Sept. 25, 1956 A. J. SUKAVA 2,763,904

AUTOMATIC CASTING MACHINE

Filed Oct. 29, 1952 3 Sheets-Sheet 1

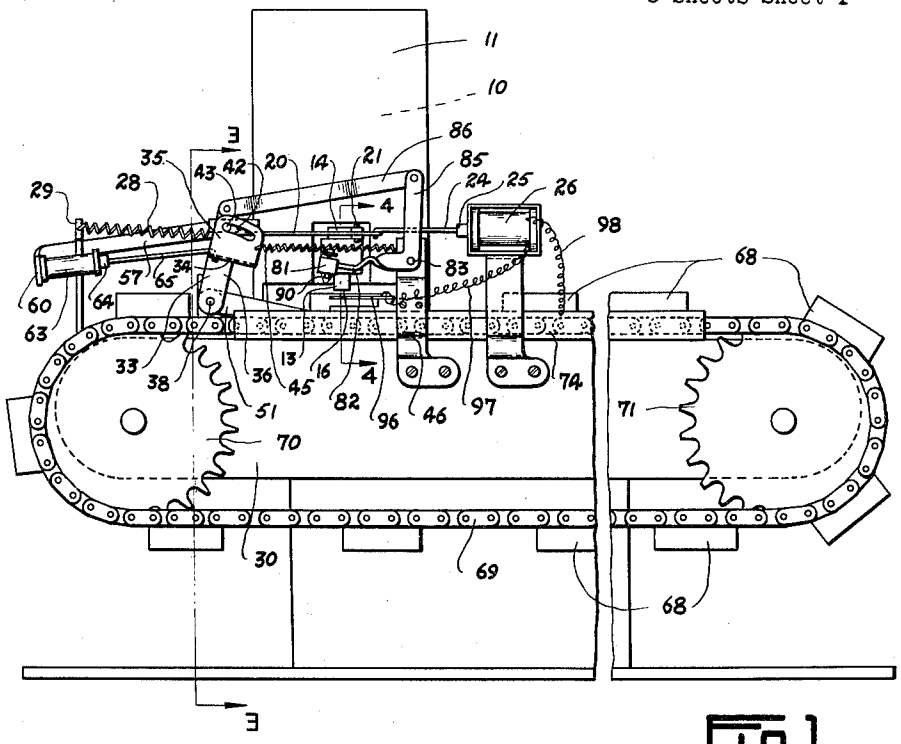


Fig. 1.

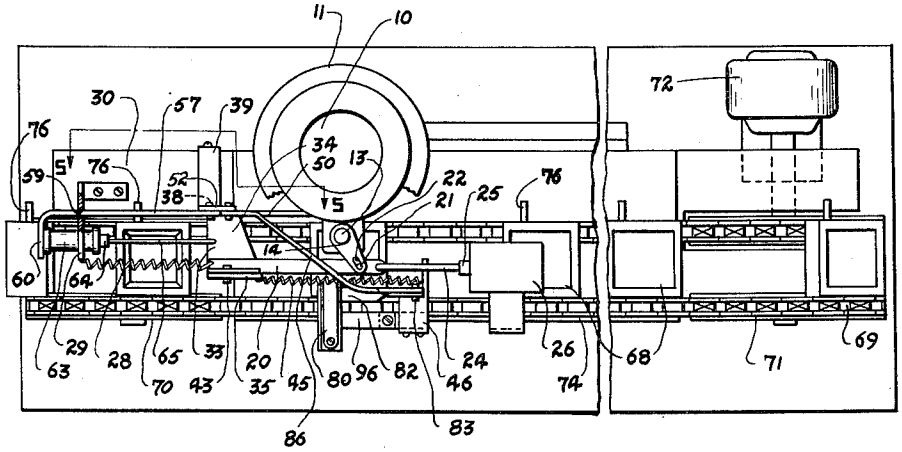


Fig. 2.

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AUTOMATIC CASTING MACHINE

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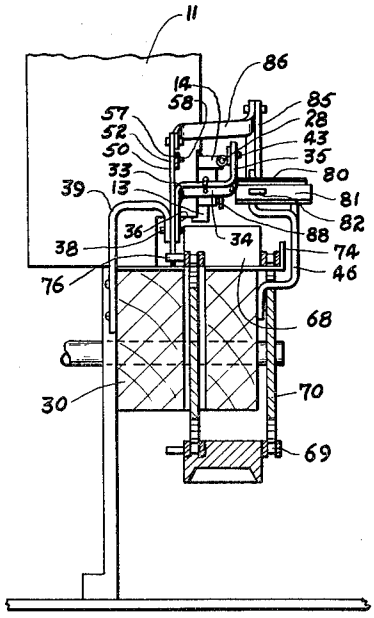


Fig. 3.

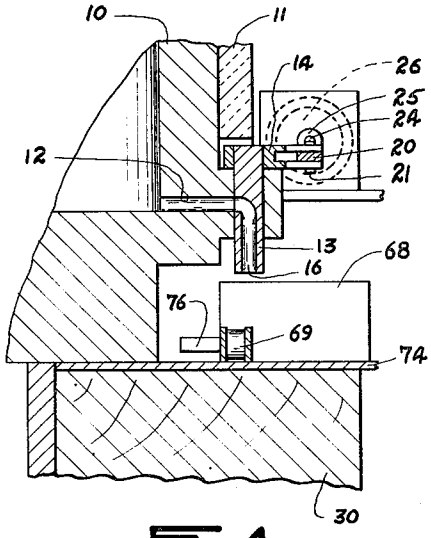


Fig. 4.

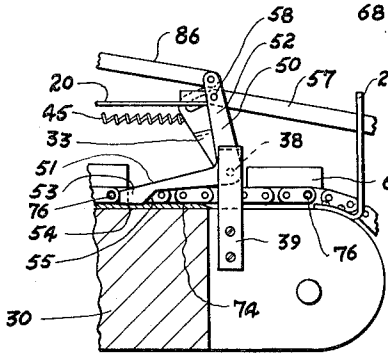


Fig. 5.

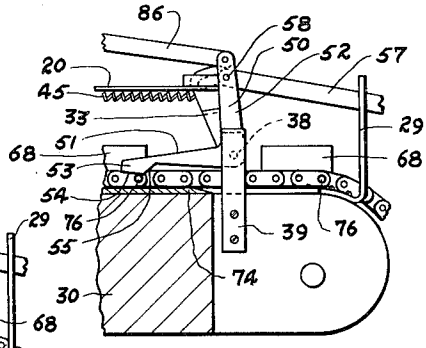


Fig. 6.

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AUTOMATIC CASTING MACHINE

Filed Oct. 29, 1952 3 Sheets-Sheet 3

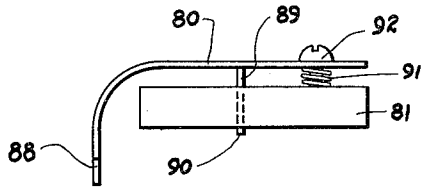


Fig. 7.

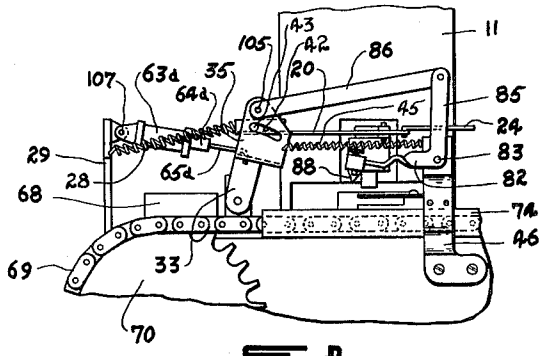


Fig. 8.

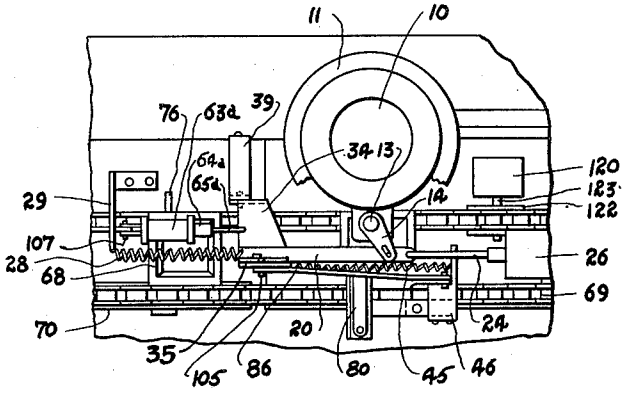


Fig. 9.

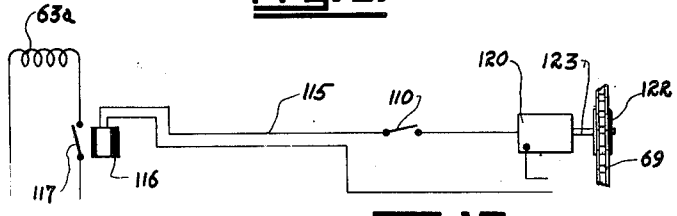


Fig. 10.

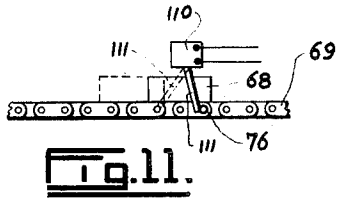


Fig. 11.

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2,763,904

AUTOMATIC CASTING MACHINE

Armas John Sukava, Montreal, Quebec, Canada

Application October 29, 1952, Serial No. 317,456

13 Claims. (Cl. 22—79)

This invention relates to an automatic casting machine.

The main purpose of this invention is the provision of a machine particularly for automatically pouring molten metal into molds without stopping the molds or moving the pouring equipment, although it may be used for pouring any other desired liquid.

Another object is the provision of a casting machine which is completely automatic in its operation, and which does not require any manual operation after it is started.

A further object is the provision of a machine in which molten metal may be rapidly poured into molds.

A still further object is the provision of a machine capable of producing metal ingots of uniform weight.

Heretofore, in the production of metal ingots, the molten metal has been usually poured by hand. Some attempts have been made to do this in a semi-automatic manner, but such devices have been very cumbersome, expensive, and difficult to operate and maintain.

The machine according to the present invention includes means for pouring molten metal into molds as the latter are moved along a predetermined course. The machine has a valve for controlling the flow of metal, and it includes means for opening the valve as each mold moves into a pouring position and closing it when the mold moves out of said position. In order to be sure of the accuracy of the timing, it is preferable to provide means on each mold for operating the flow valve actuating means at the proper time. In other words, the valve cannot be opened unless there is a mold in position, and it closes as soon as the mold moves out of the pouring position. Suitable means have been provided for shutting the flow valve upon failure of any of the following:

(*a*) The normal valve shutting means,
(*b*) The electrical power,
(*c*) The mold moving mechanism, and
(*d*) The electric motor driving the mold moving mechanism.

The flow valve controls a pipe extending from a supply of molten metal. This valve is normally closed. Molds are moved at intervals beneath the discharge end of the pipe or valve in any desired manner. Each mold has means associated with it for operating suitable actuating mechanism which opens the valve when the mold first moves under the pipe. The valve is maintained in this setting as long as the mold remains in the pouring position, but when the mold moves out of this position, the actuating mechanism closes the valve. Should the valve fail to open, no damage would be done other than that the machine would operate without filling the molds. A solenoid is connected to the valve in such a way that when the solenoid is energized the valve is closed. A contact finger may extend into each mold when the latter is in the pouring position. This finger is in the circuit of the solenoid so that when the level of the molten metal rises to make contact with the finger, the circuit is closed to energize the solenoid. The solenoid would also close the valve should the mold-moving mechanism fail when

the finger is in a mold. It is preferable to use electrical power for moving the molds in order that a solenoid arrangement may be employed to close the valve at a time of power failure. Furthermore, means may be provided for closing the valve any time the mold-moving arrangement stops.

An example of this invention is illustrated in the accompanying drawings, in which,

Figure 1 is a side elevation of one form of casting machine,

Figure 2 is a plan view,

Figure 3 is a vertical section taken on the line 3—3 of Figure 1,

Figure 4 is an enlarged vertical section taken on the line 4—4 of Figure 1,

Figure 5 is a section taken substantially on the line 5—5 of Figure 2 with the valve actuator in its normal at-rest position,

Figure 6 is a view similar to Figure 5 with the actuator in the valve opening position,

Figure 7 is an enlarged detail of the contact finger,

Figure 8 is a side elevation similar to Figure 1 of an alternative form of the invention,

Figure 9 is a plan view of Figure 8,

Figure 10 is an electrical diagram for the apparatus of Figures 8 and 9, and

Figure 11 illustrates a switch operated by the molds for controlling the pouring of the metal.

Referring to the drawings, molten metal may be supplied to the machine in any convenient manner. For example, the molten metal may be poured into a pot **10** which, if desired, may have a heating jacket **11** enclosing it. On the other hand, the metal may be actually melted in this pot and made ready for use. A passage or pipe **12** extends outwardly from the bottom of the pot and is controlled by a flow valve or spigot **13**. This valve is such that it may be rotated into two positions, one closed and one open. This valve may be controlled by an arm **14** extending outwardly from the pot.

Suitable means is provided for actuating this valve each time a mold moves into position beneath the discharge end **16** thereof, said actuating means being preferably set into operation by means associated with the mold. One way of doing this is to provide a horizontal bar **20** having a pin **21** extending into a slot **22** formed in the arm **14**. One end of this bar is connected by a link **24** of the plunger **25** of a normally de-energized solenoid **26**. The opposite end of the bar is connected by a tension spring **28** to a support **29** mounted on and projecting upwardly from a base **30**.

A connector **33** is provided having a horizontal portion **34** and vertical portions **35** and **36** extending upwardly and downwardly from opposite ends thereof. The portion **36** of the connector is pivotally mounted on a pin **38** which is carried by a bracket **39** mounted on the base **30**. The portion **35** of the connector has a horizontal slot **42** formed therein into which a pin **43** extends from the bar **20** adjacent the end thereof connected to the spring **28**. A tension spring **45** is connected to the connector portion **35** and extends away from the spring **28** to a standard **46** mounted on the base **30** at a point spaced from said connector. The spring **45** normally draws the upper end of the connector to the right of Figures 1 and 2, while spring **28** normally draws the bar **20** in the opposite direction so that the pin **43** is usually positioned at the left end of slot **42** of the connector. With these elements in these positions, the arm **14** is retained in a position with the flow valve **13** closed.

Suitable means is provided for moving the bar **20** to the left in order to open the valve. This may be done by means of a bell-crank **50** pivotally mounted on the pin **38** at the point of juncture of its horizontal and verti-

cal arms 51 and 52. The outer end of the arm 51 is formed with an enlargement 53 having a flat surface 54 along its under side and a sloping surface 55 at its inner end along the lower side of the arm. The arm 51 normally slopes downwardly from its pivot point, and the surface 54 rests on the top of the base 30, see Figure 5. A substantially horizontal arm 57 is pivotally connected at 58 to the bell-crank 50 near the top thereof, said arm extending through a slot 59 in the bracket 29. The free end of this arm is bent outwardly therefrom as at 60, and is substantially in line with the horizontal portion 34 of the connector 33. The bent end 60 of the arm 57 may be connected to the connector in any convenient manner. It is, however, desirable to provide a normally-energized solenoid 63 which is mounted on the arm end 60 and extends towards the connector. The plunger 64 of the solenoid is connected to the horizontal portion 34 of the connector by a link 65. When the solenoid is energized, the plunger is retained therein, but when it is de-energized the spring 45 moves the connector 33 to the right of Figures 1 and 2, thus drawing the plunger part way out of its solenoid.

A plurality of molds 68 are continuously moved beneath the discharge end of the flow valve 13 in any desired manner. These molds may be mounted on an endless chain conveyor 69 extending around spaced sprockets 70 and 71, either of which may be driven by a suitable source of power. It is preferable, however, to use an electrical motor 72 as a source of power in order that the flow valve may be closed when the source of power fails. This failure may be a break in the motor circuit or a stoppage of the electrical power. The molds are moved along a track 74 extending beneath the flow valve. Each mold may have a pin 76 projecting outwardly from a side thereof, and as the mold approaches the discharge end of the flow valve, its pin 76 moves beneath the arm 51 of the bell crank 50. The mold enters the pouring position when the opening in the top thereof moves beneath the valve. At this time, the mold pin moves along the sloping surface 55 of the bell-crank to lift the free end of the arm 51 thereof until the surface 54 rests on the pin, see Figure 6. This moves the upper end of the bell-crank away from the valve. The bell-crank, in turn, moves the connector 33 in the same direction through the arm 57, solenoid 63 and link 65. This movement is against the tension of spring 45. As the slot 42 of the connector is moved, spring 28 draws the bar 20 in the same direction, thus moving arm 14 to open the flow valve. Molten metal now pours into the moving mold 68 positioned beneath said valve. As soon as the mold pin clears the end of the bell-crank arm 51, the latter is free to drop downwardly on to the base 30. At this time, spring 45 draws the connector back to its normal position, and the connector through pin 43 moves the bar 20 back quickly to close the valve. This is timed to take place just before the opening of the mold moves from beneath the valve.

The solenoid 26 may normally remain de-energized or it may be energized each time the molten metal in a mold reaches a predetermined level. A contact finger 80 is mounted on an insulating block 81 carried by a substantially horizontal supporting arm 82 pivotally mounted at 83 on the standard 46, see Figures 1, 3 and 7. A vertical arm 85 is connected at its lower end to the arm 82 at the pivot thereof and at its upper end by a link 86 to the upper end of the vertical arm 52 of the bell-crank 50. The contact finger 80 is formed at its inner end with a downwardly extending prong 88. The finger is mounted on a conductor 89 extending through the block to form a contact point 90 extending below the bottom thereof. If desired, the outer end of the contact finger may be normally pressed upwardly by a spring 91, said upward movement being limited by the head 92 of an adjusting bolt extending upwardly from

the block 81 through the finger. The spring 91 urges the prong 88 downwardly with respect to the insulating block, and the position of the prong may be adjusted vertically by turning the bolt head 92.

This block is in line with an spaced outwardly from the flow valve 13. When the bell-crank 50 is in its normal position, the horizontal arm 82 is in a position where the insulating block and its contact finger is spaced well above the path of the molds 68 moving beneath the valve. However, when a mold moves into the pouring position beneath the valve, and the bell-crank is moved to cause the valve to be opened, the insulating block and the contact finger are moved downwardly so that the lower end of the prong 88 extends a short distance into the mold. The prong may be positioned at this time above the level to which the molten metal is poured in the mold, in which case the prong of the contact finger is not touched by the metal. With this arrangement, the flow valve is closed when the bell-crank clears a mold pin and returns to its normal position.

When the insulating block is in this lowermost position, the contact 90 engages a spring contact 96 which is mounted on and insulated from the standard 46. A wire 97 extends from the spring contact to one end of the coil of the solenoid 26. Another wire 98 extends from the opposite end of the solenoid coil to a suitable source of power, such as a battery, not shown. The source of power is grounded. It is obvious that the solenoid may be in a circuit having a relay-controlled switch therein, in which case wires 97 and 98 would form part of the relay circuit instead of the solenoid circuit. The spring contact bearing against the contact 90 of the insulating block will cause any slack to be taken up which may exist in the linkage extending to bell-crank 50. If desired, spring contact 96 may be omitted and the wire 97 connected directly to contact 90.

As the mold is moving out of the pouring position from beneath the flow valve, the spring 45 is supposed to close the valve. However, should the spring break or otherwise fail to close the valve, the level of the metal in the mold will rise until it touches the prong 88 of the contact finger 80. This closes the circuit of the solenoid 26 to cause the latter to be energized. The plunger 25 of the solenoid is drawn into the latter and moves the bar 20 to close the flow valve. At this time, the pin 43 moves along the slot 42 of the connector 33.

This same action will take place should anything happen to the mold conveyor, resulting in the mold stopping beneath the valve. As soon as the level of the molten metal in the mold reaches the prong 88, the solenoid 26 will close the valve.

On the other hand, the prong 88 may be adjusted so that it is moved into each mold to the desired level of the molten metal. In this case, when the metal touches the prong, solenoid 26 is energized to close the flow valve. Thus, the solenoid closes the valve when the molten metal reaches the required level. This must be timed to take place before the mold pin clears the bell-crank arm 51. When said arm does clear the pin, the bell-crank returns to its normal position to be ready to open the flow valve again. The speed of the conveyor must be adjusted to the rate of pouring so that enough metal is poured into each mold to make contact with finger 80 while the mold is beneath the control valve. If solenoid 26 fails to operate, the returning of the bell-crank to its normal position would shut the flow valve. The level of the metal in each mold may be adjusted as required by raising or lowering the prong by turning bolt head 92.

Spring 45 is much stronger than spring 28 and would draw the connector 33 to the right in Figures 1 and 2, but for solenoid 63. When this solenoid is energized, the connector is in effect rigidly connected to the bell-crank 50 so that the connector moves the latter. If the elec-

trical power were to fail with the flow valve open, the solenoid would be de-energized allowing spring **45** to move the connector and, consequently, the bar **20** to shut off the valve.

When the machine is in operation, it normally functions without any attention. As each mold approaches the flow valve, the pin **76** thereof lifts the horizontal arm of the bell-crank **50** so that the upper end of the latter through its connection with the connector **33** moves the bar **20** to open the flow valve. At the same time, the prong of the contact finger **80** is moved down into the mold a predetermined distance. As soon as the mold pin clears the bell-crank arm, spring **45** instantly closes the valve, or when the molten metal in the mold contacts the prong, solenoid **26** closes the valve. This action also lifts the contact finger clear of the mold. The speed at which the machine should operate depends upon the length of the endless mold conveyor and the time it takes for the metal to cool sufficiently to be removed from the molds.

While an endless chain conveyor has been shown, it is obvious that other types of conveyors may be used, such as a large wheel rotating in a horizontal plane.

As previously stated, should the flow valve fail to close at the correct time, or should the power of the conveyor fail, solenoid **26** closes the valve. On the other hand, if the electrical power were to fail, solenoid **63** is de-energized allowing spring **45** to close the valve.

Figures 8 to 11 illustrate an alternative form of the invention in which the valve **13** is opened by electrical power. Bell-crank **50** and the arm **57** have been omitted. Link **86** extends from the upper end of the arm **85** to the upper end of the vertical portion **35** of the connector **33**, to which it is connected at **105**. A solenoid **63***a* is pivotally connected at **107** to the support **29**. The plunger **64***a* of this solenoid is connected by a link **65***a* to the horizontal portion **34** of the connector **33**.

Figure 11 shows an electrical switch **110** mounted near the conveyor **69** and having an operating arm **111** extending downwardly therefrom. This switch is normally open, but when the arm **111** is moved out of its normal position by a pin **76** of a mold **68**, the switch is closed and remains closed until the arm returns to its normal position.

The switch **110** is in a circuit controlling the solenoid **63***a*. The switch may be in the main circuit of the solenoid, or as shown in Figure 10, it may be in a circuit **115** including a relay **116** for operating a normally open switch **117** in the solenoid circuit. The circuit **115** is connected to a suitable source of power so that when the switch **110** is closed by the pin of a mold, relay **116** is energized to close switch **117**. This results in the solenoid **63***a* being energized.

Referring to Figures 8 and 9, when the solenoid **63***a* is energized, the plunger **64***a* is drawn into it to pivot the connector **33** to the left. This allows spring **28** to draw the bar **20** in the same direction and open the valve **13**. At the same time, the link **86** pivots arm **85** which, in turn, shifts the arm **82** to move the prong **88** down into the mold positioned beneath the valve. When the solenoid is de-energized, spring **45** closes the valve.

The switch **110** and its operating arm **111** are so positioned relative to the conveyor **69** that the pin **76** of each mold moves the arm **111** as the mold moves under the valve. The pin does not release the operating arm until the back end of the mold moves from beneath the valve. As in the previously-described form of the invention, the prong **88** of the contact finger **80** causes the solenoid **26** to be energized when the molten metal in the mold reaches a predetermined level. This moves the bar **20** against the tension of spring **28** to shut the valve. This action usually takes place while solenoid **63***a* is still energized, during which time the pin **43** rides along slot **42**. Should solenoid **26** or any of the parts associated therewith fail, spring **45** will close the valve when the

mold pin clears switch **110**, allowing solenoid **63***a* to be de-energized. Should the electrical power fail, both solenoids would be de-energized, but the spring **45** would close the valve.

It is desirable to de-energize solenoid **63***a* in the event of the conveyor **69** ceasing to function. One simple way of doing this is to provide a switch which is controlled by a centrifugal governor in the circuit **115**. The numeral **120** indicates such a switch in Figure 10. The governor of this switch is operated by a moving part of the conveyor. In this example, a chain of the conveyor **69** runs over a sprocket **122** fixedly mounted on a shaft **123** which is connected to the governor of the switch **120**. This switch is closed as long as the conveyor **69** is moving. Should the conveyor stop, the switch **120** opens to break the circuit **115** which, in turn, breaks the circuit of the solenoid **63***a* to de-energize the latter. Thus, if the solenoid is holding the valve **13** open at this time, the spring **45** will close it instantly.

What I claim as my invention is:

1. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising a bell-crank pivotally mounted adjacent the path of movement of the molds, means associated with each mold for displacing an arm of the bell-crank to rock the latter out of its normal position as the mold moves beneath the valve, a connector pivotally mounted near the bell-crank, a normally-energized connecting solenoid having a plunger movably mounted therein, means connecting the solenoid to the other bell-crank arm, means connecting the plunger to the connector, an elongated slot in the connector, a bar connected near one end to the valve, a pin on the bar extending into the connector slot, spring means tending to urge the bar pin towards one end of the slot, a closing solenoid having a plunger movably mounted therein opposed to the connecting solenoid, means connecting the latter plunger to the bar, said valve being opened and the plunger of the closing solenoid being drawn part way out of the latter when the bell-crank is rocked, and means for energizing the closing solenoid when the level of liquid in a mold beneath the valve reaches a predetermined point, said energized solenoid drawing the plunger therein to close the valve.

2. Control means for a flow valve in an automatic casting machine as claimed in claim 1 in which the means for energizing the closing solenoid includes a contact finger in circuit with the solenoid, means for supporting the finger normally above any mold in the pouring position, and means connected to the other bell-crank arm and the supporting means for lowering the finger a predetermined distance into a mold when the bell-crank is rocked.

3. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising a pivotally-mounted connector, an operating solenoid mounted on a support and having a plunger movably mounted therein, a switch in circuit with the solenoid positioned to be operated by a mold located beneath the valve, means connecting the plunger to the connector, an elongated slot in the connector, a bar connected near one end to the valve, a pin on the bar extending into the connector slot, spring means tending to urge the bar pin towards one end of the slot, a closing solenoid having a plunger movably mounted therein opposed to the operating solenoid, means connecting the latter plunger to the bar, said valve being opened and the plunger of the closing solenoid being drawn part way out of the latter when the operating solenoid is energized, and means for energizing the closing solenoid when the level of liquid in a mold beneath the valve reaches a predetermined point, said energized solenoid drawing the plunger therein to close the valve.

4. An automatic casting machine as claimed in claim 3 in which the means for energizing the closing solenoid includes a contact finger in circuit with the solenoid, means for supporting the finger normally above any mold in the pouring position, and means connected to the connector and the supporting means for lowering the finger a predetermined distance into a mold when the connector is moved by the operating solenoid.

5. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising spring means connected to the valve tending to move the latter to the open position, spring means stronger than the first spring means indirectly and slidably connected to the valve normally retaining said valve in the closed position, means connected to the stronger spring means for overcoming said stronger spring means to permit the other spring means to open the valve while a mold is positioned beneath the flow valve, said overcoming means permitting the stronger spring means to close the valve when the mold moves from beneath the valve, and means connected to the valve for selectively closing said valve against the tension of the first spring means, the sliding connection of the stronger spring means permitting this even when the overcoming means is in operation.

6. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising spring means connected to the valve tending to move the latter to the open position, a connector pivotally mounted near the valve and having an elongated slot therein, a pin connected at one end to the valve and extending into the slot, spring means stronger than the first spring means secured to the connector normally moving said connector to close the flow valve, the pin being moved by the end of the connector slot, operating means connected to the connector opposed to the stronger spring means to overcome the latter and to permit the other spring means to open the valve while a mold is positioned beneath the flow valve, said operating means permitting the stronger spring means to close the valve when the mold moves from beneath the valve, and means connected to the valve for selectively closing said valve against the tension of the first spring means, said pin moving in the connector slot if the operating means is in operation at the time.

7. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising spring means connected to the valve tending to move the latter to the open position, spring means stronger than the first spring means indirectly and slidably connected to the valve normally retaining said valve in the closed position, a normally-energized solenoid having a movable core connected to the stronger spring means, means for moving the solenoid to overcome the stronger spring means to permit the other spring means to open the valve when a mold moves beneath the flow valve, said stronger spring means closing the valve when the mold moves from beneath the valve or when the solenoid is de-energized, and means connected to the valve for selectively closing said valve against the tension of the first spring means, the sliding connection of the stronger spring means permitting this even when the overcoming means is in operation.

8. Control means for a flow valve in an automatic casting machine as claimed in claim 7 in which the means for selectively closing the flow valve comprises a normally de-energized solenoid having a movable core connected to the valve, said core being drawn into the solenoid when the latter is energized to close the valve.

9. Control means for a flow valve in an automatic casting machine as claimed in claim 8 including a contact to be moved into each mold positioned beneath the flow valve, and means mounted near the valve and carrying the contact for moving the latter into each mold beneath the valve, said contact being in a circuit with the normally de-energized solenoid and closing said circuit when the level of metal poured in the mold reaches a predetermined point.

10. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising spring means connected to the valve tending to move the latter to the open position, spring means stronger than the first spring means indirectly and slidably connected to the valve normally retaining said valve in the closed position, a solenoid having a movable core connected to the stronger spring means, means for energizing the solenoid when a mold moves beneath the valve and de-energizing the solenoid when the mold moves away therefrom, the energizing of the solenoid drawing the core thereinto to overcome the stronger spring means permitting the other spring means to open the valve, and means connected to the valve for selectively closing said valve against the tension of the first spring means, the sliding connection of the stronger spring means permitting this even when the solenoid is energized.

11. Control means for a flow valve in an automatic casting machine as claimed in claim 10 in which the means for selectively closing the flow valve comprises a second solenoid having a movable core connected to the valve, said core being drawn into the second solenoid when the latter is energized to close the valve.

12. Control means for a flow valve in an automatic casting machine as claimed in claim 11 including a contact in a circuit with the second solenoid, and means mounted near the valve and carrying the contact for moving the latter into each mold beneath the valve, said contact closing the circuit when the level of metal poured in the mold reaches a predetermined point.

13. In an automatic casting machine having means for directing molten metal to a flow valve and means for moving molds beneath the valve; control means for the flow valve comprising a horizontal bar connected to the valve, a spring connected to the bar tending to move the valve to the open position, a connector pivotally mounted near the bar and having an elongated slot therein, a pin projecting from the bar into the slot, a spring stronger than the first spring secured to the connector normally moving said connector to close the flow valve, the pin being moved by the end of the connector slot, operating means connected to the connector opposed to the stronger spring to overcome the latter and to permit the other spring to open the valve while a mold is positioned beneath the flow valve, said operating means permitting the stronger spring to close the valve when the mold moves from beneath the valve, and means connected to the valve for selectively closing said valve against the tension of the first spring, said pin moving in the connector slot if the operating means is in operation at the time.

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