewein H. Naffziger
BY
Paul Fitzpatrick
ATTORNEY

United States Patent Office

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3,122,800

AUTOMATIC METAL POURING MACHINE

Dewein H. Naffziger, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed May 1, 1961, Ser. No. 106,808
13 Claims. (Cl. 22—77)

My invention relates to metal casting and particularly to automatic apparatus for pouring metal into molds. The molds and the ladles from which they are filled may be of known structure, my invention relating to the control of the pouring operation.

The principal purposes of the invention are to insure accurate filling of molds with metal with a minimum of supervision or intervention by an operator. The nature of the invention may be indicated by a brief outline of the preferred embodiment. A number of molds are mounted on a conveying means of some sort which carries them past a pouring station and stations where the castings are removed and the cores are inserted for return of the molds to the pouring station. A ladle of the type known as a teapot ladle is provided with means to cause it to register with the molds, specifically to traverse with the mold and with means to tilt the ladle to pour metal into the mold. An infrared sensing device controls tilting of the ladle to cause the metal to be poured and an infrared sensing device responds to filling of the mold (more specifically, to the presence of metal in the riser) to reverse the tilt of the ladle and stop the pouring operation. By the nature of the system it assures filling of the molds and is inherently adapted to filling molds of diverse capacity.

The nature of the invention and the advantages thereof will be more fully appreciated from the succeeding detailed description of the preferred embodiment thereof.

In the drawings, FIGURE 1 is a partial plan view of a pouring installation.

FIGURE 2 is a perspective drawing illustrating the equipment prior to the beginning of a pouring cycle.

FIGURE 3 is a similar view illustrating the pouring.

FIGURE 4 is a simplified schematic diagram of the electrical and hydraulic circuits for control of the mechanism.

Referring first to FIGURES 1 to 3 for an explanation of the physical installation, the molds 51 are mounted on arms 52 radiating from a vertical shaft 53 driven very slowly by any suitable mechanism. The molds are thus conveyed clockwise about the shaft 53 as illustrated past a pouring station 54 at which is located a teapot ladle 56. As the molds pass the pouring station they are filled and during further travel are cooled, are opened, the castings are removed, the molds are cleaned, sand cores are inserted, and the molds are closed and brought back to the pouring station. The molds are metal molds of any suitable type and each has a sprue 57 and one or more risers 58. While it would be possible to rotate shaft 53 intermittently so as to hold the mold stationary at the pouring station 54, I prefer a constantly moving conveying means for the molds and therefore provide means to traverse the ladle during pouring. For this purpose the ladle 56 is mounted on a carriage 60 mounted on ways or tracks so that it may reciprocate or traverse generally tangentially to the path of the molds. A double-acting hydraulic traverse cylinder 61 is provided to move the carriage back and forth. The ladle 56 includes a spout 62 and is mounted to tilt about an axis at 63. A ladle tilting hydraulic cylinder 64 may be actuated to cause the ladle to pour. Preferably it is a single acting cylinder, since the ladle may be lowered or untilted by its own weight.

To cause the ladle to traverse along with the mold during the pouring a trip rod 66 extends upward from each mold in position to engage a valve actuating lever 67 on the carriage as the mold reaches pouring position. Lever 67 physically operates a valve to be referred to later which supplies oil under pressure to the carriage cylinder 61 so that the carriage follows the movement of the mold. Because of the circular path of the trip rod and the linear movement of the lever 67 the two disengage after a movement of the mold somewhat less than the distance between the successive molds. The release of lever 67 reverses the carriage cylinder 61 to retract the carriage to its initial position in time to be engaged by the trip rod 66 of the next mold.

FIGURE 3 illustrates the pouring stage of the cycle, the stream of metal flowing from the ladle into the sprue 57 being indicated by 68. The pouring operation is controlled by an infrared sensitive scanner or electric eye 70 of any suitable commercial type mounted on the carriage 60. The scanner is focused on the path of the metal 68 adjacent the spout so that, when the ladle is tilted upwardly and the stream emerges from the spout, it will actuate the scanner 70 and effect control through suitable amplifier relay means to terminate the raising or tilting of the ladle. The ladle remains in its tilted condition and the pouring continues until terminated by a second scanner 72 supported by the bracket 73 on the carriage 60. The scanner 72 is directed nearly vertically and located to respond to infrared radiation from metal in the riser 58 of the mold being poured. The scanner 72 causes the ladle to lower or untilt and thus end the pouring.

The nature of the physical installation will be apparent from the foregoing, so we may proceed to the description of the essentials of the control system illustrated by FIGURE 4. In the interest of a concise presentation of the system many auxiliary elements such, for example, as circuit breakers, signal lights, and manual emergency controls have been omitted from FIGURE 4. These are immaterial to the operation of the system according to the invention, but may be desirable in the installation. Also, no attempt is made to describe the structure of the radiation sensitive scanners, amplifiers, relays, valves, and such conventional elements, which are stock items.

Considering first the hydraulic system briefly, FIGURE 4 shows schematically the traverse cylinder 61 and the tilt cylinder 64 previously referred to. A suitable motor-driven pump 75 draws oil from a reservoir 76 and supplies it through line 77 to a tilt cylinder control reversing valve 78 and a traverse cylinder control reversing valve 80. A return line 81 connects these valves to the reservoir, and a suitable relief valve 82 may be provided. The reversing valve 80 is mechanically actuated by the lever 67, indicated in FIGURE 4, which operates the valve in a direction to cause traverse of the carriage with the molds. Valve 80 modulates flow to cause accurate registry of the ladle with the mold as they move together. The spring 83 moves the valve to the full reverse position when the lever 67 is released by the trip rod 66 and thus rapidly retracts the carriage. The tilt control valve 78 is electromagnetically actuated by the "up" solenoid 84 and "down" solenoid 86. This valve is of a type having a neutral position in which fluid is locked in the cylinder 64 to hold the ladle in its position of tilt. The valve is moved to either extreme of travel by energization of one or the other of the solenoids 84 and 86.

The control circuits are energized from a suitable power source 7 through a disconnect switch 8. Busses 9 and 10 are energized from the two sides of the line through switch 8. A number of lines, identified by the numerals 11 to 27 inclusive, connecting the two busses contain switches, relays and amplifiers, as well as the

valve control solenoids 84 and 86. The primary energizing relay R1 in line 11 is energized by the "start" push button switch. It is held energized through a normally closed "stop" push button switch and its holding contact R1*h* in line 12. Relay R1 thus remains energized unless there is a power failure, the main switch 8 is opened, or the "stop" button is pressed. Relay R1 also controls a front contact in line 19 and a back contact in line 23. The term "front" and "back" used herein mean normally open and normally closed, respectively. Line 13 runs from bus 9 through a limit switch LS1 and the coil of relay R2. The limit switch is operated by the carriage 60 and is shown in the position that it occupies at the beginning of the cycle with the carriage fully retracted. Relay R2 operates back contact R2*b*1 in line 15, front contact R2*f* in line 19, and back contact R2*b*2 in line 21.

With relays R1 and R2 energized, an energizing circuit is completed to relay R3 in line 19. This circuit is through back contact Rs1*b* of the spout scanner in line 18 and contact R2*f*, contact R1*f*, and back contact R4*b* of relay R4 in line 19. Relays Rs1 and R4 are deenergized at this time. Relay R3 closes its holding contact R3*h* in line 20 so that R3 remains energized after R2 is deenergized. Relay R3 closes its front contact R3*f* in line 21, which is a step in energizing the "up" solenoid 84.

At about this time, a trip rod 66 engages lever 67 and the carriage starts to traverse. Limit switch LS1, which was held closed by the carriage in its retracted position to energize relay R2, opens the circuit to relay R2 and energizes a timing relay TR1 in line 14. Timing relay TR1 operates a delayed opening back contact TR1*bd* in line 19 and a front contact TR1*f* in line 22 which is closed instantly. When R2 is deenergized, its back contact in line 21 closes, completing the energizing circuit of the "up" coil 84, and the ladle tilt cylinder begins to move the ladle to initiate pouring. This circuit remains energized and the ladle continues to rise until the scanner 70 senses the stream flowing from the ladle and actuates amplifying relay RS1 to open its back contacts RS1*b* to break the circuit through the coil 84 and cause the ladle to remain in the pouring attitude. A desirable auxiliary feature is provided by the delayed opening back contact TR1*bd* of the timing relay TR1 in line 19. This provides a circuit for energizing coil 84 parallel to that through RS1*b* for a limited period of time to insure that tilting of the ladle is not prematurely interrupted by response to spatter from filling the teapot ladle or dribble from the spout when the ladle is full.

Deenergization of R2 also closes its back contact R2*b*1 in line 15 which is in the energizing circuit for a second timing relay TR2. This circuit, however, is open until RS1 responds to pouring of metal and closes its front contact RS1*f* in line 16. When this occurs, relay TR2 is energized and closes its holding contact TR2*h* in line 15. This timing relay also closes its front contacts TR2*fd* in line 26, but only after a predetermined delay. These contacts are a part of the means by which the ladle is lowered upon completion of the pouring cycle. The purpose of the TR2 delayed action contact is to disable the lowering circuit during the initial stages of pouring so that any incidental spatter will not cause the ladle to be retracted.

At this point the ladle is being traversed automatically with the mold and has been tilted, and the mold is being filled. Relays R1, TR1, TR2 and R3 are energized. This condition continues until the infrared scanner 72 picks up radiation from the riser indicating that the mold is filled. Since TR1*f* in line 22 is closed and TR2*fd* in line 26 has had time to close when RS2 responds to scanner 72 and closes its front contact RS2*f*, relay R5 is energized. It closes its front contact R5*f* in line 24, thus completing a circuit through relay R4 in line 25. Contacts R5*f* also complete the circuit through TR1*f* and "down" coil 86 so that the ladle tilt valve 78 is operated to end the pouring. R4 closes its front contacts R4*f* in line 22 to hold this circuit energized. If, through some failure of the apparatus, there is no response to metal in the riser, the ladle will be moved down through the action of a limit switch LS2 in line 25. This switch is closed by movement of the carriage just before it reaches the end of its normal travel. It energizes R4 and the "down" solenoid, and the "down" solenoid remains energized through contacts R4*f*.

When the trip rod disengages from lever 67, the scanner 72 moves out of alignment with the riser and RS2 is deenergized, opening contact RS2*f* and deenergizing relay R5. However, the "down" solenoid 86 remains energized as well as R4 through contacts TR1*f* and R4*f*. The ladle "down" circuits are finally deenergized when the carriage returns to its initial position on the return traverse and limit switch LS1 deenergizes TR1, which opens all of the "down" circuits at contact TR1*f* in line 22. This limit switch also energizes relay R2, thus breaking the electric circuit for timing relay TR2 at contact R2*b*1 in line 15. Relay R3 was previously deenergized upon energization of R4, which opens back contact R4*b* in line 19. The electrical circuits are therefore restored to the condition initially described and the cycle is ready to repeat. If the operator wants to shut the machine down he operates the "stop" button in line 12, deenergizing relay R1. This, incidentally, closes the back contact R1*b* in line 23 to energize the "down" solenoid 86 and lower the ladle.

It will be apparent from the foregoing that the control system provided to carry out the purposes of the invention operates by very simple and reliable means to insure filling of each mold regardless of variations of capacity and to guard against malfunction of the apparatus from such causes as metal splashes or other transient conditions. The invention makes it possible to dispense with an operator to actuate the ladle to fill the molds. Because of the flexibility of the system it is successful even where different parts are being cast in succession or rotation.

The detailed description of the preferred embodiment of the invention for the purposes of explaining the principles thereof is not to be construed as limiting the invention, since many changes may be made by the exercise of skill in the art.

I claim:

1. An automatic casting machine comprising, in combination, means defining a pouring station, a ladle at the pouring station, means for presenting molds successively at the pouring station, means responsive to the presence of a mold at the pouring station operative to tilt the ladle to pour metal into the mold, first means responsive to heat radiation from the stream of metal flowing from the ladle effective to stop the tilting of the ladle, and second means responsive to heat radiation from metal in the top of the mold due to filling of the mold operative to untilt the ladle to stop pouring metal.

2. An automatic casting machine comprising, in combination, conveying means, a plural number of molds carried by the conveying means, a ladle, ladle traversing means adapted to traverse the ladle in concurrence with the movement of a mold on the conveying means, ladle tilting and untilting means adapted to initiate and terminate pouring from the ladle into a mold, means responsive to registration of a mold with the ladle effective to operate the traversing means and the ladle tilting means, means sensitive to flow from the ladle effective to stop the ladle tilting means, means sensitive to filling of the mold effective to operate the untilting means, and means responsive to predetermined travel of the traversing means effective to operate the untilting means.

3. An automatic casting machine comprising, in combination, conveying means, a plural number of molds carried by the conveying means, a ladle, ladle traversing means adapted to traverse the ladle in concurrence with the movement of a mold on the conveying means, ladle tilting and untilting means adapted to initiate and termi-

nate pouring from the ladle into a mold, means responsive to registration of a mold with the ladle effective to operate the traversing means and the ladle tilting means, means responsive to flow from the ladle effective to stop the ladle tilting means, means responsive to filling of the mold effective to operate the untilting means, means responsive to predetermined travel of the traversing means effective to reverse the traversing means, and means responsive to said travel effective to operate the untilting means.

4. An automatic casting machine comprising, in combination, conveying means, a plural number of molds carried by the conveying means, a ladle, ladle traversing means adapted to traverse the ladle in concurrence with the movement of a mold on the conveying means, ladle tilting and untilting means adapted to initiate and terminate pouring from the ladle into a mold, means responsive to registration of a mold with the ladle effective to operate the traversing means and the ladle tilting means, means sensitive to flow from the ladle effective to stop the ladle tilting means, means sensitive to filling of the mold effective to operate the untilting means, and means effective to block operation of the untilting means for a predetermined time after initiation of operation of the tilting means.

5. An automatic casting machine comprising, in combination, conveying means, a plural number of molds carried by the conveying means, a ladle, ladle traversing means adapted to traverse the ladle in concurrence with the movement of a mold on the conveying means, ladle tilting and untilting means adapted to initiate and terminate pouring from the ladle into a mold, means responsive to registration of a mold with the ladle effective to operate the traversing means and the ladle tilting means, means sensitive to flow from the ladle effective to stop the ladle tilting means, means sensitive to filling of the mold effective to operate the untilting means, means responsive to predetermined travel of the traversing means effective to reverse the traversing means and means responsive to said travel to operate the untilting means, and means effective to block operation of the untilting means for a predetermined time after initiation of operation of the tilting means.

6. A machine as recited in claim 5 including time delay means effective to disable the flow sensitive means temporarily upon actuation of the ladle tilting means.

7. An automatic pouring machine for filling molds with molten metal comprising, in combination, at least one mold having a riser, a source of molten metal located to pour into the mold, means to cause the source to pour, first radiation-responsive means actuated by radiation from the pouring metal operative to regulate the pouring, and second radiation-responsive means actuated by radiation from the metal in said riser of the mold effective to terminate the pouring.

8. An automatic pouring machine for filling molds with molten metal comprising, in combination, at least one mold having a riser, a ladle located to pour into the mold, means to cause the ladle to pour, first radiation-responsive means actuated by radiation from the pouring metal operative to regulate the pouring, and second radiation-responsive means actuated by radiation from the metal in said riser of the mold effective to terminate the pouring.

9. A machine as recited in claim 8 in which the ladle tilts to pour and said first radiation-responsive means senses heat radiated from the pouring metal and terminates tilting movement of the ladle.

10. A machine as recited in claim 8 in which the ladle tilts to pour and untilts to terminate pouring and said second radiation-responsive means senses heat radiated from the metal in the riser and initiates untilting movement of the ladle.

11. An automatic pouring machine for filling molds with molten metal comprising, in combination, at least one mold having a riser, a source of molten metal located to pour into the mold, means to cause the source to pour, first infrared radiation-responsive means focused upon and actuated by the radiation from the pouring metal operative to regulate the pouring, and second infrared radiation-responsive means focused upon and actuated by radiation from the metal in said riser of the mold effective to terminate the pouring.

12. An automatic casting machine comprising, in combination, means defining a pouring station, a ladle at the pouring station, means for presenting molds successively at the pouring station, means responsive to the presence of a mold at the pouring station operative to tilt the ladle to pour metal into the mold, means responsive to flow of metal from the ladle effective to stop the tilting of the ladle, means responsive to filling of the mold operative to untilt the ladle to stop pouring metal, and means to disable the flow-responsive means temporarily at the initiation of tilting of the ladle.

13. An automatic casting machine comprising, in combination means defining a pouring station, a ladle at the pouring station, means for presenting molds successively with the pouring station, means responsive to the presence of a mold at the pouring station operative to tilt the ladle to pour metal into the mold, means responsive to flow of metal from the ladle effective to stop the tilting of the ladle, means responsive to filling of the mold operative to untilt the ladle to stop pouring metal, and means to disable the filling-responsive means temporarily when filling of the mold is initiated.

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