A. H. WIEDHOFFT.

DIE CASTING MACHINE.

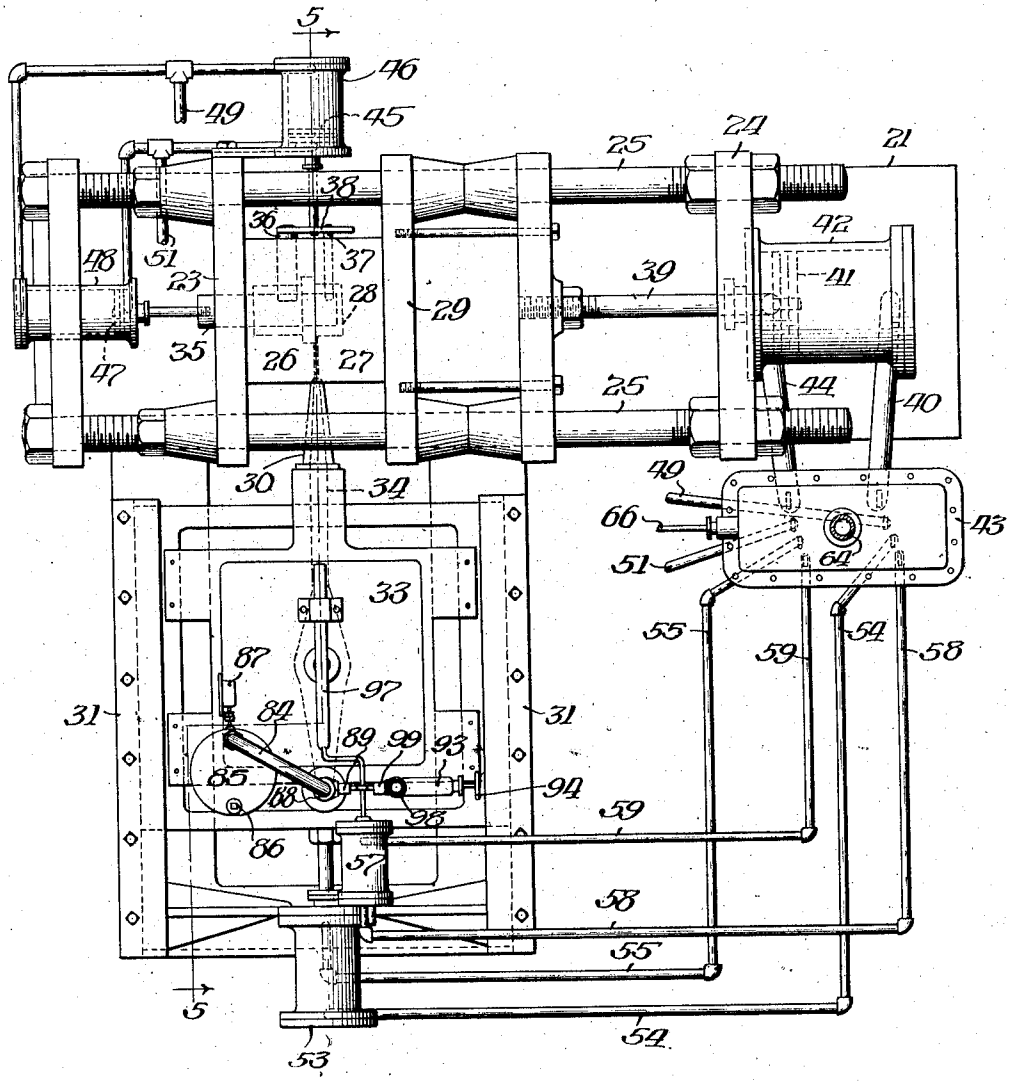
APPLICATION FILED MAR. 11, 1918.

1,332,940.

Patented Mar. 9, 1920.

4 SHEETS—SHEET 1.

Fig. 1.



Witness:

Geo. E. Dixon

Inventor

Alfred H. Wiedhofft

By Pond & Wilson

Attys.

A. H. WIEDHOFFT.

DIE CASTING MACHINE.

APPLICATION FILED MAR. 11, 1918.

1,332,940.

Patented Mar. 9, 1920.

4 SHEETS—SHEET 2.

Fig. 2.

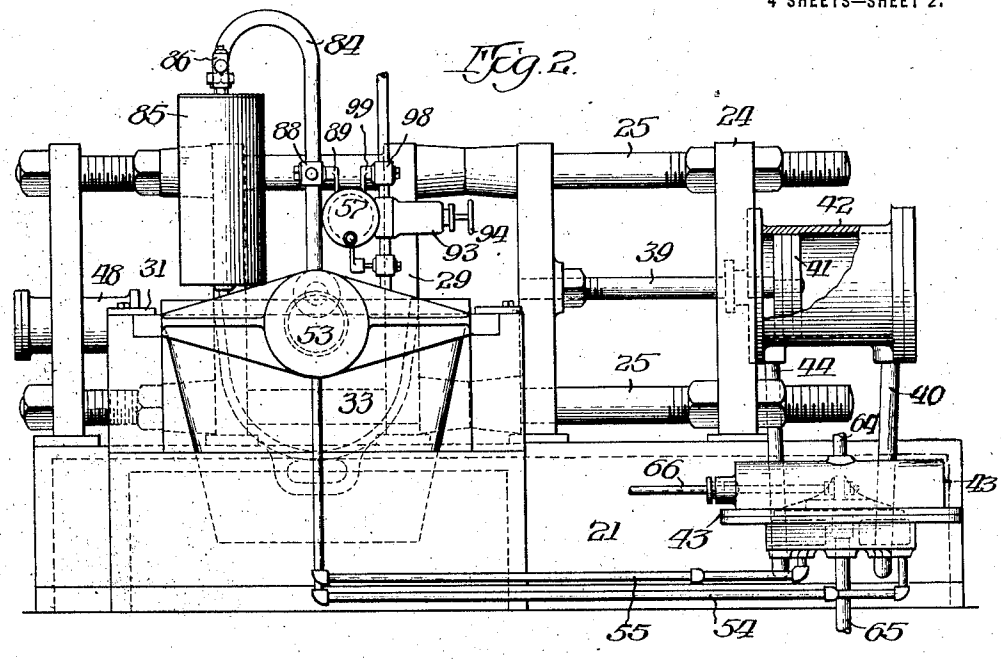


Fig. 3.

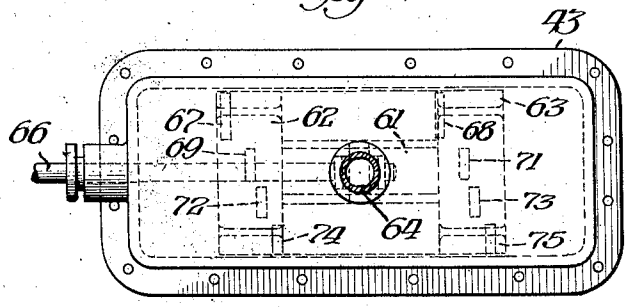
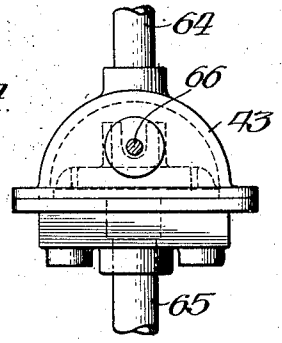


Fig. 4.



Witness:

F. C. Dyson

Inventor:

Alfred H. Wiedhofft

By Fondalwilson

Attys.

A. H. WIEDHOFFT.

DIE CASTING MACHINE.

APPLICATION FILED MAR. 11, 1918.

1,332,940.

Patented Mar. 9, 1920.

4 SHEETS—SHEET 3.

Fig. 5.

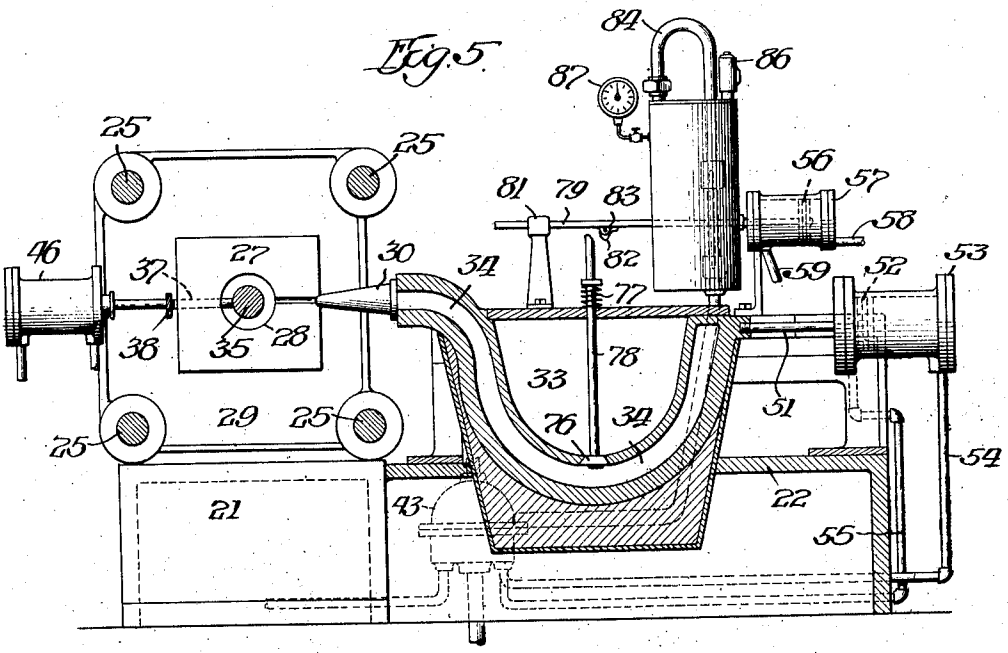
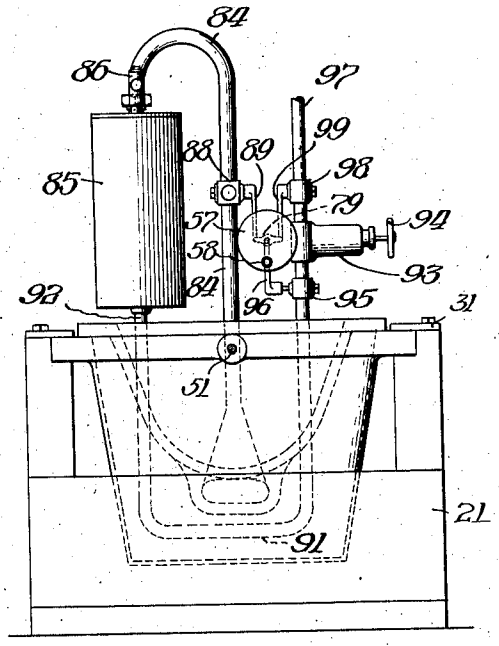


Fig. 6.



Witness:

F. C. Davison

Inventor:

Alfred H. Wiedhofft

By Pondelwilson Attys

A. H. WIEDHOFFT.

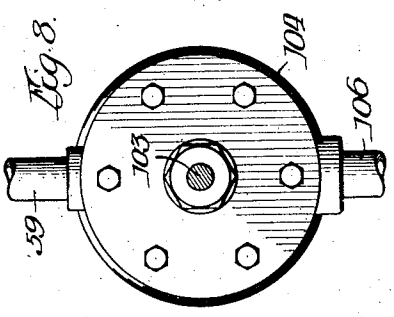
DIE CASTING MACHINE.

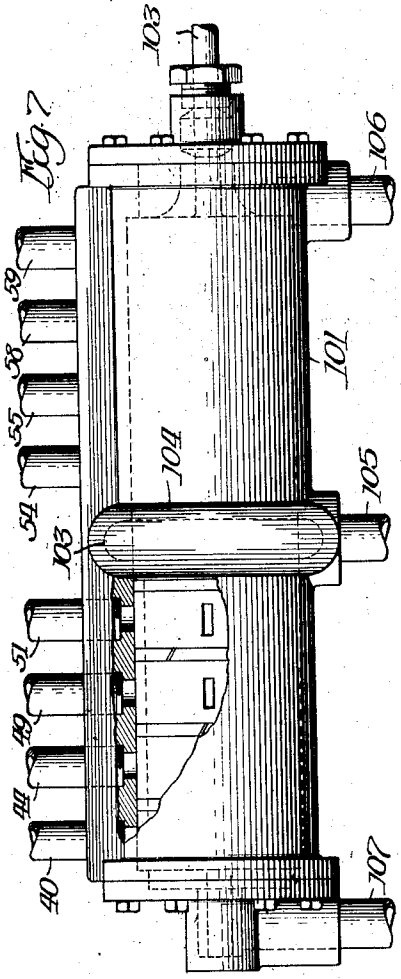
APPLICATION FILED MAR. 11, 1918.

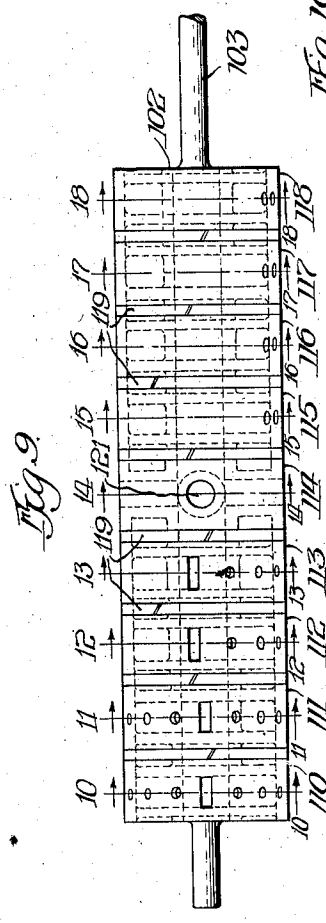
1,332,940.

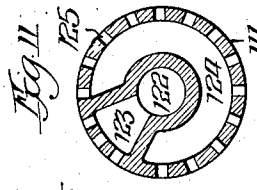
Patented Mar. 9, 1920.

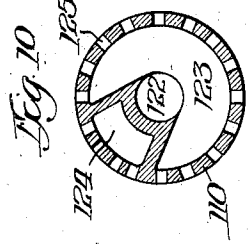
4 SHEETS—SHEET 4.

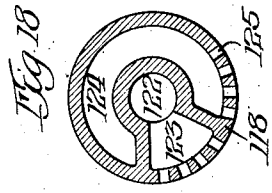


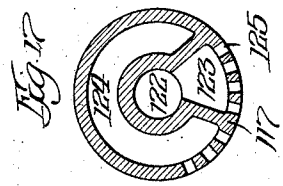


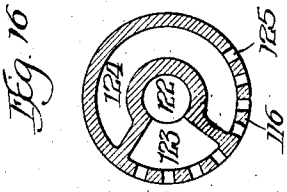


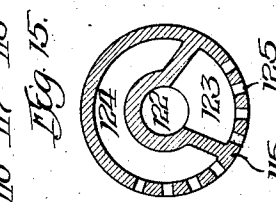


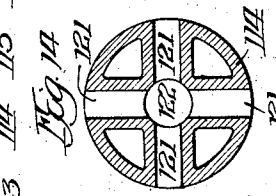


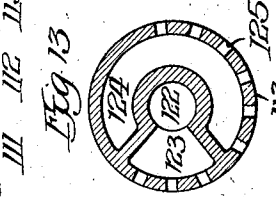


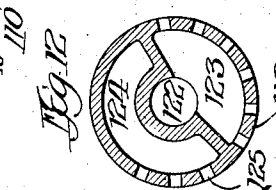












Witness:

Inventor

Alfred H. Wiedhofft

By Pondelbilson

Attys

UNITED STATES PATENT OFFICE.

ALFRED H. WIEDHOFFT, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-HALF TO CHARLES SODERHOLM, OF CHICAGO, ILLINOIS.

DIE-CASTING MACHINE.

1,332,940. Specification of Letters Patent. Patented Mar. 9, 1920.

Application filed March 11, 1918. Serial No. 221,597.

To all whom it may concern:

Be it known that I, ALFRED H. WIEDHOFFT, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Die-Casting Machines, of which the following is a specification.

This invention relates in general to die casting machinery, and more particularly to the mechanism or apparatus for operating the dies, cores, melting pot, and the means for delivering the metal to the dies under the requisite pressure.

In the operation of die casting machines it is essential that a series of movements be performed in predetermined sequence at each operation of the machine. For example, the dies or molds must first be closed, the core or cores are then inserted into proper position within the mold, the melting pot is then moved into operative relation to the mold, and then the molten metal is forced from the pot into the mold under the requisite pressure which usually is in the neighborhood of three hundred pounds to the square inch. The melting pot is then backed away from the mold, and the core or cores are withdrawn, and finally the die is opened to permit the casting to drop out. This series of steps must be taken in regular predetermined order, and the sectional die must be held in tightly closed position under a pressure greater than the pressure of the metal which is forced into the mold, otherwise an imperfect casting will result. Prior to my present invention these various movements of the different elements of the machine have been under the control of the operative who by manipulation of various controlling levers caused the movements to be effected in the necessary timed relation. The speed of the machine, however, was necessarily dependent upon the dexterity of the operative, and if he failed to manipulate the levers in their proper order disastrous results to the machine in injury to the dies or the operating mechanisms invariably followed.

One of the primary objects of my present invention is to provide an automatic control for the various operating elements of the machine which will cause them to be positively operated with absolute accuracy in requisite predetermined timed relation. By automatically controlling the operation of the machine its speed over a manually-controlled machine may be greatly increased, and all dangers of breakage or injury to the machine resulting from improper timing or inaccurate sequence of operations is entirely obviated.

Another object of my invention is to utilize the same power which moves the various elements, for the purpose of retaining the elements in the positions to which they have been moved until such time as it is necessary to reverse their movements. In other words, the power which is employed to move the dies into closed position is utilized in retaining them in closed position while the molten metal is injected into the mold under high pressure. The utilization of the same instrumentality for both moving and holding the dies materially simplifies the construction of the machine over those machines which employ one mechanism for moving the dies and another mechanism for holding them in their closed position.

A further feature of my invention resides in a novel apparatus for generating the pressure which is utilized to force the molten metal into the mold, and for controlling the application and release of this pressure in accurate timed relation with respect to the operation of the other elements of the machine.

Still another feature of my invention resides in the provision of novel apparatus for maintaining the requisite pressure so that it is available for forcing the molten metal into the mold at each operation of the machine.

Various other objects and many of the inherent advantages of my invention should be readily appreciated as the invention becomes better understood by reference to the following description when considered in connection with the accompanying drawings.

Referring to the drawings:—

Figure 1 is a plan view of a die casting machine equipped with my invention;

Fig. 2 is a side elevation of the machine shown in Fig. 1,

Fig. 3 is an enlarged plan view of the controller;

Fig. 4 is an end elevation thereof;

Fig. 5 is a sectional view substantially on the line 5—5 of Fig. 1;

Fig. 6 is an elevation looking toward the left at the mechanism shown in Fig. 5;

Fig. 7 is a side elevation, partly in section, of another form of controller;

Fig. 8 is an end elevation thereof;

Fig. 9 is a view of the rotatable element of the controller shown in Fig. 7; and

Figs. 10 to 18, inclusive, are transverse sectional views on the lines 10 to 18, respectively, of Fig. 9.

By referring to the drawings, it will be observed that the machine comprises generally a main base portion 21 and a laterally extending base portion 22. Upon the main base portion there are fixedly mounted a pair of upwardly extending frame members or webs 23 and 24 rigidly connected together by a plurality, in the present instance four, of heavy bolts or stay rods 25. The die is made in two parts 26 and 27, respectively, which when brought together, as shown in Fig. 1, provide the centrally disposed chamber or mold 28 in which the casting is formed.

The die 26 is fixedly secured to the upright member 23, while the die 27 is carried by a cross-head 29 adapted to slide longitudinally upon the rods 25. The movable die member 27 is moved longitudinally upon the rods 25 toward and from the stationary die member 26 to close and open the mold in a manner which will be later described.

In guideways 31 mounted upon the laterally extending portion 22 of the base frame there is slidingly mounted the metal melting pot 33 which is heated by gas flames, or other suitable heating apparatus, (not shown) to maintain a supply of molten metal in the pot. Centrally and extending beneath the pot proper is formed the channel 34 provided at its discharge end with a nozzle 30 adapted to be inserted into a socket provided by the dies so that the molten metal discharged from the channel into the nozzle is directed into the mold 28 to form the casting.

In order to give the casting the proper shape it is customary to employ core members which are inserted through the walls of the die into the mold chamber before the metal is forced into the mold, and which are subsequently withdrawn from the mold before the die is opened to release the casting. These core members vary considerably in shape and number depending upon the shape of the castings to be produced. In the present instance for purposes of illustration I have shown three core members designated by reference characters 35, 36 and 37, respectively, two of these core members being shown as carried by a cross-head 38 and the third member 35 being mounted independently of the other two. In Fig. 1 the core members are shown as disposed in operative position in the mold, and they are withdrawn from the dies after the casting is cooled by mechanism which will be later described.

The parts of the machine thus far described are of usual and well-known construction, and my present invention pertains primarily to the apparatus for operating and controlling the movements of these various movable parts. It is the purpose of my invention to actuate the various movable parts of the machine in predetermined timed relation, and to control the movements entirely automatically so that the machine will not be dependent upon the accuracy or reliability of manual manipulations. With this end in view I propose to utilize fluid pressure, such as compressed air or steam, steam being preferable for moving the various elements and holding them in the requisite positions during definite required periods of time.

Referring now to the apparatus for actuating the movable member 27 of the die, it will be observed that this member is connected through means of a piston rod 39 with a piston 41 disposed in a cylinder 42 carried upon the frame member 24. Steam is supplied to the cylinder for closing the die through a pipe 40 connected with a controller designated generally by 43, and during closing movements of the die the steam ahead of the piston is exhausted through a pipe 44 back to the controller from which it is discharged in a manner which will be later described.

The core members 36 and 37 are advanced and retracted by means of a piston 45 acting in a cylinder 46, and similarly, core member 35 is actuated by a piston 47 operating in a cylinder 48. In the present instance I have shown core members of such shape that they may be simultaneously advanced and withdrawn from the die, consequently the pistons 45 and 47 may be simultaneously actuated. I have, therefore, shown a common steam supply pipe 49 connected to the outer ends of the cylinders 46 and 48 to move the core members inwardly, this pipe being connected with the controller 43, as shown in Fig. 1, and similarly, a common pipe 51 connected to the inner ends of the cylinders and to the controller serves to conduct the exhaust from ahead of the pistons 45 and 47, and to supply live steam from the controller to withdraw the respective core members from the dies at the proper time.

The melting pot is moved toward and from the dies by a piston 52 working in a cylinder 53, the piston being actuated in opposite directions by steam supplied from the controller 43 through the pipes 54 and 55.

The delivery of a predetermined quantity of molten metal from the pot 33 into the channel 34, and the discharge of this metal from the channel into the mold under pressure are effected by the actuations of a piston 56 mounted in a cylinder 57 to which steam is supplied from the controller to actuate the piston in opposite directions through pipes 58 and 59. The mechanism which is actuated by the piston 56 will be hereinafter described in detail.

In the operation of the machine it is essential that the various elements be operated in predetermined sequence as follows:—

The movable die 27 is first moved into closed position against the stationary die 26, and it must be held in closed position with sufficient force to prevent separation of the dies when the molten metal is forced into the mold under a pressure of approximately three hundred pounds. After the dies have been closed the cores are projected into position within the mold chamber, and these cores are then held in this position until after the metal is poured. Next the metal pot is moved toward the dies in the position shown in Fig. 1, and thereupon a quantity of molten metal is forced into the mold under pressure which is supplied as will be later described. After this portion of the cycle of operations has been completed, a reverse movement of all these parts takes place, that is, the mechanism controlled by the cylinder 57 is reversed, the metal pot is retracted from the dies, the cores are withdrawn from the mold, and finally the movable die is separated from the stationary die to permit the completed casting to drop out of the mold chamber.

This sequence of operations is established and maintained with accuracy by the controller 43. It will be observed from Figs. 1 and 3 that this controller comprises an elongated chamber in which is reciprocably disposed a slide valve 61 adapted to open and close a plurality of series of ports to which the various operating cylinders hereinbefore mentioned are connected as shown. The space between the piston members 62 and 63 of the slide valve is supplied with steam under pressure from a steam supply pipe 64 which receives its supply of steam from a boiler, or any convenient source. The spaces beyond the outer faces of the members 62 and 63 are connected with an exhaust pipe 65 through which the exhaust steam is discharged. The slide valve is reciprocated back and forth in the controller chamber by means of a rod 66 which may be actuated by a crank, a cam, or any suitable continuously operating mechanism (not shown) which runs at a predetermined speed.

A plurality of series of ports are arranged in the lower part of the controller chamber so as to be controlled by the slide valve. These ports are arranged in pairs, and each port of each pair is adapted to be alternately in communication with the live steam chamber and the exhaust chamber of the controller. These ports are indicated on the drawings by reference characters 67, 68, 69, 71, 72, 73, 74 and 75, respectively. One port of each pair is connected by a pipe to one end of one of the operating cylinders hereinbefore described, and the other port is connected with the opposite end of such cylinder.

Assuming now that the parts assume the position shown in Fig. 3, it will be observed that port 68 is partially opened to the steam supply chamber between the piston heads 62 and 63 so that steam under pressure supplied by pipe 64 will be conducted by the pipe 40 to the outer end of cylinder 52 where, acting upon the piston 41, it will move the die 27 into closed position. Any steam in front of the piston will be discharged through the pipe 44 and the port 67 into the exhaust chamber of the controller, and eventually out through the exhaust pipe 65. As the slide valve continues to move toward the right, viewing Fig. 3, the port 68 will remain uncovered so that the steam pressure will continue to be exerted through the pipe 40 upon the outer face of the piston 41, thereby holding the die in closed position against the pressure of the molten metal which will be forced into the mold before the machine completes its cycle. As the slide valve continues to move toward the right the port 71 will be uncovered so that steam under pressure will be admitted from the steam chest through the pipe 49 to the outer ends of cylinders 46 and 48, thus forcing the pistons 45 and 47 inwardly to position the core members within the mold. If, as has been previously mentioned, the character of the core members is such that they cannot be simultaneously moved, the operating cylinders therefor would necessarily be connected with the controller independently of each other, and so arranged that the pistons would be actuated in the desired sequential relation. Obviously, also, more cylinders to operate additional core members would require corresponding additional ports in the controller and connecting pipes to the cylinders. In the present machine, however, which has been shown for purposes of illustration merely, the core members are so constructed that they may be simultaneously projected into the mold and consequently the cylinders 46 and 48 may be supplied with steam through a common supply pipe 49 as explained. Simultaneously with the establishment of communication between the steam chest and the port 71, communication will also be established between the exhaust chamber and the port 69 so that any steam in front of the pistons 45 and 47 will be ex-

hausted through the pipe 51, the port 69, exhaust chamber of the controller, and finally through the exhaust pipe 65. The core members having been positioned, as explained, they will be retained in this position by the steam pressure exerted upon the outer faces of the pistons 45 and 47 so long as the port 71 is in communication with the steam chest or chamber between the slide valve heads 62 and 63.

Further movement of the slide valve to the right will admit steam through the port 73, from whence it will be conducted by the pipe 54 to the outer end of the cylinder 53 where acting upon the piston 52 it will move the metal pot into coöperative relation with the dies. Exhaust from in front of the piston 52 will be in the meantime be discharged through the pipe 55 and the port 72 into the exhaust chamber of the controller.

Final movement of the slide valve to the right will admit steam through the port 75 from whence it will be conducted by the pipe 58 to the outer end of the cylinder 57 where, acting upon the piston 56, it will operate the various mechanisms which control the metal flow and the pressure for discharging the molten metal into the mold. The exhaust from in front of the piston 56 will be returned through the pipe 59 and port 74 to the exhaust chamber of the controller.

At this point in its travel the controller will have caused all of the pistons to be moved inwardly so as to operate the various elements of the machine to which they are connected. Thereupon the slide valve will proceed to travel in the opposite direction to reverse the cycle of operation. As the slide valve travels now toward the left, it will first momentarily close both ports 74 and 75, and then just after it passes the central position shown in Fig. 3 it will open port 74 to the steam supply chamber of the controller and the port 75 to the exhaust chamber at the opposite end of the controller. The piston 56 will thereupon be moved in the reverse direction, the steam behind it being exhausted through the pipe 58 and port 75 to reverse the metal and pressure controlling apparatus. Further movement of the slide valve to the left will admit steam through the port 72 and permit steam to be exhausted from the cylinder through port 73 to thereby retract the metal pot from its operative position. Further movement of the slide valve will cause the pistons 45 and 47 to be moved outwardly so as to withdraw the core members from the mold, and finally port 67 becomes an admission port and port 68 an exhaust port which causes outward movement of the piston 41 to retract the movable die member 27 and permit the completed casting to drop out of the mold. It should be noted at this point that pressure was maintained against the outer face of the piston 41 through the port 68 until all of the operations except the withdrawal of the movable die member had been completed. Thus all liability of premature and accidental separation of the die members was obviated.

The mechanism by which the molten metal and the fluid pressure for delivering it into the mold are controlled will now be explained, and in this connection attention is directed particularly to Figs. 5 and 6 wherein this apparatus is best shown. In the bottom of the melting pot 33 there is provided a port communicating with the channel 34 and normally closed by a valve 76 which is held in seated position by an expansion spring 77 surrounding the upwardly projecting stem 78 of the valve. A slide rod 79 is connected with the piston 56 and is guided at its inner end by a guide 81 which maintains the rod in alinement above the upper chamfered end of the valve stem. A pivoted cam 82 is carried by the slide rod 79 in such position that upon initial inward movement of the piston 56 this cam engaging the chamfered end of the valve stem will force the valve 76 downwardly away from its seat permitting a predetermined quantity of molten metal to flow from the pot into the channel 34. After the cam passes beyond the valve stem the valve is returned against its seat by the spring 77, and upon reverse movement of the slide bar 79 the cam 82 will turn on its pivot against the action of a light spring 83 so that the cam will ride idly over the valve stem. Consequently but one opening of the valve 76 is effected at each complete reciprocation of the piston 56.

The upper end of the channel 34 opposite to the discharge nozzle 30 is connected with a steam pipe 84 communicating with a steam reservoir 85 in which a quantity of steam is contained under pressure. This steam reservoir is preferably equipped for safety purposes with a blow-off valve 86 set to blow off at a predetermined desired maximum pressure and a steam gage 87 from which the pressure in the reservoir may be observed. The pipe 84 is equipped with a three-way valve 88 provided with an arm 89 which is connected with the slide rod 79. This connection between the arm and the slide rod is preferably an adjustable lost motion connection so timed that immediately after a charge of molten metal has been delivered from the pot into the channel 34 and the valve 76 is again seated, the valve 88 will establish direct communication through the pipe 84 between the steam reservoir and the channel 34 so that a quantity of steam under considerable pressure, three hundred pounds being the average pressure required, will be delivered to the channel back of

the charge of molten metal to forcibly deliver this metal into the die mold 28. Upon return movement of the slide rod 79 the valve 88 will be actuated to shut off communication to the reservoir 85 and open the channel 34 to the atmosphere, permitting the steam in this channel to escape.

The supply of steam in the reservoir 85 is established and maintained by the same burners which heat the metal melting pot, and for accomplishment of this purpose I have made provision for intermittently converting a predetermined quantity of water into steam, this quantity being just sufficient to maintain the requisite steam pressure. In the heating chamber beneath the melting pot I have therefore arranged a coil or boiler tube 91 one end of which is connected to the bottom of the reservoir 85, as indicated at 92, while the other end is connected to a regulating chamber 93. This regulating chamber, or "regulator" as it is commercially called, consists merely of a chamber in which is disposed an adjustable piston the position of which longitudinally of the chamber may be regulated and adjusted by a hand-wheel 94 so that by manipulation of this hand-wheel the capacity of the chamber may be increased or diminished as desired. This chamber receives a quantity of water from a city supply or other source, the quantity being determined by the adjusted capacity of the chamber, and this quantity is delivered at each actuation of the machine to the generating coils 91 where it becomes converted into steam to replace in the reservoir that steam which was utilized in forcing a charge of molten metal into the mold as previously explained.

In the pipe connecting the coil 91 with the regulator 93 is interposed a shut-off valve 95 which is equipped with an arm 96 connected with the slide rod 79, and likewise above the regulator in the water supply pipe 97 which is connected with any suitable source of water supply there is interposed a shut-off valve 98 also equipped with an arm 99 attached to the slide rod 79.

When the piston 56 is in its outermost position, as shown in Fig. 5, the valve 95 is closed and valve 98 is opened so that the regulator chamber is filled with water. Movement of the slide rod to the left, viewing Fig. 5, first closes valve 98, thus shutting off the water supply, and opens valve 95, permitting the measured quantity of water contained in the regulator 93 to flow by gravity into the steam generating coils 91 where it is converted into steam under pressure which is delivered to the reservoir 85 and restores the pressure lost in the operation of delivering the charge of molten metal into the mold. Upon reverse movement of the slide rod 79, valve 95 is first closed, and then valve 98 is opened, permitting the regulator to again be filled with a measured quantity of water. At each actuation of the slide rod by the piston 56 the valves 76, 88, 95 and 98 are successively actuated in timed relation so as to deliver the molten metal from the melting pot into the channel, force this metal under pressure into the mold, admit a regulated quantity of water to the steam generating coils to replace the steam employed for delivering the metal and refill the regulator with water for the next operation.

It will be manifest, therefore, that I have made provision for producing and maintaining a fluid pressure adapted to forcibly deliver the molten metal to the mold, within the machine itself, thus obviating the necessity for external boilers or expensive air-compressing apparatus which has heretofore been considered necessary as a source of pressure supply for forcing the molten metal into the mold under the requisite pressure.

In lieu of the reciprocatory slide valve type of controller heretofore explained, I may, if preferred, utilize a rotary type of controller one preferred form of which is illustrated in Figs. 7 to 18, inclusive, and as this type of controller is fully understood it will be obvious that it may be substituted for the reciprocatory slide valve type, as shown in Fig. 1 of the drawings, by simply connecting up the various pipes to the proper ports of the controller. In this rotary type of controller a cylindrical casing 101 is employed within which there is rotatably mounted in suitable bearings a rotary element designated generally by reference character 102. The operating shaft 103 by which this element is rotated may be driven at the desired speed by any suitable mechanism (not shown) in the same manner that the slide valve type of controller is actuated at the required speed.

The casing 101 is provided along one side with a series of alined ports with which the various pipes leading to the operating cylinders of the machine previously described are connected, and for convenience I have numbered these pipes the same as the pipes shown on Fig. 1, it being understood that the pipes lead to the cylinders the same as are illustrated on that figure.

An internal circumference groove 103 is provided in the casing 101 intermediate its ends, and in order to afford sufficient capacity this groove is continued around the thinner portions of the casing walls in an annular rib 104. Steam under pressure is continuously supplied to this groove 103 by a steam supply pipe 105. Each end of the casing forms a discharge or exhaust chamber from which the exhaust steam is delivered through the exhaust pipes 106 and 107.

The rotating element 102 consists of a series of cylindrically-shaped sections, des-

ignated by 110 to 118, respectively, and these sections each of which is hollow are preferably cast integrally, an expansion piston ring 119 being interposed between adjacent sections at the peripheries to prevent leakage around the various sections.

Referring now to Figs. 9 and 14, it will be observed that central section 114 is provided with a plurality of radially extending passages or channels 121 each of which is in continuous communication at its outer end with the surrounding groove 103 and at its inner end with a bore or channel 122 extending longitudinally of the rotatable element 102, and it might be stated at this point that this central bore or channel extends from end to end of the rotatable element establishing communication and supplying steam to all sections.

Considering now section 110 of the rotatable element, a transverse view of which is shown in Fig. 10, it will be recalled that steam should be supplied through the pipe 40 during a considerable period of time, while steam to return the piston 41 should be supplied to the pipe 44 throughout a relatively short period only. Each section of the rotatable element is divided by radial partition walls into a steam supply chamber 123 communicating with the longitudinal bore 122 and an exhaust chamber 124, all of the exhaust chambers on one side of the central section 114 being in communication with each other and with the exhaust pipe 107, while the sections on the other side of the central section are in communication with each other and with the exhaust pipe 106. Steam being supplied to chamber 123 of section 110 will be delivered to the pipe 40 as the controller element is rotated, through a series of peripheral ports 125 as these ports are brought successively into registration with the casing port establishing communication with the pipe 40. At the same time the exhaust chamber 124 of section 111 will be in communication with the pipe 44 so that any steam ahead of the piston 41 may be delivered to the discharge or exhaust pipe 107. When in the operation of the machine the time has been reached where it is desirable to relieve the pressure upon the outer face of the piston 41 and to reverse the movement of this piston, the steam supply chamber 123 of the section 111 will be brought into communication with the pipe 44, while simultaneously the exhaust chamber 124 of the section 110 will be brought into registration with the pipe 40. The rapidity of movement of the piston in both directions will, of course, be determined by the size of the ports 125 which both supply the live steam and control the discharge of the exhaust steam, and by making these ports of the requisite size and spacing them the requisite distance apart a back pressure may be maintained if desired in the cylinder to cushion the piston at the extremes of its movement.

The core operating cylinders receive their steam supply for positioning the cores through the supply chamber 123 of section 112, and exhaust chamber 124 of section 113 simultaneously receives the exhaust from ahead of the core-positioning pistons through the pipe 51. Reverse movement of the core-positioning pistons is effected by supplying steam to the pipe 51 from the supply chamber 123 of section 113, while the exhaust from the outer end of the cylinders is received by the exhaust chamber 124 of section 112 and delivered to the exhaust pipe 107.

The cylinder 53 receives its supply of steam for moving the metal pot into operative position through the pipe 54 from the supply chamber 123 of section 115, the exhaust from this cylinder during this operation being delivered by pipe 55 to chamber 124 of section 116, and thence to the exhaust pipe 106. To effect retractive movement of the metal pot, steam is supplied to the pipe 53 from the supply chamber 123 of section 116, the exhaust during this movement being delivered through pipe 54 to exhaust chamber 124 of section 115, and thence to the exhaust pipe 106.

Similarly inward movement of piston 56 is effected by steam supplied to pipe 58 from the supply chamber 123 of section 117, the exhaust being delivered through pipe 59 to exhaust chamber 124 of section 118. Reverse movement of this piston is effected by delivery of steam to pipe 59 from supply chamber 123 of section 118, the exhaust during this movement being delivered by pipe 58 to the exhaust chamber 124 of section 117 and thence to the exhaust pipe 106.

It will be manifest from the foregoing that at each revolution of the controlling element 102 steam is supplied to the various cylinders in proper timed relation so as to effect requisite movements, and upon each complete revolution of the controlling element the machine automatically performs a complete cycle of operations. Manifestly the timing of the various operations and movements is controlled by the arrangement of the supply and exhaust chambers and the position and number of the ports in each of the sections of the rotatable element, and by the design of this element any desired sequence of movements may be secured. The apparatus insures accuracy of operation in the machine since all of the operations are automatically controlled by mechanism which requires neither manual manipulation nor adjustment after it has once been properly set, and with this apparatus not only are dangers of breakage incident to inaccurate timing in the relative movements of the various parts obviated, but the machine is

enabled to operate at extremely high speeds which are only limited by the time required for cooling of the castings which are produced.

It is believed that my invention and many of its inherent advantages will be understood from the foregoing without further description, and it should be obvious that the invention is not circumscribed by the details of construction shown and described for purposes of illustration merely, but is capable of considerable modification and variation in structural details without departing from the essence of the invention as set forth in the following claims.

I claim:

1. In a die casting machine, the combination of a separable die, a core therefor, a movable metal pot, means for delivering metal under pressure from said pot into said die, hydraulic means for automatically actuating said die, core, pot and metal-delivery means and a controller for causing said hydraulic means to actuate said elements in predetermined sequence.

2. In a die casting machine, the combination of a separable die, a core therefor, a movable metal pot, means for delivering metal under pressure from said pot into said die, fluid pressure-operated means for actuating each of said die, core, pot and metal-delivery means, and a single means for automatically controlling said pressure-actuated means whereby they are caused to operate in predetermined timed relation.

3. In a die casting machine, the combination of a die, a core, a metal pot, metal-delivery means, fluid pressure actuated means for operating said various elements, and a controller for automatically causing said pressure actuated means to operate in predetermined timed relation.

4. In a die casting machine, the combination of a separable die, a core therefor, a movable metal pot, fluid pressure actuated means for closing said die and holding the same in closed position under pressure, fluid actuated means for positioning said core within the die and removing the same therefrom, fluid actuated means for moving said metal pot and holding the same in movable position, and a controlling device for automatically controlling the actuation of said means whereby said means are caused to operate in pre-determined timed relation.

5. In a die casting machine, the combination of a plurality of movable elements, pressure actuated pistons for operating said elements, and an automatic controlling device for causing said pistons to operate in predetermined timed relation.

6. In a die casting machine, the combination of a plurality of movable elements, pistons for actuating said elements, means for supplying pressure to said pistons, and automatic means for controlling and timing the delivery of pressure to said pistons whereby the pistons are caused to operate in predetermined timed relation.

7. In a die casting machine, the combination of a plurality of movable elements, individual pistons for actuating said elements, means for supplying pressure to operate said pistons and an automatic controlling device adapted to automatically admit and shut off the pressure to each of said pistons, whereby said elements are caused to be operated in predetermined timed relation.

8. In a die casting machine the combination of a separable die, a core therefor, means for delivering metal under pressure to said die, pressure actuated means for moving said die and said core, means for automatically moving said die into closed position and holding the same in closed position under pressure and opening said die in predetermined relation to the movements of the core and the metal-delivery means.

9. In a die casting machine, the combination of a separable die, a core, metal-delivery means, fluid pressure actuated devices for operating said die, core and metal-delivery means, and controlling means for automatically causing said die to be closed and held in closed position under pressure during the movements of the core and the metal-delivery means and for subsequently opening said die.

10. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, a fluid pressure supply, fluid pressure actuated means for admitting metal from the pot to said channel and means for delivering fluid under pressure directly into said channel to discharge the metal therefrom in predetermined timed relation to the admission of the metal thereto.

11. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, a steam supply chamber, means for admitting metal from said pot and steam under pressure from said chamber to said channel in timed relation, and means for intermittently recharging the chamber with steam under pressure.

12. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, a steam supply reservoir, means for automatically admitting metal from the pot to said channel and admitting steam under pressure from said reservoir to said channel to discharge the metal and for recharging said reservoir with steam under pressure, all in predetermined timed relation.

13. In a die casting machine, the combination of a metal delivery channel, a steam supply reservoir, a steam generating coil,

means for admitting steam from said reservoir to said channel to discharge the metal therefrom, and means for admitting a predetermined quantity of water to said generating coil wherein said water is converted into steam to renew the supply in said reservoir.

14. In a die casting machine, the combination of a metal delivery channel, a steam supply reservoir, a steam generating coil connected with said reservoir, means for alternately delivering steam from said reservoir to said channel and permitting the steam to exhaust to atmosphere from the channel, and means for intermittently delivering a predetermined quantity of water to said generating coil wherein said water is converted into steam to recharge the reservoir.

15. In a die casting machine, the combination of a metal delivery channel, a steam generator, means for intermittently delivering steam produced by said generator to said channel to discharge the metal therefrom under pressure, and means for intermittently delivering to said generator a predetermined quantity of water for replacing the steam delivered to said channel.

16. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, a steam supply chamber, and means for admitting metal from said pot and steam under pressure from said chamber to said channel in timed relation, whereby said metal is delivered by pressure of said steam from the channel.

17. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, a steam reservoir, means for intermittently admitting steam from said reservoir to said channel, a steam generator connected with said reservoir, and means for admitting a pre-determined quantity of water to said generator after each withdrawal of steam from said reservoir, whereby the steam supply in said reservoir is replaced from said generator.

18. In a die casting machine, the combination of a metal melting pot, a delivery channel therefor, means for admitting metal from said pot to said channel, a steam reservoir, means for admitting steam to said channel after each admission of metal thereto to discharge the metal therefrom, a generating coil connected with said reservoir, and means for admitting a pre-determined quantity of water to said coil to replace the steam in said reservoir.

ALFRED H. WIEDHOFFT.