June 3, 1941. D. DOYEN 2,244,490

CASTING MACHINE

Filed Oct. 27, 1938 8 Sheets-Sheet 1

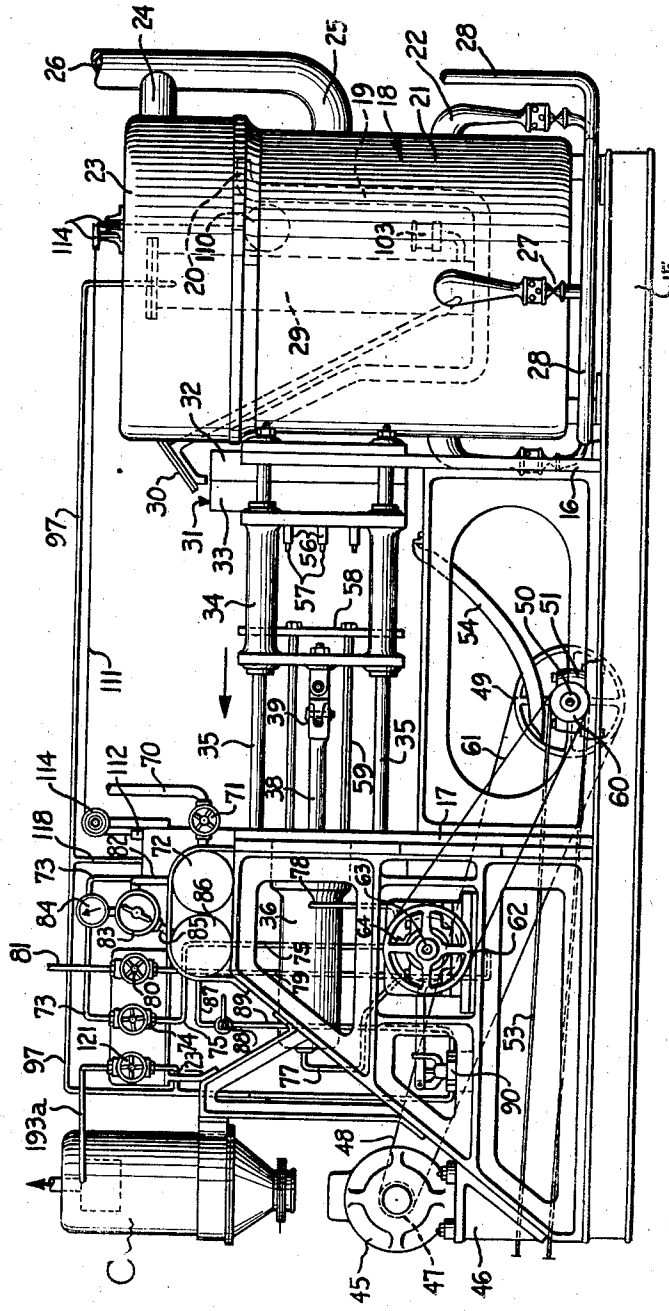


FIG. 1

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CASTING MACHINE

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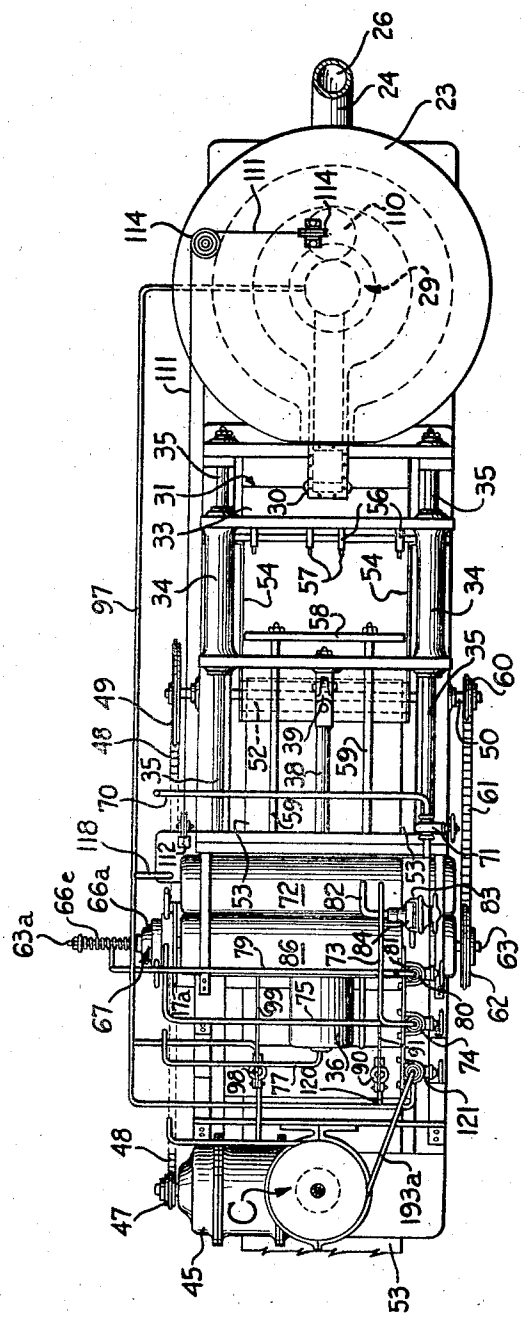


FIG. 2

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CASTING MACHINE

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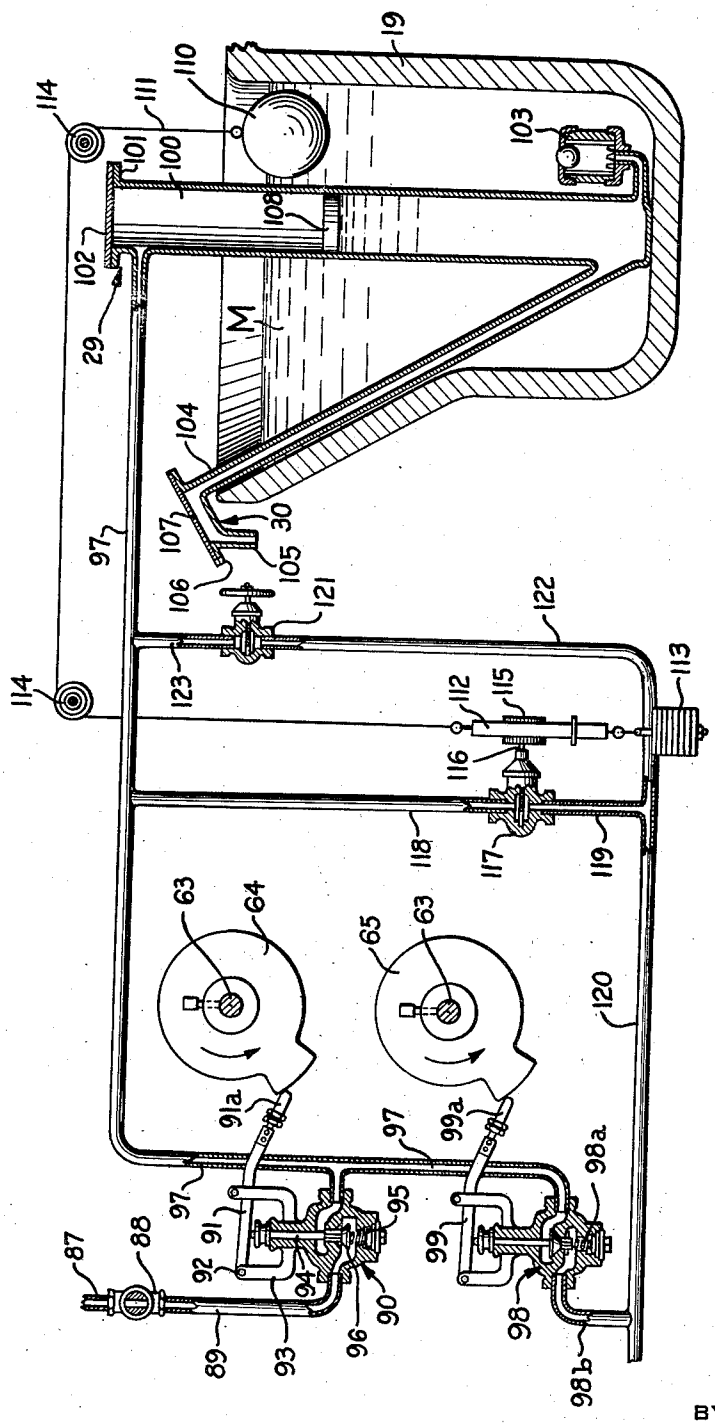


FIG. 3

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CASTING MACHINE

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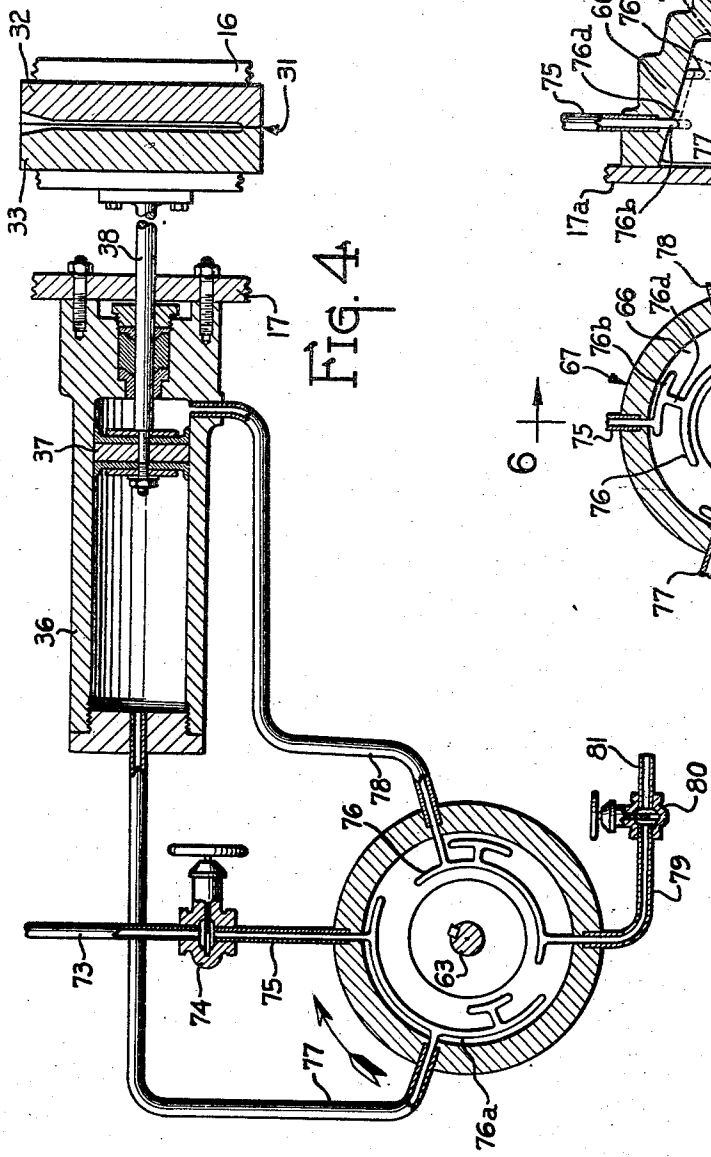


FIG. 4

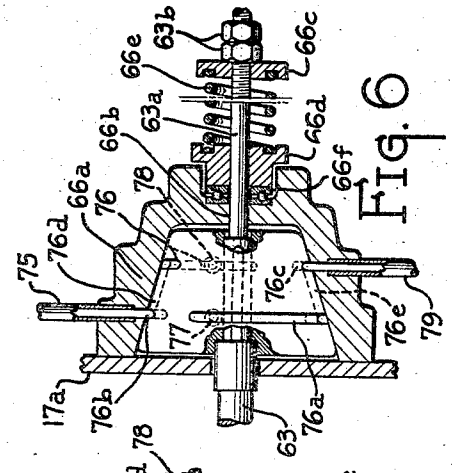


FIG. 6

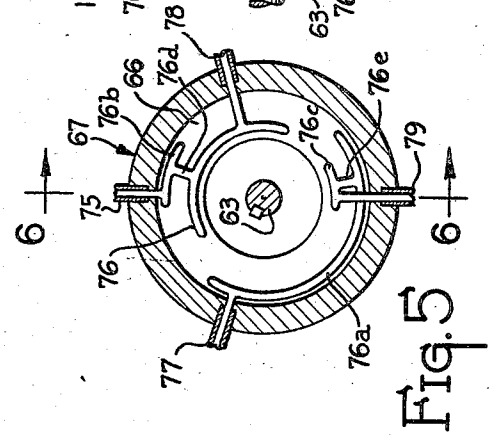


FIG. 5

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CASTING MACHINE

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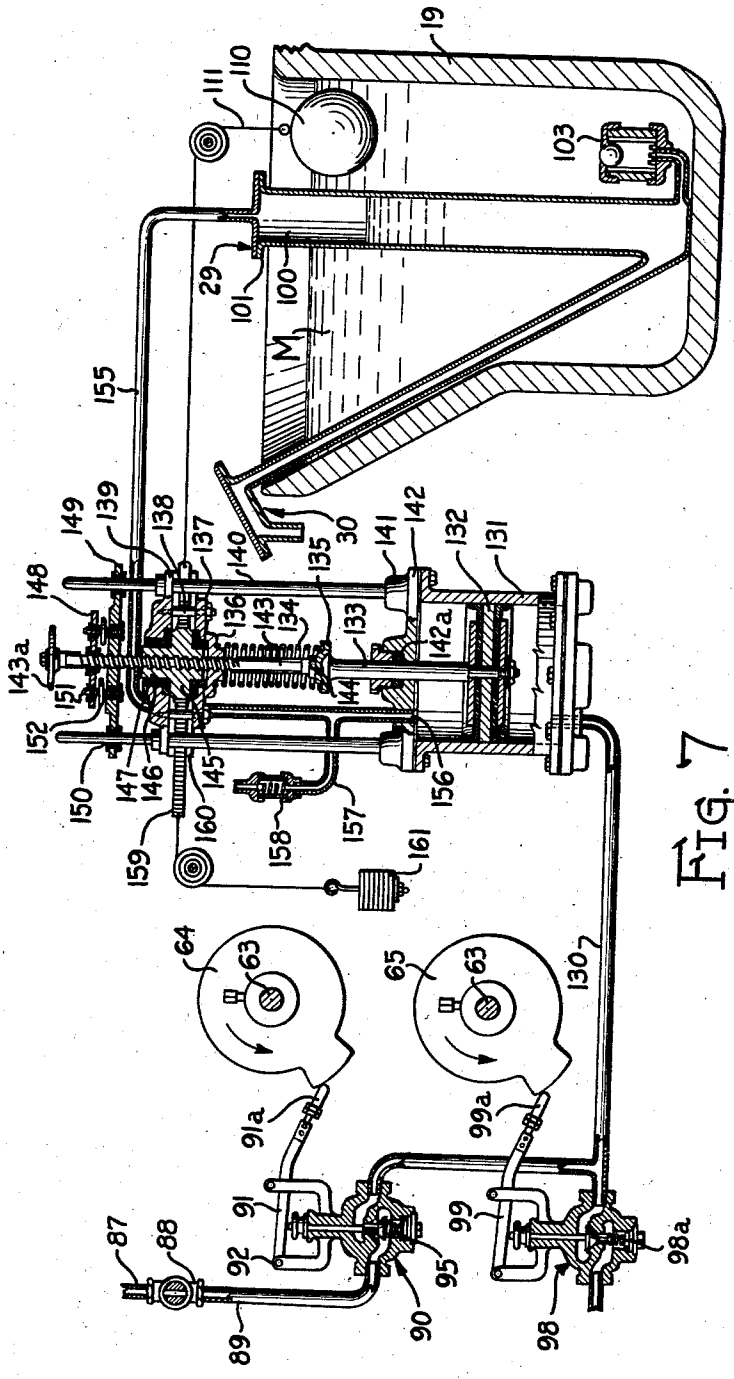


FIG. 7

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CASTING MACHINE

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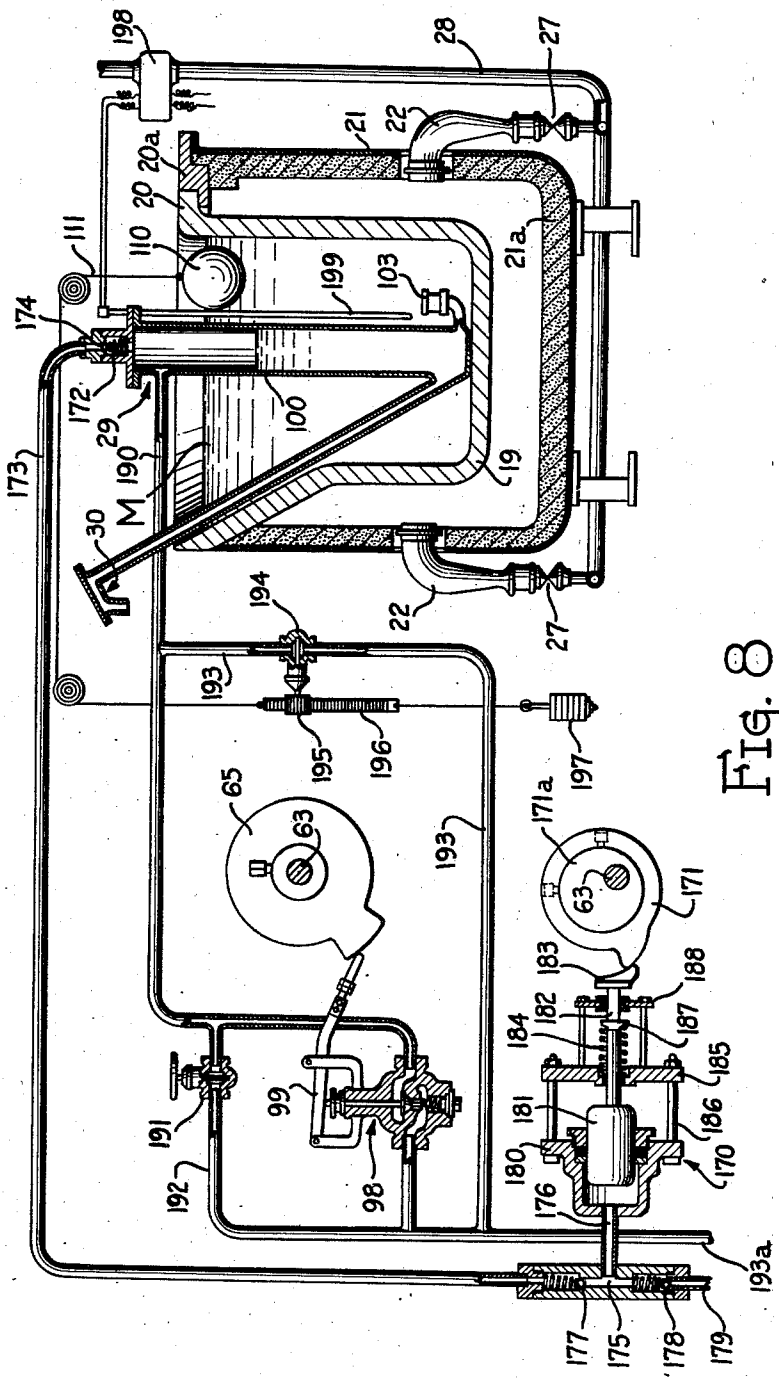


Fig. 8

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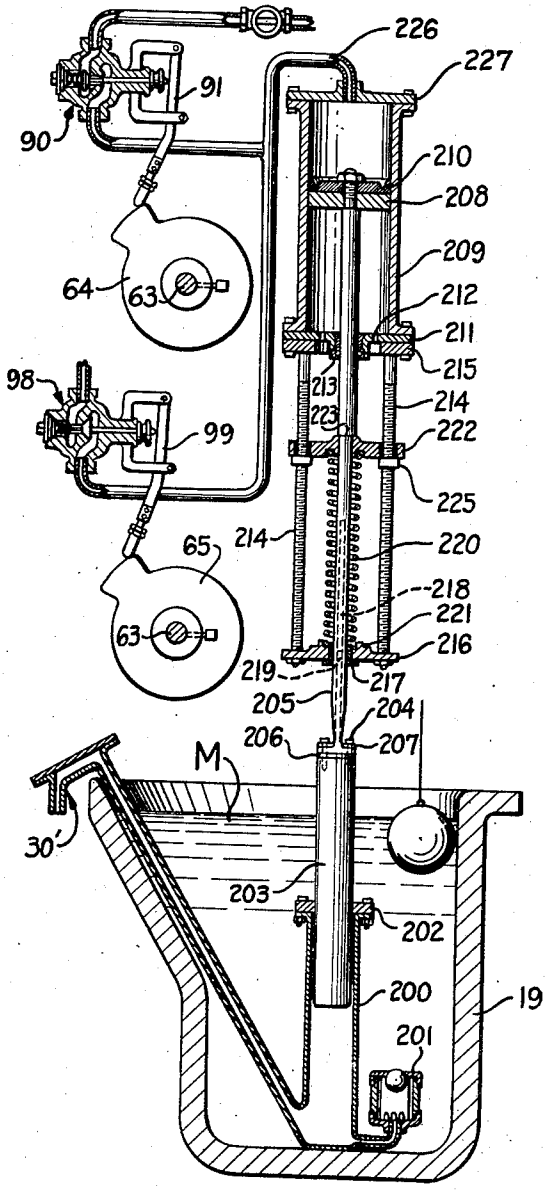


Fig. 9

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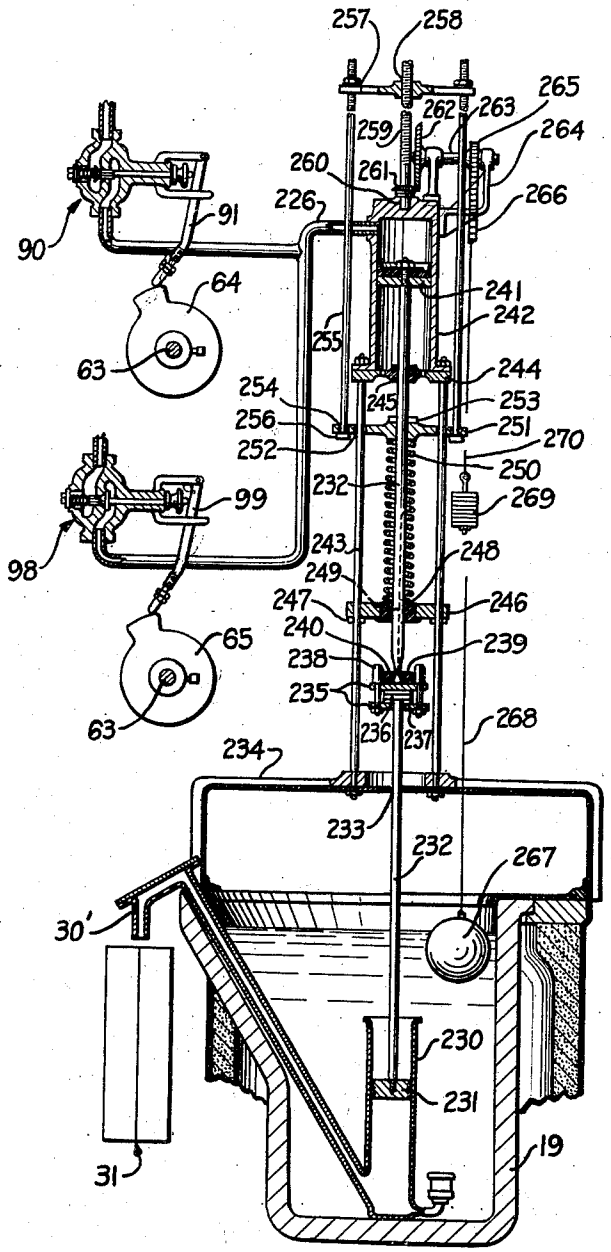


Fig. 10

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Patented June 3, 1941 2,244,490

UNITED STATES PATENT OFFICE

2,244,490

CASTING MACHINE

Daniel Doyen, Brussels, Belgium

Application October 27, 1938, Serial No. 237,191
In Belgium December 17, 1937

18 Claims. (Cl. 22—57)

This invention relates to an automatic machine to cast metal parts, more particularly to an automatic machine for casting lead grids for storage battery plates and the like.

In the past lead grids for storage battery plates have been made by hand-casting, in which a separable mould, adapted for manual opening and closing, was provided, into which the molten metal was poured by a ladle or dipper. The ladle was filled from the surface of the molten metal in a container in which the metal has been heated to the point of liquefaction. This method had the disadvantage that the ladle would pick up oxides of the metal which floated on the surface, and also other impurities which are usually found floating on the surface of molten metal. From the ladle these oxides and other impurities were poured directly into the mould which often resulted in imperfect castings.

The hand-casting method was subject to further difficulties, in that the molten metal in the ladle or dipper would cool in the process of being transferred from the container of the molten metal to the mould which often resulted in premature freezing of the metal and caused further imperfect castings. Furthermore, this method of casting could not be carried out with sufficient speed to be economical and the costs of operation were almost prohibitive.

This inconvenience in the hand-casting has resulted in the design of many different methods and machines to overcome the difficulties pointed out. One type of machine proposed utilized several moulds which were adapted to open and close automatically, and which were mounted on a rotating table, so that they would pass in succession before a workman who poured the metal into the successive moulds by hand with a ladle filled by dipping from the surface of the molten metal in a container. A part of the operation of this method was done mechanically, that is, the opening and closing of the mould but in general, the method suffered the great inconvenience that a large number of moulds were required and did not overcome the difficulty that the pouring of the molten metal from the top of the container still allowed the introduction of oxides and impurities into the cast, and, at the same time, did not overcome the difficulty presented by the cooling of the metal in the ladle in its transference from the container to the mould.

To obviate these difficulties it was next proposed to provide a mechanical pump in the container for the molten metal which would force the molten metal directly from the container into the mould. The molten metal in this case would be taken from below the top surface in the container and would, therefore, prevent oxides and other impurities, floating on the surface, from being introduced into the mould. This machine was a considerable step forward toward the mechanization of casting work but it solved the problems in only an imperfect manner because it still required a large number of moulds and also presented difficulties arising from a complicated pump mechanism whose output could not be regulated so as to force a predetermined amount of metal to the mould at each operating stroke.

Inasmuch as the quantity of metal required to fill the moulds is substantially the same for each casting, it was essential that the pump deliver the same amount of metal each time to the mould.

Furthermore, in the prior art, difficulties were experienced with the mechanisms furnished to open and close the moulds automatically, inasmuch as rotating cams were usually used for this function. The cams were extremely difficult to adjust properly so as to maintain the proper pressure relation between the halves of the separable mould and frequently the mould halves were not properly engaged and a gap would appear between them which would spoil the casting made under these conditions because large seams would be formed on the casting where the molten metal had been dissipated in the gap between the mould halves.

To avoid the difficulties of the machines of the prior art, described above, the present invention contemplates an automatic machine for casting molten metal which dispenses with the ladle and provides a pumping means which forces molten metal from the container at a point below its free surface directly to the mould and also contemplates the provision of an automatic mechanism for opening and closing the moulds in timed relation with other operations which prevents the formation of gaps between the halves of the moulds by maintaining a constant pressure tending to thrust the halves of the moulds into cooperation.

This invention contemplates the provision of a mechanism for opening and closing the mould automatically and the provision of means for pumping the molten metal from a point below its free surface in the container to the mould by placing fluid pressure on a portion of its free surface. In a preferred form of the invention, the fluid pressure is impressed directly upon the surface of the molten metal in a confined area which is segregated from the rest of the molten metal by

the pumping means. A timed relation is maintained between the movements of the mould halves and the application of fluid pressure in the pump means. The segregation of a portion of the free surface has the advantage that it dispenses with the necessity of providing a fluid-tight cover for the whole top of the container.

To overcome the difficulties arising from the cooling of molten metal during the interval in which it is being transferred from the container to the mould, the body of the pumping means, mentioned above, may be positioned within the container, so that it will be surrounded by the molten metal with which it is in communication by means of a one-way valve which automatically closes when fluid pressure is being exerted upon the surface of the segregated metal in the pumping means. The invention also contemplates the provision of a one-way valve cooperating with the pump means which may be mechanically controlled in timed relation with the action of the fluid pressure.

The invention further contemplates the provision of a mechanism in which a pumping means cooperates with a control mechanism, which assures that the conditions under which the pumping means is operating will be such that the pumping means will deliver at each actuation, a predetermined amount of molten metal to the mould. This control mechanism is preferably responsive to a function of the level of the molten metal in the container, and arranged so that the above mentioned purposes are obtained automatically at all times during which the pumping means is operating. A float may be placed in the container to cooperate with the free level of the molten metal to obtain this result, the float being adapted to cooperate with a system of auxiliary apparatus to control the functions of the pumping means.

The cooling of the molten metal during transference in the feed line between the pump and the mould is prevented by placing the feed line in the molten metal in the container so that the temperature of the feed line will be substantially that of the molten metal, thereby substantially preventing any cooling of the metal even though it passes out above the maximum level of the molten metal in the container The relatively short portion of the feed line which is located above the free surface of the molten metal in the container will still have a sufficiently high temperature to prevent freezing of the molten metal.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Figure 1 is an elevational view of a machine embodying one form of the invention.

Figure 2 is a plan view of the machine illustrated in Figure 1.

Figure 3 is an enlarged schematic diagram of the control and distribution system for the fluid pressure controlling the pump mechanism ejecting the molten metal.

Figure 4 is an enlarged schematic diagram, partly in section, illustrating the control and distribution system for the fluid pressure system controlling the movements of mould portions.

Figure 5 is a sectional elevation of a detail of the distributor means shown in Figure 4.

Figure 6 is a longitudinal section of the distributor means shown in Figures 4 and 5, taken along line 6—6 of Figure 5.

Figure 7 is an enlarged schematic diagram illustrating a variation of the control and distribution system for the fluid pressure illustrated in Figure 3.

Figure 8 is an enlarged schematic diagram of another variation of the control and distribution system for the fluid pressure as illustrated in Figure 3.

Figures 9 and 10 are schematic diagrams illustrating another variation of the control and distribution system for the fluid pressure as illustrated in Figure 3.

Modifications illustrated in Figures 1 to 6

Referring to Figure 1 of the drawings, a base member **15** is provided which is preferably made of cast iron to which are attached upright members **16** and **17** which may be of any convenient construction being properly braced for strength at selected points as is well known in the art.

Adjacent the right end (Figure 1) of the base member **15**, a furnace **18** is provided which is shown partly in cross-section in Figure 8, in which a melting pot **19** of refractory material is supported by cooperating with the furnace **18** through the medium of an outwardly projecting flange **20** and a concentric supporting ring **20a**. The furnace **18** has a metallic housing which is preferably divided into a lower and upper section, the lower section **21**, which supports the melting pot **19**, being lined with refractory material **21a** to form a fire pot about the melting pot into which gas burners **22** or the like are adapted to project flames to maintain the temperature of the melting pot to a desired degree, and upper section **23** being adapted to be fitted over the lower section **21** to cover the melting pot **19**. To prevent the accumulation of undesired gases in the furnace, vents **24** and **25** are provided to cooperate with a chimney **26** which is adapted to draw the gases from both portions of the furnace. The burners **22** are provided with control valves **27** to regulate the amount of gas burned in the lower portion of the furnace about the melting pot **19**. The valves **27** may be connected to a common supply pipe **28** which is in communication with a source of inflammable gas (not indicated).

Positioned on the interior of the melting pot **19**, a pumping means **29** is provided which is shown in phantom in Figure 1. The pumping means is provided with a spout **30** which cooperates with an inlet of a mould **31**, which is divided into two portions, a fixed portion **32**, fixedly attached to the frame upright **16**, and a movable portion **33**, attached to guide members **34**. The guide members are adapted to slide along guide rods **35** mounted in position between the main uprights **16** and **17**.

In order to move the guide members **34** along the guide rods **35**, a fluid pressure actuated cylinder **36** is provided which is attached to the frame member **17** adjacent the left side (Figure 1) of the frame **15**. On the interior of the cylinder, a piston **37** (Figure 4) is provided to drive a stem **38**, which is attached to the end of the guide members **34** by means of a universal joint **39**. The joint **39** compensates for minor discrepancies in alignment between the mould portions as the guide members **34** move along the guide rods **35** under the influence

of the piston 37. The piston 37 in the cylinder 36 is actuated by fluid pressure which is subject to control apparatus functioning cooperatively with the pump 29 and will be described in detail hereinafter.

On the extreme left end of the frame member 15 (Figure 1) an electric motor 45 is mounted upon a bracket 46 which may be attached to the upright frame member 17 if desired. The motor 45 may be supplied with a speed reducing device to drive a sprocket wheel 47 which engages with a chain 48 to drive a second sprocket 49 mounted upon shaft 50, which is journaled in bearings 51 suitably mounted on the frame member 15 relatively near the center thereof. The shaft 50 is mounted transversely of the frame member 15 as is clearly shown in Figure 2, and adjacent its center portion is supplied with a cylindrical enlargement 52 which extends a substantial distance between the bearings 51 on the shaft 50. A wide web 53, which is cut away at the extreme left end in Figure 1, is adapted to cooperate with the cylindrical enlargement 52 to form an apron upon which cast articles are carried away to any desired position to the left of the machine. The cast articles are deposited upon the web 53 through the medium of a conveyor 54 mounted on the frame member at a point below the mould 31 to catch the ejected castings from the mould. The ejected castings ride down the conveyor 54 under the influence of gravity until they are deposited on the surface of the web 53, thence being carried to the desired location.

A mechanism is provided to cooperate with the movable portion 33 of the mould to eject the finished castings formed in the mould after completion of a casting operation. The movable portion of the mold is provided with small undercuts to hold the casting in position upon separation from the fixed portion 32 of the mould. Bosses 56 are provided on the rear face of the movable portion of the mould to house ejector pins 57 which cooperate with the casting to thrust the completed casting from the movable portion of the mould when the ejector pins 57 cooperate with a plate 58 mounted on rods 59 firmly fixed in the frame member 17. This holds the plate 58 in proper position to contact the ejector pins 57 when the movable portion of the mould has been moved to the left (Figure 1) under the influence of the stem 38. When the completed casting is ejected through the action of the pins 57, it falls upon the conveyor 54 and moves to the web 53 as described hereinbefore.

Returning to the shaft 50, the forward end thereof (Figure 1) is provided with a sprocket 60, keyed to the shaft 50 in the well known manner, which cooperates with a chain 61, engaging another sprocket 62 keyed to a shaft 63 also mounted transversely on the frame 15 in parallel juxtaposition with the shaft 50. The shaft 63 has keyed thereto at intermediate positions cam members 64 (Figure 3) and 65 and at a point adjacent its end, a rotor member 66 of a fluid pressure distributor 67, the purposes of which are to be described hereinafter.

From a source of fluid pressure (not shown), a conduit 70 leads fluid (under pressure) to a hand valve 71, thence into a pressure accumulator 72 which, in turn, is in communication with a conduit 73 leading to a second hand valve 74 and thence by a conduit 75 to the fluid pressure distributor 67, where the fluid under pressure is distributed through the medium of indentations 76 and 76*a* (Figures 4 and 5) in the rotor 66 to conduits 77 and 78, which conduits lead fluid to the opposite ends of the cylinder 36 to control the movements of the piston 37 for opening and closing the mould 31 in timed relation with other functions during the casting cycle. The conduit 77 is in communication with the left end (Figure 4) of the cylinder 36 and may be utilized at selected times to thrust the movable portion 33 of the mould 31 by fluid pressure through the agency of the piston 37 into cooperation with the fixed portion 32 of the mould during the pouring period of the casting cycle. The conduit 78 is in communication with the right or forward end of the cylinder 36 and fluid pressure may be utilized at selected times to thrust the movable portion 33 of the mould 31 out of cooperation with the fixed portion 32. During the periods in which the fluid under pressure flows through the conduit 77, the opposite end of the cylinder 36 is vented to the atmosphere by the conduit 78 (Figure 4) through the medium of the indentations 76 cooperating with the conduit 79. Conduit 79 is provided with a hand valve 80 which, in turn, cooperates with a conduit 81 which is vented to the atmosphere. In a similar manner, when the fluid under pressure is flowing through the conduit 78 to the cylinder 36, the opposite end of the cylinder is vented to the atmosphere by conduit 77 which cooperates with conduit 79 through indentations 76, 76*e*, and 76*c*, (Figure 5).

Again referring to Figures 4, 5, and 6, the details of construction of the fluid pressure distributor 67 are shown in which the rotor 66 is keyed to the shaft 63 as already described. The rotor 66 may be of frusto-conical construction and adapted to fit into a housing 66*a* having a conical depression to cooperate closely with the side of the frusto-conical rotor member 66 to form a gas-tight connection between them. To hold the rotor member in close engagement with the housing 66*a*, a stem 63*a* is provided which projects forwardly from the shaft 63 through a central aperture 66*b* in the housing 66*a*; the outer end of the projection 63*a* is threaded and provided with lock nuts 63*b* which may be utilized to thrust a pair of washers 66*c* and 66*d* against the housing 66*a* through the medium of a coil spring 66*e*, and thereby pull the rotor and the housing together. To reduce the friction between the collar 66*d* and the housing 66*a*, an anti-friction means 66*f* is provided to act between them. The housing 66*a* may be held in stationary position by being anchored against a portion 17*a* of the frame, the conduits 75, 77, 78 and 79 aiding in holding the housing in position.

As pointed out above, the rotor 66 is provided with indentations on the frusto-conical peripheral surface, which are utilized to place in communication at selected times the conduits 77 and 78 with conduits 75 and 79. Figure 4 shows the position in which the left end of the cylinder 36 is in communication with the source of fluid pressure as introduced into the distributor by means of the conduit 75, which is in communication with indentation 76*a* and conduit 77. In the same figure, the forward or right end of the cylinder 37 is vented to the atmosphere by being placed in communication with the conduit 79 through the agency of conduit 78 and the indentation 76. With the parts in position as shown in Figure 4, the piston 37 is capable of placing the movable portion 33 of the mould into close cooperative relation with the fixed portion 32, at which time molten lead is introduced into the mould as will be described hereinafter.

Turning to Figure 5, a second position of the distributor 67 is shown in which the conduit 78 and the forward end of the cylinder 36 are placed in communication with the conduit 75 through the agency of the indentation 76 to direct the fluid pressure into the forward end of the cylinder to enable the piston 37 to move the movable portion of the mould 31 from its cooperative relation with the fixed portion 32. At the same time, the conduit 77 and the left end of the cylinder 36 are placed in cooperative relation with the conduit 79 to be vented to the atmosphere and allow the fluid entrapped in the cylinder to escape upon movement of the piston 37.

The indentations 76 and 76*a* are provided with displaced portions 76*b* and 76*c* which are connected to the principal branch by means of lateral passages 76*d* and 76*e*. The lateral passages 76*d* and 76*e* may be parallel to the longitudinal axis of the shaft 63 as shown in Figure 6. Figure 6 also shows the displacement of the portion 76*c* from the principal branch 76*a* and also the displacement between the principal branch 76 and the lateral branch 76*b*. The rotor 66 is constantly rotated through the agency of the shaft 63 to which it is keyed and the relation of the lengths of the indentations 76, 76*a*, 76*b* and 76*c* with reference to the conduits 75, 77, 78 and 79 are such that a timed relation may be obtained between the different portions of the casting cycle having reference particularly to the operation of the piston 37 and the cams 64 and 65 (Figure 3) which are also keyed to the shaft 63.

Returning again to the accumulator 72, a second conduit 82 leads therefrom to a pressure regulator 83 which is adapted to lower the pressure as measured by a gauge 84. From the regulator 83, a conduit 85 leads the fluid pressure to a second accumulator 86, and from thence it is led by means of conduit 87 to a hand valve 88. From the hand valve 88, a conduit 89 leads the fluid pressure to a normally closed valve 90 (shown in detail in Figure 3) under control of cam 64 mounted upon the rotating shaft 63. The hump of the cam 64 cooperates with a lever 91 through the medium of an adjustable rider 91*a*. The arm 91 is pivoted on pin 92, journaled in a projection 93 on the casing of the valve 90, and cooperates with a central pin 94 to thrust the same downwardly against a spring member 95 to remove the valve member 96 from its seat to open the valve. The action of the spring 95 is sufficient to close the valve after the hump of the cam 64 has passed its cooperative position with the lever 91.

The actuation of the valve 90 allows the fluid pressure to flow into conduit 97 which is in communication with a second normally open valve 98 of somewhat similar construction as valve 90, being normally held open by a spring 98*a*. An arm 99 through an adjustable rider 99*a* is adapted to cooperate with the hump of the cam 65 also mounted upon the rotating shaft 63, whereby the cam 65 is adapted to close the valve 98 in timed relation with the opening of the valve 90. The timed relation is preferably such that when the valve 90 is open, the valve 98 is closed. These valves are both in communication with the pump means 29, preferably adjacent its upper end, by means of conduit 97, and control to a certain degree the flow of fluid pressure to and from the pump means.

The pump means 29 is in the nature of an elongated cylinder 100, preferably made of metal not attacked by the molten metal. It may be positioned in a vertical position in the molten metal M of the melting pot 19, and adjacent its upper end, it is provided with an outwardly extending flange 101 to which is attached a closure plate 102 in any well known manner. Adjacent its lower end, the cylinder 100 is provided with a one-way valve 103 which may be of any well known construction being designed to allow the molten metal to flow through the valve 103 into the interior of the cylinder to maintain the level of the molten metal on the interior of the cylinder substantially the same as that found in the container 19. The cylinder 100 is also provided at its lower end with an outlet tube 104 which forms at its upper end the spout 30 being provided with a downwardly extending tube 105 which is positioned immediately above the pouring inlet of the mould 31. For convenience in cleaning, the outlet pipe 104 and the tube 105 are provided with an outwardly extending flange 106 to which is bolted a plate 107 in the nature of the closure member.

If preferred, the interior of the cylinder 100 is provided with a floating separation plate 108 which is carried by the surface of the molten metal. The plate 108 is especially useful when a fluid is used in the fluid pressure system which is chemically active with the molten metal because the plate separates the molten metal from the fluid so as to prevent any reaction between them. By the use of a fluid pressure acting directly on the surface of the molten metal, or by the interdeposition of the plate 108, it is possible to use fluid pressure from one source to actuate both the actuating cylinder for the mould and the means to force the molten metal to the mould.

Referring to Figure 3 of the drawings, a mechanism is disclosed which controls the quantity of molten metal that is forced from the spout 30 by the pump 29 under the influence of fluid pressure controlled by valves 90 and 98 flowing through conduit 97. It is essential in a casting machine of this type, that a uniform quantity of molten metal, exactly sufficient to fill the mould, is supplied during the pouring period. Inasmuch as the level of the molten metal M in the container 19 has a substantial influence upon the effectiveness of a predetermined amount of fluid pressure impressed upon the surface of the molten metal inside of the cylinder 100 to force the molten metal to the spout 30, there is a relation between the height of the metal and the amount of pressure required which may be correlated to deliver a uniform quantity of metal to the spout, so that the mould may be exactly filled during each pouring period. This invention contemplates the provision of a mechanism which correlates the level of the molten metal in the container 19 and the fluid pressure maintained in the conduit 97 to actuate the pumping means 29 to attain the result mentioned.

For this purpose, a float 110 cooperating with the surface of the molten metal is provided which is connected by a line or cord 111 to a rack bar 112 and a weight 113. The line 111 cooperates with the float 110 and the rack 112 over pulleys 114 which are conveniently located to reduce resistance of movement of the line 111 to a minimum. The rack 112 is supported by suitable guides (not shown) to cooperate with a pinion 115 which is attached to the spindle 116 of a valve 117. As the float 110 moves in response to changes in level of the molten metal, the rack 112 will move in response thereto, so that the pinion 115 will change the position of the closure

element of the valve 117, so that the valve will constrict or open the aperture through which gas may be flowing from conduit 118 to conduit 119. The conduit 118 is in communication with the conduit 97, described above, and the conduit 119 is in communication with conduit 120 which is preferably vented to the atmosphere having communication with the outlet side of valve 98 by means of conduit 98b. A second valve 121, adapted for manual manipulation, is in communication with conduit 120 by conduit 122 and with conduit 97 by conduit 123, so as to be in parallel with the valve 117.

By this mechanism the amount of fluid pressure in the conduit 97 which actuates the pumping means 29 may be controlled by the valves 117 and 121 in such a manner as to have a relation to the height of the molten metal in the container 19. As the level of the molten metal recedes in the container 19, the valve 117 will be closed to a corresponding extent to raise the pressure in the conduit 97 in some relation corresponding to the change in level of the molten metal, so that the spout 30 will deliver a substantially constant amount of molten metal to the mould.

The shaft 63, carrying cams 64 and 65 and the rotor 66 of the distributor 67, controls the sequential operation of the elements of the casting machine. As shown in Figure 3, the cams 64 and 65 are mounted in the same angular relation with respect to the shaft 63, so that when the hump of the cam 64 cooperates with the arm 91 of the valve 90, the hump of the cam 65 is simultaneously cooperating with the arm 99 of the valve 98. In this manner, the two valves are actuated simultaneously, so that when the valve 90 is opened, the valve 98 will be closed to allow the building up of a proper fluid pressure in the conduit 97 to force the molten metal from the spout 30 through the agency of the pump 29.

During the same time interval, the rotor 66 will be positioned to supply fluid pressure to the left end of the cylinder 36 and venting the opposite end to the atmosphere (Figure 4), so that the movable portion of the mould will be held in cooperative relation with the fixed portion 32. It is essential that the mould is tightly closed with the two mould portions in close cooperative relation to prevent leaks during the period in which the fluid pressure is acting in the pump 29 to force the molten metal through the spout 30 into the mould for the pouring operation. As the humps of the cams 64 and 65 rotate and cease to cooperate with the arms 91 and 99 of the valves 90 and 98 respectively, the valves will again move to their normal positions, that is, the valve 90 will be closed by the action of its spring 95 and the valve 98 will be opened by the action of its spring 98a. This will release the fluid pressure from the surface of the molten metal in the pump 29 to terminate the pouring period and allow the valve 103 to open to equalize the levers of the molten metal on the outside and the inside of the pump and in readiness for another cycle.

During this time interval, the rotor 66 of the distributor 67 will have moved substantially to the position shown in Figure 5, in which the fluid pressure is led to the forward or right end of the cylinder 36 and the left end will be vented to the atmosphere. Under these circumstances, the fluid pressure flowing in conduit 78 will act against the piston 37 to move the movable portion 33 of the mould to open the same and allow the removal of the completed casting. The completed casting is thrust from the movable portion 33 of the mould by the ejector pins 57 which come forcibly into contact with plate 58 as the movable portion 33 moves to an extreme open position. The force of gravity will cause the ejected castings to fall on conveyor 54 which guides them by a sliding action to the moving apron 53, which conveys the castings to a desired position to the left of the machine (Figure 1).

Upon ejection of the castings from the mould, the distributor rotor 66 will have moved to a new position to inaugurate a new cycle.

Modification illustrated in Fig. 7

In Figure 7, a modification of the casting machine is shown in which fluid pressure to actuate the pump means 29 is segregated from the fluid pressure employed to actuate the cylinder 36 which acts to open and close the mould. In this form of the invention, the shaft 63 is again furnished with cams 64 and 65 which control valves 90 and 98 and also distributor 67 which controls the flow of fluid pressure to the cylinder 36 in a manner similar to the modification illustrated in Figures 1 to 6. The fluid pressure actuating the pump 29 in the modification illustrated in Figure 7 is conducted from the valves 90 and 98 through conduit 130 to an end of a cylinder 131 which has a piston 132 adapted to thrust a piston rod 133 against the action of a spring 134 and to form a fluid pressure on the opposite side of the piston 132, whose purpose will be described hereinafter. Spring 134 is seated between an enlargement 135 on the end of the piston rod 133 and a seat 136 positioned on a plate 137 attached in spaced relation by studs 138 to a fixed plate 139 held in position with reference to the cylinder 131 by rods 140. The rods 140 are fixed in bosses 141 in an end closure plate 142 of the cylinder 131, through which the piston rod 133 projects by cooperating with a central aperture which is provided with proper packing devices 142a to form a leak-proof connection as is well known in the art.

Positioned in the coils of spring 134, a threaded rod 143 is provided which has on its end adjacent the cylinder 131 an enlarged portion 144 which cooperates with the enlargement 135 on the piston rod 133. The rod 143 is in threaded relation with a pinion 145 which is held in position in the space between plates 137 and 139 and is provided with lateral projections 146 journaled for free rotation in anti-friction members 147 held in position in central apertures in plates 137 and 139. The distal end of the threaded rod 143 is in threaded relation with a pair of spaced plates 148 and 149. The plate 149 is of such length as to cooperate with the rods 140 extending from the head 142 of the cylinder 131 and is provided with bushed apertures 150 which hold the plate 149 in sliding relation with reference to the rods 140. The plates 148 and 149 are held in adjustable relation with each other by means of threaded rods 151 which are provided with hand-manipulating devices 152 to separate the plates 148 and 149 to provide a locking relation between them and rod 143 by locking the threaded portion of the rod to the plates. The upper end of the threaded rod 143 is provided with a hand wheel 143a, so that the rod may be suitably adjusted by manual manipulation in its relation to plates 139 and 149.

The cylinder 131 is in communication with the pump means 29 through conduit 155 which cooperates with the pump means 29 adjacent its upper end and with the cylinder 131 through an

aperture 156 in the cylinder end plate 142. A lateral extension 157 is provided for the conduit 155 which terminates in a one-way valve 158 which may be of a spring pressed ball type if preferred and is adapted to close by fluid pressure formed in the conduit 155 and opens to the atmosphere when the pressure in the conduit 155 is sub-atmospheric. The action of the valve 158 is adapted to maintain the pressure in the conduit 155 at substantially atmospheric pressure when the piston 132 is in the optimum retracted position under the influence of spring 134.

In this modification, the fluid pressure, active in the chamber of the cylinder 131 adjacent plate 142 by the piston 132, is used to force molten metal from the pump means 29 positioned in the molten metal container 19 to the moulds (not shown). Inasmuch as the pressure in this chamber is maintained at atmospheric pressure when the piston 132 is in retracted position, it is clear that the length of the stroke of piston 132 in cylinder 131 controls the quantity of fluid supplied to the pump means 29 and, therefore, is related to the fluid pressure developed. The rod 143 being threaded adjacent its distal end, and provided with an enlargement 144 at its proximate end, a mechanism is provided which allows the rod 143 to be adjusted longitudinally, so that the point of cooperation between the enlargement 144 with the enlargement 135 on the piston rod 133 may be controlled to adjust the length of the stroke of the piston 132 and thereby control the fluid pressure available to actuate the pump means 29.

The enlargement 144 on the threaded rod 143 acts as a stop for the piston rod 133 by abutting against the adjustable enlargement 135 as shown in Figure 7. An initial adjustment of these members is obtained by manual manipulation of the parts in which the threaded rods 151 may first be loosened so as to draw plates 148 and 149 together and remove the locking relation between them and the rod 143, so that the rod 143 may be by means of hand wheel 143*a* rotated to change its longitudinal relations. With the members in loosened position, the relation between the longitudinal position of the rod 143, plate 149, and pinion 145 may be determined by experiment to obtain the desired piston stroke, after which the threaded rods 151 are again tightened by manual manipulation to fix the relation of the members in the desired adjustment. As the screws 151 are tightened, the plates 148 and 149 tend to be forced apart so as to lock the plates to the threaded portion of the rod 143 by a cramping action in the threaded portions. When an adjustment is obtained, the position of the enlargement 144 has been determined to control the stroke of the piston 132 and, in turn, control the fluid pressure available to actuate the pump means 29. As the enlargement 144 is moved a greater distance from the plate 142, the piston 132 must traverse a greater distance because engagement of enlargement 135 on the end of piston rod 133 with the enlargement 144 on the end of the threaded rod 143 limits the stroke.

The relative position of the enlargement 144 on the rod 143 is further controlled automatically by a mechanism which cooperates with the pinion 145 in a manner similar to that already described with reference to the embodiment illustrated in Figures 1 to 6. In the present modification, the fluid pressure acting on the surface of the molten metal in the container 19 is also controlled by a function which is responsive to changes of level in the molten metal. For this purpose, float 110 is provided to cooperate with the free surface of the molten metal in the container, the float acting through line 111 to move a rack 159 supported by guides 160 in cooperative relation with pinion 145. A counterweight 161 is provided to keep tension in line 111 and to effectuate further the movements of the float 110. As the float 110 raises or lowers in response to changes in level of the molten metal, the rack 159 changes its position correspondingly to rotate the pinion 145. The pinion 145, being in threaded relation with the rod 143, raises or lowers the rod in response to changes in level of the liquid and thereby changes the relation between the enlargement 144 and the plate 142. This relation controls the length of the stroke of the piston 132 and thereby controls the fluid pressure acting in the pump means 29.

As already described, the amount of the fluid pressure acting in the pump means 29 has a direct relation to the amount of metal supplied to the mould during the pouring period. In this mechanism, the fluid pressure supplied for this purpose to the pump means is controlled directly by a function of the change of the level of the molten metal in the container 19 to change the stroke of the piston 132 so as to maintain the quantity of molten metal supplied to the mould substantially uniform. Upon release of the fluid pressure in the conduit 130, by the release of valves 90 and 98 through the action of the humps of the cams 64 and 65, spring 134 pushes the piston 132 to its initial optimum retracted position and all of the parts of the fluid pressure system are at substantially atmospheric pressure and ready for another cycle. The timed relations between cams 64 and 65 and the distributor rotor 66 are similar in this modification to that already described with relation to the modification illustrated in Figures 1 to 6. The mechanism for controlling the movements of the mould are also similar to those already described and no further description will be necessary.

Modification illustrated in Figure 8

In this modification of the invention a mechanism is provided in which fluid pressure utilized to actuate the pump means 29 in the molten metal container 19 is supplied by evaporation of a volatile liquid at the relatively high temperature of the molten metal. A small amount of the volatile liquid, preferably an amount capable of being metered, is supplied at desired times to the pump means 29 by a secondary pump means 170, actuated by an eccentric 171, which is adjustably positioned on shaft 63 by cooperating with an inner eccentric 171*a*. The pump means 170 is in communication with a source of liquid (not indicated) and with a chamber 172 on the pump means 29 by conduit 173, these connections to be described in detail hereinafter.

Upon evaporation of the volatile liquid in the pump means 29, a fluid pressure is generated in the cylinder 100 which ejects molten metal from the spout 30 into the mould (not shown). This motivating fluid pressure is controlled by a system of valves in a manner similar to that already described with reference to Figures 1 to 7, the amount of fluid pressure utilized for forcing the molten metal from the cylinder 100 bearing a relation to the height of the molten metal in the container 19.

To attain these ends, the closure plate for the cylinder 100 of the pump means 29 is provided with a valve chamber 172 which is in communication with the cylinder 100 and with conduit 173. The flow of fluid from the cylinder 100 to the conduit 173 is prevented by a spring-pressed ball valve 174 which is, however, responsive to pressure in conduit 173 to allow entry of liquid into the chamber 172 where it is evaporated under the influence of the high temperature to form the fluid pressure already mentioned.

The conduit 173 is in communication with a second valve chamber 175 which is in direct communication with pump 170 by means of conduit 176. The chamber 175 controls the flow of liquid from a source (not indicated) to the pump means 170 and also the flow of liquid from the pump means 170 to the evaporating chamber 172. For this purpose, a pair of spring-pressed ball valves are provided. The first valve 177, which is responsive to pressure in the chamber 175, allows liquid to flow from the pump means 170 to the evaporating chamber 172 through the medium of the conduit 173 and the second valve 178 which is responsive to suction in the chamber 175 and allows liquid to flow from the source (not indicated) through conduit 179 to the pump means 170. During the compression stroke of the pump means 170, the valve 178 will be closed, while the valve 177 will open to allow the passage of liquid as already described, while during the suction stroke of the pump 170, the valve 177 will be closed, and the valve 178 will open to allow entry of liquid.

The pump means 170 may be of any convenient construction and is preferably provided with a casing 180, in which a piston 181 is fitted to reciprocate under the influence of a connecting rod 182 terminating in a rider 183 cooperating with the hump of the eccentric 171 on the shaft 63. The hump of the eccentric 171 thrusts the piston 181 into the casing 180 to create the pressure necessary to displace the liquid into the the evaporating chamber 172. After the hump of the cam has ceased cooperating with the rider 183, a spring 184 is provided which acts between a stationary plate 185, supported in spaced relation from body 180 by means of bolts 186, and a collar 187, positioned on the connecting rod 182. The action of the spring 184 returns the rider 183 into the path of the hump of the cam 171 for a new actuation. Guiding means 188 are provided to cooperate with the connecting rod 182 to support the rider 183 during the period in which it is in cooperative relation with the hump of the cam 171.

In order to control the amount of fluid pressure formed in the cylinder 100 of the pump means 29, a second conduit 190 is provided which is in communication with the upper end of the cylinder 100. The conduit 190 is in communication with valve 98 which serves a purpose similar to that already described with reference to Figures 3 and 7. Cam 65, which actuates the valve 98 through the medium of lever 99, is placed in an angular relation with reference to shaft 63 and cam 171 to obtain substantial simultaneous actuation of valve 98 and pump means 170. In this manner, the valve 98 is closed at the time the pump means 170 injects liquid into the evaporating chamber 172 to supply motivating fluid pressure to eject the molten metal from the spout means 30. The pressure in the cylinder 100 is modified by the use of a hand valve 191 in a by-pass 192 in parallel with the valve 98. A second by-pass 193 is provided, in which is positioned valve 194 which is provided with a control pinion 195 actuated by a rack 196. The movements of the rack 196 are controlled by float 110 through the medium of line 111 cooperating with a counter-weight 197 to further effectuate the movements of the float. The action of the valve 194 is similar to the action of valve 117 in Figure 3. The fluid pressure acting in the cylinder 100 is controlled in this manner by a function of the level of the molten metal in the container 19, which, in both cases, is obtained by the interaction of the float 110 and the rack 196, the valve 194, and the counter-weight 197.

The vapor of the evaporated fluid may be allowed to escape to the atmosphere if desired by means of conduit 193*a*, or if found economical it may be condensed and used again. A condenser C (Fig. 1) may be provided for this purpose from which the pressure is relieved in the well known manner.

The furnace for supplying the heat to the container 19 in the various modifications may be regulated by an automatic valve 198 which controls the flow of combustible fuel to the burners 22. The valve 198 may be of the solenoid-controlled type and is regulated by the temperature responsive means 199, positioned in the body of the molten metal. Any convenient regulating system may be utilized for this purpose, as long as automatic valve 198 supplies combustible material to the burners at a rate exactly sufficient to maintain the temperature of the molten metal within prescribed limits.

The action of the pump means 29, except as described above, is substantially similar to that described in Figure 3, and need not be described in further detail. Other elements of the machine controlled by the shaft 63, particularly the fluid pressure means controlled by the regulator 67, cooperate with the pump means 29 in a manner similar to that already described in the other modifications.

Modifications illustrated in Figs. 9 and 10

In the modifications illustrated in Figures 9 and 10, the pump means for ejecting the molten metal from the container 19, into the mould 31 is actuated by fluid pressure means which thrusts a plunger downwardly into a cylinder to force the molten metal from spout 30 as counter-distinguished from the previously described modifications in which fluid pressure acted directly upon the surface of the molten metal in the pump means 29. In the modification illustrated in Figure 10, an automatic control means is provided to vary the length of the stroke of the plunger in the pump cylinder in accordance with a function of the change of level of the molten metal in the container so as to assure the deliverance of a constant quantity of molten metal to the mould at each actuation of the pump.

Referring to Figure 9, a submerged cylinder 200 is provided having a one-way inlet valve 201 acting in a manner similar to the one-way valves already described with reference to previous modifications. A spout means 30' is provided to cooperate with the lower end of the cylinder 200. The upper end of the cylinder 200 is closed by an apertured plate 202, attached to the cylinder in any convenient manner, through which a cylindrical plunger 203 is adapted to reciprocate to displace molten metal from the cylinder 200 through the spout means 30' which the one-way valve 201 has entrapped. The plunger 203 is

preferably made of the metal which is stable at high operating temperatures and chemically non-reactive with the molten metal M in the container.

Attached to the upper end of the plunger 203 by bolts 204, a connecting rod 205 is provided which is insulated from the plunger 203 by an insulating plate 206. Bolts 204 are also provided with insulating bushings 207 to prevent heat transfer from the plunger 203 to the connecting rod. A piston 208 is attached to the upper end of the connecting rod 205 and is adapted to cooperate with an actuating cylinder 209, held in fixed position in any convenient manner (not indicated). Piston 208 is provided on its upper side with gasket 210 to form an expansion chamber in which fluid pressure is adapted to thrust the piston 208 downwardly and thereby actuate the plunger 203 in the submerged cylinder 200. The lower end of the cylinder 209 is provided with a closure plate 211 which vents the lower chamber to the atmosphere by means of apertures 212 and supports a central bushing 213 to guide the longitudinal movement of the connecting rod 205. Projecting downwardly from the lower end of the cylinder, threaded rods 214 are provided which are attached to the closure plate 211 by a supporting plate 215 and are held in spaced relation at their lower ends by plate 216. The plate 216 is provided with a central anti-friction bushing 217 to further guide the connecting rod 205 in its longitudinal movement. To prevent rotation of the connecting rod 205, a longitudinal slot 218 is provided therein to cooperate with a key 219, preferably fixed in bushing 217 anchored in plate 216.

To thrust the piston 208 and the plunger 203 upwardly after release of the fluid pressure in the chamber above the piston, a spring 220 is provided which preferably embraces the connecting rod 205 and acts between a seat 221 on plate 216 and a second plate 222 attached adjacent a central position to the connecting rod 205 by abutting against a shoulder 223 formed on the connecting rod. The downward stroke of the piston 208 and the plunger 203 is controlled by threaded collars 225, positioned upon the threaded portion of rods 214 which form an abutment for plate 222 which is attached to the connecting rod 205. The collars 225 are adapted for manual adjustment to control the length of the stroke of the piston and plunger.

The chamber formed above the piston 208 is in communication with a source of fluid pressure by conduit 226 which is fixed in cylinder head 227 and leads to valves 90 and 98. Valves 90 and 98 have been described hereinbefore and their function in this modification is similar to that already described. Valve 90 is controlled by cam 64 through the agency of arm 91, cam 64 being attached to shaft 63. In a similar manner, valve 98 is controlled by cam 65 which is also attached to shaft 63 through the medium of arm 99. The action of the cams 64 and 65, by the rotation of the shaft 63, admit and release fluid pressure in the chamber of the cylinder 209 at selected times to control the movements of the plunger 203 in timed relation with the movements of the movable mould portion as has already been described with reference to the other modifications.

Referring to Figure 10, a submerged pump cylinder 230 is provided having the same type of one-way valve and spout means as before described with reference to other modifications. The upper end of the cylinder 230 is open and a relatively short plunger 231 is provided to reciprocate in the cylinder to force the molten metal from the spout 30 to the mould 31.

The plunger 231 is driven by an articulated connecting rod 232 which extends through an aperture 233 formed in cover 234 of the furnace. The articulated connecting rod is formed with a universal joint adjacent its central portion which consists of plates 235 clamped on a head 236 formed on the end of the one portion of the connecting rod 232 with heat insulating material 237 juxtaposed between the parts. The clamping action is attained by bolts 238 threading through proper apertures in plates 235. One plate 235 is provided with a socket 239 to cooperate with a spherical head 240 formed on a part of the connecting rod 232. The upper end of the connecting rod 232 is connected with a piston 241 which is adapted to reciprocate in a cylinder 242, held in fixed relation with the cylinder 230 by means of bolts 243 fixedly attached to the cover 234 of the furnace. The lower end of the cylinder 242 is provided with a perforated plate 244 which vents the lower portion of the cylinder to the atmosphere and is provided with a central bushing 245 to cooperate with the connecting rod 232 and guide the same during its longitudinal movement. The connecting rod is further supported and guided by plate 246 which is supported by rods 243 and held in position thereon by adjustable collars 247. A central bushing 248 is provided in the plate 246 to cooperate with the connecting rod to guide it during its longitudinal movement in cooperation with the bushing 245 in the closure plate of the cylinder. The central bushing 248 is also provided with a projection 249 which registers with a longitudinal slot cut in the connecting rod 232 so as to prevent rotation of the connecting rod with respect to the rods 243.

The plate 246 forms a seat for one end of a spring 250 which preferably embraces the connecting rod to thrust the piston 241 and the plunger 231 upwardly after it has been actuated by fluid pressure in the cylinder 242. The spring 250 also engages a plate 251 adjacent its other end, the plate having a central aperture cooperating with the connecting rod 232 and abutting against a stop 253 fixedly positioned on the connecting rod 232. The spring 250 pushes upwardly on the plate 251 which is provided with apertures 252 to ride along the rods 243 to abut against the collar or stop 253, which transmits the upward thrust to the piston 241 and brings the piston with the plunger 231 to an initial position upon release of fluid pressure in the cylinder.

The plate 251 is also provided with outwardly extending portions beyond the rods 243 which portions are provided with apertures 254 to cooperate with depending rods 255 which have on their lower ends enlarged heads 256. The depending rods 255 are supported by a plate 257 which is positioned above the head of the cylinder 242. The plate 257 is provided with a centrally-located threaded aperture 258 through which extends a threaded rod 259, rotatably journaled at its lower end in an aperture 260 formed in the head of the cylinder. A beveled pinion 261 is keyed to the threaded rod 259 adjacent its journal and is adapted to cooperate with a beveled gear 262, keyed to a horizontal shaft 263, which is journaled in brackets 264 attached to the upper end of the cylinder. The shaft 263 has a sprocket 265 keyed thereto which

is adapted to cooperate with the bight of a chain 266 whose depending ends are attached to the float 267 by line 268 and to counter-weight 269 by line 270.

The float as illustrated cooperates with the surface of the molten metal in the container 19 and as the level varies, the float will move in correspondence thereto which enables the float in cooperation with the counter-weight 269 to move the chain 266 with reference to the sprocket 265 to cause a rotation of shaft 263 which, in turn, rotates the beveled gear 262, the beveled pinion 261, and the threaded rod 259. Rotation of the threaded rod 259 changes the position of the plate 257 by displacing the plate longitudinally of the rod 259, so that the heads 256 of the depending rods 255 change their relation with the plate 251. The relation between the plate 251 and the heads 256 determine the stroke of the piston 241 and thereby controls the stroke of the plunger 231 in the submerged pump in the furnace. In this manner, the stroke of the plunger 231 may be controlled by some function of the change of level of the molten metal in the container 19, so that a predetermined amount of molten metal may be ejected from the spout 30' into the mold 31.

Fluid pressure is led to the cylinder 242 by means of the conduit 226 in a manner similar to that described with reference to Figure 9, and is controlled by valves 90 and 98. The timed relation between the pump means in the molten metal container and the fluid pressure means actuating the moulds remains substantially the same in this modification as in those already described.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed is:

1. In a device of the class described, separable moulds, a container for molten metal, means to feed the molten metal from the container to the moulds, fluid pressure means to force the molten metal from the container into the conveyor means to feed the molten metal to the moulds, and means responsive to changes of the level of the molten metal to vary the fluid pressure in proportion to said changes whereby a predetermined amount of molten metal is fed to the moulds through the conveyor means.

2. In a device of the class described, a container for molten metal, separable moulds, conveyor means to carry molten metal from the container to the moulds at selected times, fluid pressure actuated means cooperating with the conveyor means to force the molten metal to the moulds by fluid pressure, a source of fluid pressure, and means responsive to changes of the level of the molten metal in the container to vary the fluid pressure in proportion to said changes of level whereby the conveyor means is caused to deliver a substantially unvarying, predetermined amount of molten metal to the moulds.

3. In a device of the class described, a container for molten metal, separable moulds, pump means immersed in the molten metal in the container to force molten metal from the container to the moulds at selected times, valve means cooperating with the pump means to place the pump means in communication with the molten metal at selected times, a source of fluid pressure, and control means acting between the source of fluid pressure and the pump means to allow the fluid pressure to actuate the pump means in timed relation with the operation of said moulds, and means responsive to variations in level of the molten metal in the container to determine the amount of fluid pressure applied to the pump means to maintain the quantity of molten metal forced to the moulds substantially uniform.

4. In a device of the class described, a container for molten metal, separable moulds, fluid pressure actuated means to separate the moulds at selected times, a second fluid pressure actuated means cooperating with the container and the moulds to force molten metal to the moulds at selected times, a source of fluid pressure, and control means acting between the source of fluid pressure and the two fluid pressure actuated means to actuate the separable moulds and to force molten metal to the moulds in a selected sequence, and means being responsive to the variations in the level of the molten metal in the container to vary the amount of fluid pressure available to actuate the second fluid pressure actuated means to maintain the quantity of molten metal forced to the moulds substantially constant.

5. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, fluid pressure actuated means to open and close the moulds, pump means in the molten metal to lift the molten metal above its level in the container and to force molten metal into the molds, a second fluid pressure actuated means to actuate the pump means, control means for the first and second fluid pressure actuated means to control their sequence of actuation, and an automatic control means independent of the first control means for the second fluid pressure actuated means to control the amount of molten metal forced into the moulds by the pump means.

6. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, an elongated chamber in the container extending from above the level of the molten metal to a substantial distance below the surface into the molten metal, conveyor means in communication with the lower end of the elongated chamber, extending above the surface of the molten metal and in communication with the moulds, a one-way valve adjacent the lower end of the elongated chamber to place the chamber in communication with the molten metal to maintain the same level of molten metal in the chamber, means cooperating with the source of fluid pressure and the upper end of the chamber to place a fluid pressure on the surface of the molten metal at selected times to force molten metal from the conveyor means into the moulds, and means responsive to changes in the level of the molten metal to vary the amount of the fluid pressure acting on the sur-

face of the molten metal in the chamber, whereby the conveyor means will deliver a substantially constant quantity of molten metal to the moulds.

7. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, fluid pressure actuated means to open and close the moulds, a closed cylinder positioned in the molten metal in the container, a one-way valve in the lower end of the cylinder to allow the molten metal to flow into the cylinder to fill the cylinder except for a relatively small space adjacent its upper end, conveyor means communicating with the cylinder adjacent its lower end to convey molten metal in the cylinder to the moulds, fluid pressure means cooperating with the source of fluid pressure to place a variable fluid pressure on the surface of the molten metal in the cylinder to force the molten metal through the conveyor means into the moulds, control means cooperating with the source of fluid pressure, the fluid pressure actuated means and the fluid pressure means to give a predetermined sequence of operation of the various means, means to vent the upper end of the cylinder to the atmosphere at selected times and a second control means responsive to variations in the level of the molten metal in the container to control the fluid pressure on the surface of the molten metal in the cylinder whereby the conveyor means delivers a predetermined amount of molten metal to the moulds.

8. In a device of the class described, a container for molten metal, separable moulds, means to open and close the moulds, fluid pressure actuated means associated with the container to force molten metal to the moulds, a source of fluid pressure, a second fluid pressure actuated means cooperating with the source of pressure to create a variable fluid pressure to actuate the first fluid pressure actuated means, control means cooperating with the means to open and close the moulds, and the second fluid pressure actuated means to cause a predetermined sequential operation, and a second control means for adjusting the second fluid pressure actuated means in response to changes in the level of the molten metal in the container to vary the fluid pressure created by the second fluid pressure means whereby the first fluid pressure actuated means is caused to deliver a predetermined substantially unvarying amount of molten metal to the moulds.

9. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, fluid pressure actuated means to open and close the moulds, a closed cylinder positioned in the container, a one-way valve in the lower end of the cylinder, conveyor means communicating with the cylinder to convey molten metal to the moulds by fluid pressure acting on the surface of the molten metal, control means cooperating with the source of fluid pressure, the fluid pressure actuated means and the cylinder to give a predetermined sequence of operation, means to vent the upper end of the cylinder to the atmosphere at selected times, and a second control means responsive to variations in the level of the molten metal in the container to control the fluid pressure on the surface of the molten metal in the cylinder whereby the conveyor means is caused to deliver a predetermined amount of molten metal to the moulds.

10. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, a closed cylinder positioned in the molten metal in the container, conveyor means communicating with the cylinder adjacent its lower end to convey molten metal in the cylinder to the moulds, fluid pressure means cooperating with the source of fluid pressure to place a fluid pressure on the surface of the molten metal in the cylinder to force the molten metal through the conveyor means into the moulds, control means cooperating with the source of fluid pressure, and the fluid pressure means to give a predetermined sequence of operation, means to vent the cylinder to the atmosphere and the molten metal at selected times, and a second control means responsive to variations in the level of the molten metal in the container to cause the conveyor means to deliver a predetermined amount of molten metal to the moulds.

11. In a device of the class described, a container for molten metal, separable moulds, pump means positioned within the container and adapted to deliver molten metal to the moulds, actuating means for the pump means, fluid pressure actuated means adapted to cooperate with the actuating means, a source of fluid pressure, variable stop means cooperating with the actuating means, control means responsive to changes of the level of the molten metal in the container to vary the position of the stop means for the actuating means to cause the pump means to deliver a substantially uniform amount of molten metal to the moulds.

12. In a device of the class described, a container for molten metal, a mould, means to supply molten metal from the container to the mould at selected times, and control means responsive to changes of the level of the molten metal in the container to control said supply means, whereby the latter means will convey a substantially uniform amount of metal to the mould during each cycle of operation thereof.

13. In a device of the class described, a container for molten metal, separable moulds, conveyor means operable by fluid pressure cooperating with the moulds and the container to convey molten metal from the container to the moulds at predetermined times, and control means cooperating with the conveyor means to maintain the amount of metal conveyed to the moulds substantially constant, said control means being responsive to variations of the level of the molten metal in the container.

14. In a device of the class described, a container for molten metal, separable moulds mounted adjacent the container, pump means mounted in the container at least partially submerged in the molten metal, conveyor means to convey the molten metal from the pump means to the moulds, actuating means for the pump means, and control means for the actuating means cooperating with the level of the molten metal to vary the capacity of the pump means in response to variations of the level of the molten metal to maintain the amount of metal conveyed to the moulds substantially constant.

15. In a device of the class described, a container for molten metal, separable moulds, fluid-pressure actuated means to separate the moulds at predetermined times, conveyor means at least partially submerged in the molten metal in the container and operable by fluid pressure to convey molten metal from the container to the

moulds, a source of fluid pressure of substantially constant pressure, control means for the fluid pressure to control the sequence of actuation of the separable moulds and the conveyor means, separate power means to actuate the control means, and an automatic control means independent of the first control means cooperating with the conveyor means to control the amount of fluid pressure supplied thereto, to maintain the amount of molten metal conveyed to the moulds substantially constant.

16. In a device of the class described, a container for molten metal, separable moulds, a source of fluid pressure, fluid pressure actuated means to open and close the moulds, pump means in the molten metal to lift the molten metal above its level in the container and to force molten metal into the moulds, a second fluid pressure actuated means to actuate the pump means, control means for the first and second fluid pressure actuated means to control their sequence of actuation, a second control means for the second fluid pressure actuated means to control the amount of molten metal forced into the moulds by the pump means, and means to actuate the second control means responsive to changes in level of the molten metal to allow the pump means to discharge a substantially constant amount of molten metal into the moulds.

17. In a device of the class described, a container for molten metal, separable moulds, fluid pressure actuated means to separate the moulds at predetermined times, conveyor means at least partially submerged in the molten metal in the container and operable by fluid pressure to convey molten metal from the container to the moulds, a source of fluid pressure of substantially constant pressure, control means for the fluid pressure to control the sequence of actuation of the separable moulds and the conveyor means, separate power means to actuate the control means, and a second control means cooperating with the conveyor means responsive to the level of molten metal in the container to control the amount of fluid pressure supplied thereto, to maintain the amount of molten metal conveyed to the moulds substantially constant.

18. In a device of the class described, a container for molten metal, separable moulds, fluid pressure actuated means to separate the moulds at predetermined times, conveyor means at least partially submerged in the molten metal in the container and operable by fluid pressure to convey molten metal from the container to the moulds, a source of fluid pressure of substantially constant pressure, control means for the fluid pressure to control the sequence of actuation of the separable moulds and the conveyor means, separate power means to actuate the control means, and a second control means cooperating with the conveyor means and bleeding the fluid pressure supplied to the conveyor means to a value which is proportionate to the level of the molten metal in the container so as to enable the conveyor means to convey a substantially constant amount of molten metal from the container to the moulds.

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