Feb. 5, 1935. W. M. LESTER 1,989,812

APPARATUS FOR DIE CASTING

Filed Feb. 5, 1932 4 Sheets-Sheet 1

Fig. 1

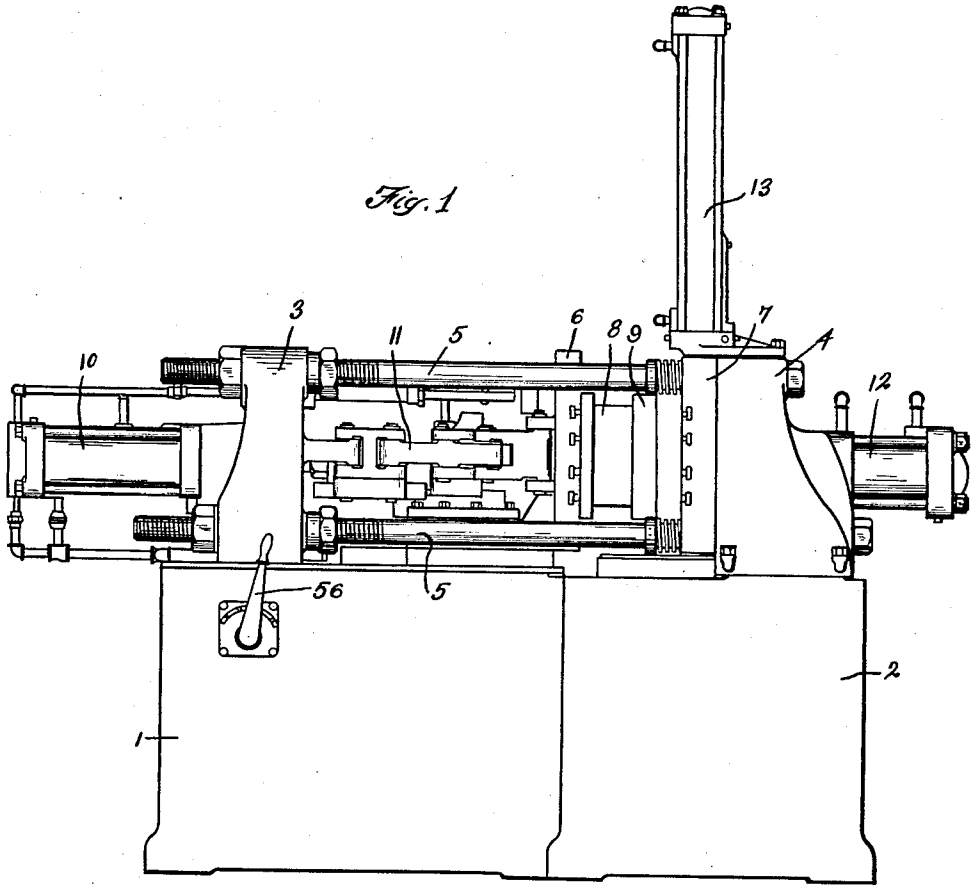


Fig. 10

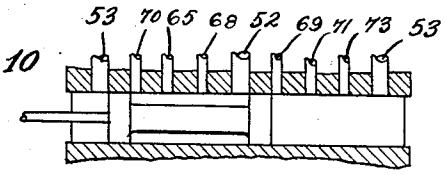


Fig. 11

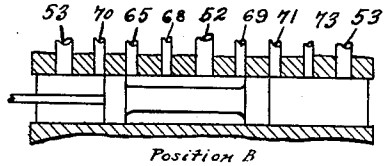
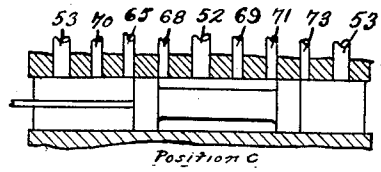


Fig. 12



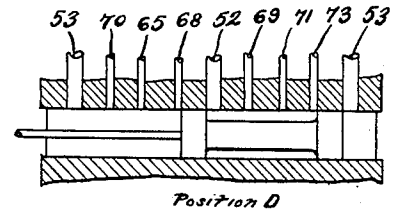


Fig. 13

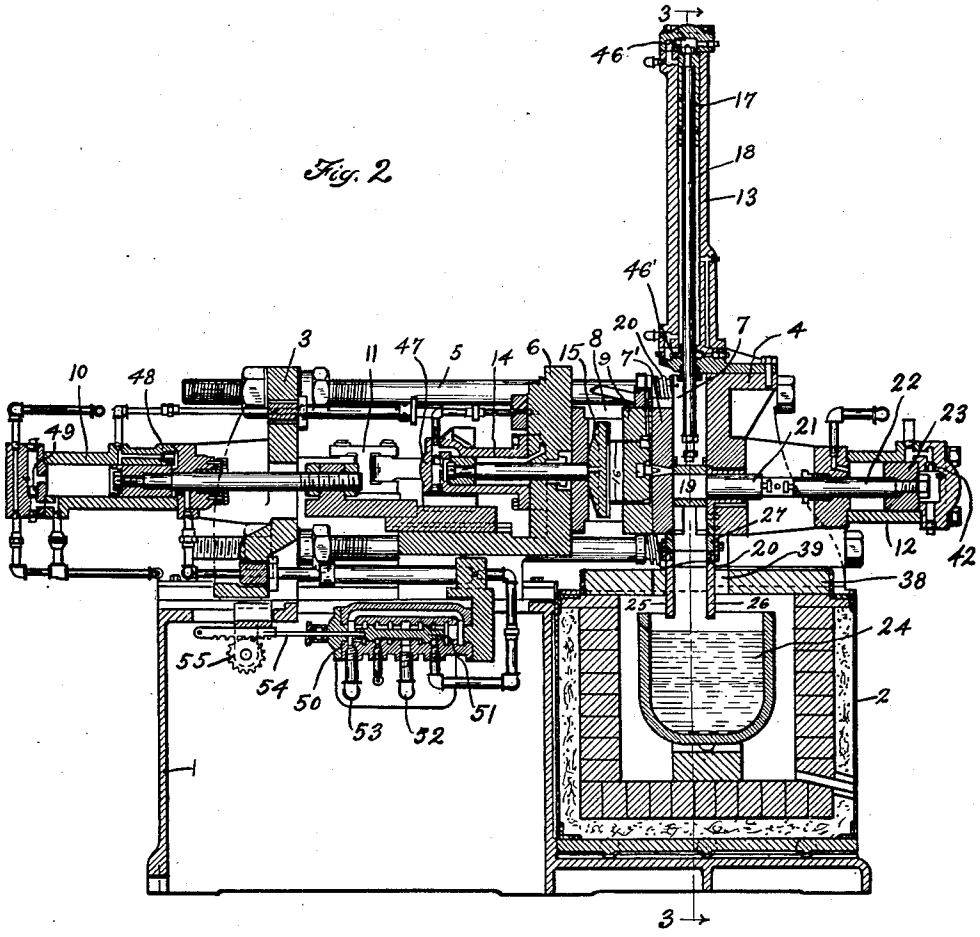
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Fig. 2



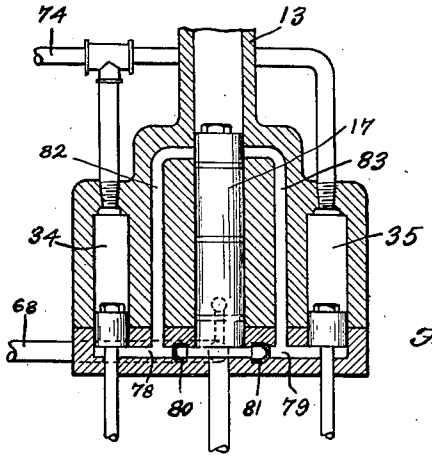


Fig. 5

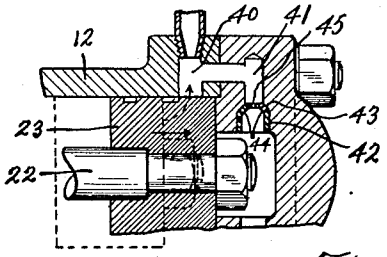


Fig. 4

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APPARATUS FOR DIE CASTING

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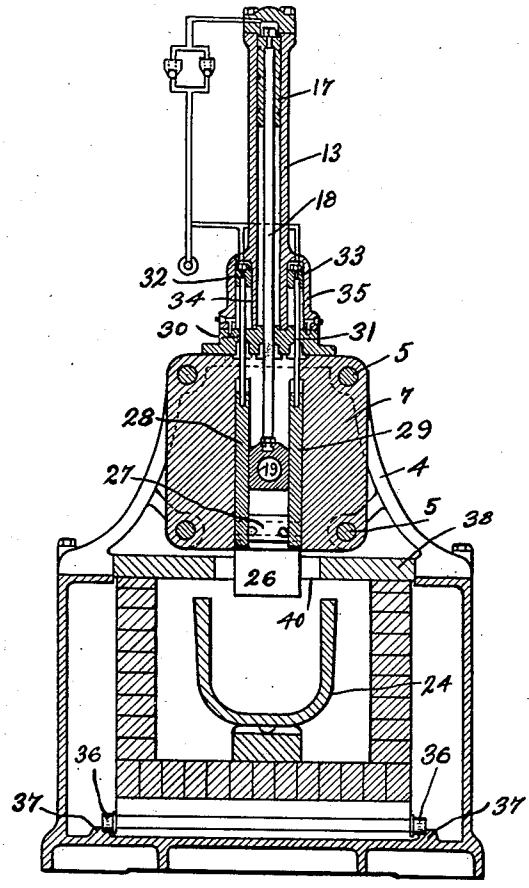


Fig. 3

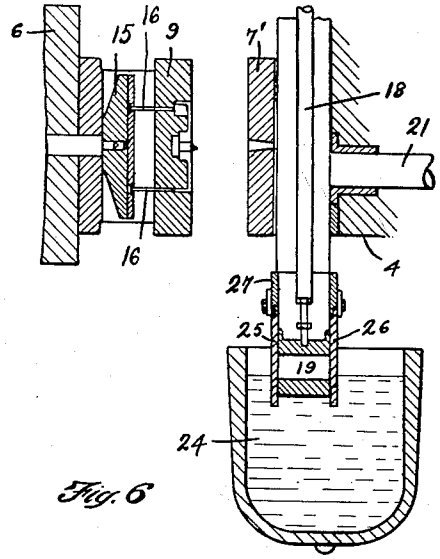


Fig. 6

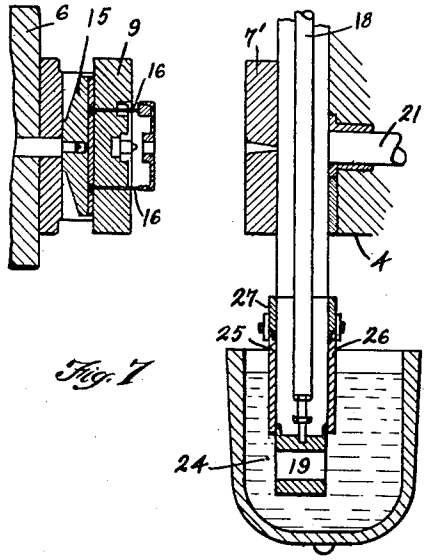


Fig. 7

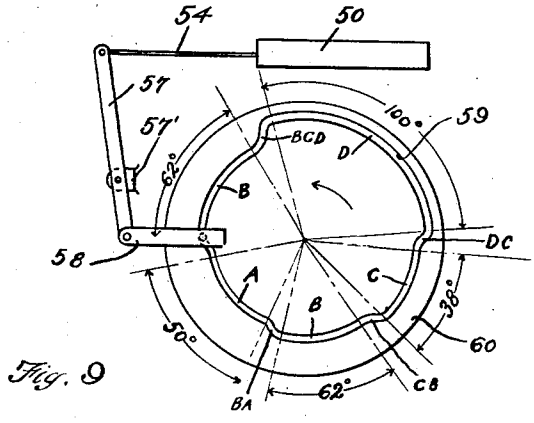


Fig. 9

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APPARATUS FOR DIE CASTING

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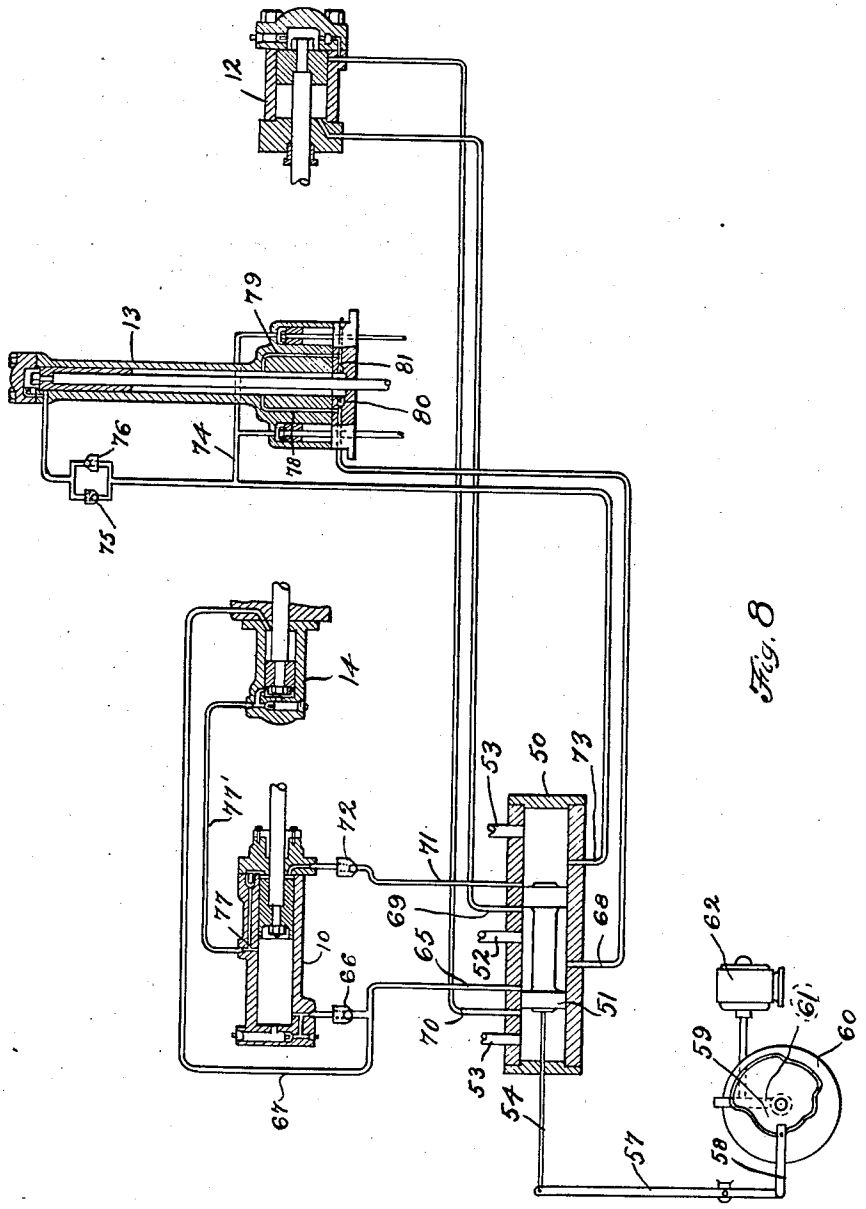


Fig. 8

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UNITED STATES PATENT OFFICE

1,989,812

APPARATUS FOR DIE CASTING

William M. Lester, Shaker Heights, Ohio

Application February 5, 1932, Serial No. 591,184

3 Claims. (Cl. 22—68)

My prevent invention relates to the art of die casting or to the manufacture of finished metal castings by forcing molten or plastic metal under pressure into a metallic mold. The subject matter of the present invention is related to and includes certain novel improvements over my copending application Serial No. 561,676, filed September 8, 1931.

The hereindescribed die casting method and machine are particularly applicable to the commercial production of die castings of the higher melting point alloys such as copper, brass and bronze allloys. More precisely my invention has for its object the provision of an automatic mode of operation capable of producing completed castings in quantity production at the rate of about two hundred and fifty (250) pieces per hour. Further objects include the provision of automatic single control means, a co-related hydraulic actuating system, and independently movable closure slides for cooperating with the metal extracting reservoir. Additional objects shall become apparent as the following description proceeds. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawings:

Fig. 1 is a side elevation of the exterior of a die casting machine constructed according to the principles of my invention; Fig. 2 is a vertical sectional view of Fig. 1; Fig. 3 is a transverse vertical section taken substantially upon line 3—3 of Fig. 2 in the direction of the arrows; Fig. 4 is an enlarged sectional detail of a portion of one of the hydraulic actuating cylinders; Fig. 5 is an enlarged sectional detail view of the construction of the metal lift and slide cylinders, with the major elements resolved into a single plane for the purpose of convenience of description; Figs. 6 and 7 are enlarged detail views of the metal lift and slides in varying positions in relation to the melting pot; Fig. 8 is a diagrammatic illustration of the automatic hydraulic actuating system; Fig. 9 is a diagram illustrative of the sequence of operations of the automatic hydraulic actuating system; Figs. 10 to 13 inclusive are diagrams showing the various positions of the master control valve during one complete cycle of operation.

Now directing attention more particularly to Figs. 1, 2, and 3, my die casting machine consists of the main base casting 1 and melting pot housing 2, above which is mounted the fixed frame composed of the vertical end members 3 and 4 which are rigidly secured to each other by means of the horizontal rods 5. The vertical end member 3 may be variably spaced from the end member 4 by means of varying the position of the fastening nuts on the cross rods 5. A pair of die plates 6 and 7 are mounted upon the cross rods 5. Die plate 6 is adapted to carry the movable die bolster 8 and the die mold 9. The die plate 7 carries the die mold 7' and is relatively fixed, while the die plate 6 is horizontally movable by means of the hydraulic cylinder 10 and toggle link mechanism 11. Additional hydraulic operating cylinders are assembled on the frame and consist of the plunger cylinder 12, the metal lift cylinder 13, and the ejector cylinder 14. The ejector cylinder 14 is carried by the movable die plate 6 and is adapted to reciprocate the plate 15 to which are secured ejector pins 16 extending through the die 9. The vertical metal lift cylinder 13 carries the piston 17 which is connected by means of the rod 18 to the metal lift reservoir 19. The die plate 7 is engaged by the compression coil springs 20 upon the rods 5, whereby it is forced against the frame end 4. When the dies are in locked position as shown in Fig. 2, however, by virtue of the pressure exerted by the toggle link mechanism 11, the die plate 7 is forced against the reservoir 19, tending to maintain the latter in locked registered position with the plunger 21. The plunger 21 is adapted to pass into and through the interior of the metal reservoir 19, and is reciprocably operated by means of the piston rod 22 and piston 23 in the hydraulic cylinder 12.

A melting pot 24 is disposed below and in the vertical line of travel of the reservoir 19. An appropriate type of furnace construction, adapted to utilize a gas, electric, or solid fuel heating means, surrounds the melting pot 24 and is enclosed within the housing 2. A pair of vertically reciprocable closure plates extend from the bottom of the end plate 4 and the die plate 7 to a point slightly above the liquid level in the melting pot 24. Directing attention to Fig. 3, the closure plates or slides 25 and 26 are secured to the cross head member 27 by means of suitable bolts and clamping plates. A pair of vertically extending arms 28 and 29 connect the cross head 27 to the piston rods 30 and 31. The piston rods 30 and 31 in turn carry the pistons 32 and 33 in the vertical cylinders 34 and 35, which are positioned on opposite sides of the lift cylinder 13. The last described mechanism is adapted to impart a vertical reciprocal movement to the closure plates 25 and 26, which movement is of sufficient length to immerse the lower ends of the plates 25 and 26 slightly below the liquid level of the metal in the melting pot 24 substantially as shown in Fig. 7.

The melting pot furnace may be mounted upon

a set of rollers 36 riding upon the trackway 37, whereby the entire furnace and melting pot may be removed from the right hand end of the machine assembly for the purpose of cleaning, inspecting and recharging. An insulating cover plate 38 having a central opening 39 for the reception of the closure plates 25 and 26, is positioned over the top of the furnace.

Now directing attention to Figs. 2, 3, 6 and 7, the cycle of operation of the above described parts may be simply outlined as follows. Starting from the position as shown in Fig. 2, the metal reservoir 19 travels downward and is totally immersed beneath the level of the metal in the melting pot 24, as shown in Fig. 7. In the meantime the dies 8 and 9 have been opened and the pressure upon the die plate 7 has been removed and the corresponding binding pressure upon the ends of the reservoir 19 has been likewise removed whereby such reservoir 19 is permitted to proceed upon its downward travel. While the reservoir 19 has reached its lowermost position in the melting pot 24, the closure plates 25 and 26 have also traveled to their lowermost position as shown in Fig. 7. In the next stage of operations, referring to Fig. 6, the reservoir 19 begins its return upward stroke with a charge of metal retained in its interior cavity by virtue of the closing action of the end plates 25 and 26. The plates 25 and 26 accompany the reservoir 19 along that portion of its travel between the melting pot and the bottom of the end plate 4 and die plate 7. When the reservoir 19 has reached its uppermost position, as shown in Fig. 2, the link mechanism locks the dies 8 and 9 and also exerts a locking pressure on the ends of the reservoir 19 between the die plate 7 and the end plate 4. The plunger 21 then passes into the reservoir 19, forcing the metal contained therein into the interior of the die cavity formed by the dies 8 and 9. The plunger 21 is then removed and the parts are now in position to repeat the above outlined cycle of operation.

As has been hereinbefore indicated, means are provided for the actuation of the elements performing the above outlined casting cycle which include the hydraulic actuating cylinders 10, 12, 13 and 14. In order to prevent hammering and knocking actions in these hydraulic cylinders, a by-pass and throttling valve construction is provided whereby a cushioning action is imparted to the final portion of the stroke of the piston in such cylinders. This latter construction is illustrated in greater detail in Fig. 4, which is an enlarged detail section taken from the head end of the plunger cylinder 12.

Referring now to Fig. 4, the hydraulic pressure inlet or outlet passage 40 as the case may be, depending upon which direction the piston is traveling, leads into the side of the cylinder at a point substantially adjacent the end. A second passage 41 leads around to the end of the cylinder. In the passage 41 there is disposed the automatic throttling valve 42 which is adapted to bear against the beveled seat 43 in such passage. A plurality of openings 44 communicate from the portion of the throttle valve 42 bearing against the bevel seat to the interior of the valve. A throttling passage 45 is provided in the central portion of the transverse abutment to the valve 42. The operation of the above described cushioning means and throttling valve is as follows: Assuming the piston to be traveling in the direction of the arrow as indicated in Fig. 4 and at a position substantially as indicated by the dotted lines, the exhaust liquid will be free to pass out directly through the passage 40. However, when the walls of the piston 23 attain such a position as to close the outlet passage 40 in the wall of the cylinder, it will then be necessary for any exhaust liquid to pass through the throttle valve opening 45, thereby offering a substantial resistance to the travel of the piston, and correspondingly imparting a cushioning action to the final portion of the piston stroke. When hydraulic pressure is admitted to the passage 40, liquid will travel through the secondary passage 41 to the throttle valve 42, forcing the latter away from the beveled seat 43, thereby giving access to fluid flow through the inclined openings 44, and substantially relieving the throttling effect of the single opening 45.

Similar throttling valves 46 and 46' are provided in the head and rod ends of the lift cylinder 13 respectively; likewise, throttling valve 47 in the head end of the ejector cylinder 14 and valves 48 and 49 in the rod and head ends of the liquid cylinder 10. Although the length of the secondary by-passes in the cylinders 10, 13 and 14 may be varied in order to obtain increased cushioning action, the construction of the by-passes and throttling valves is substantially equivalent to that illustrated in Fig. 4.

Since it is contemplated to provide a single unitary control means for co-relating the action of the hydraulic cylinder, I have provided a four-way valve 50 having the double piston flange 51, and a plurality of annular passages which are adapted to be placed in communication with each other at various intervals by means of movement of such plunger 51. The main hydraulic pressure supply pipe 52 is connected to the central annular passage and a return fluid pressure pipe is connected to each end of said valve. The pipes 52 and 53 may be connected to any suitable hydraulic pressure pump, which has not been shown nor described herein since such means are well known. Pipe 52 may be termed the high pressure pipe and pipes 53 the low pressure pipes. A valve stem 54 connects to the inner valve plunger 51, and may be connected by means of the gear rack and gear device to the exterior operating hand lever 56; or, as in the case of continuous automatic operation, a lever 57 fulcrumed at the point 57' and connected by means of the link arm 58 to the cam track 59 of the revoluble disc 60 provides a means for automatic mechanical control of the valve action. A suitable worm reduction gear mechanism 61 and electric driving motor 62 will be satisfactory for the purpose of rotating the cam disc 60. It will thus be seen that rotation of the cam disc 60 will impart a reciprocal movement to the valve plunger 51 whereby various predetermined hydraulic pressure connections will be made to the actuating cylinders.

Referring to Figs. 8 to 13 inclusive, the operation of the hydraulic pressure actuating system is as follows: At the beginning of the cycle of operations, the valve plunger 51 is in the position as indicated in Fig. 11 and denominated as position B. Such position B corresponds to the arc B of the cam track 59 as indicated in Fig. 9. The remainder of the valve position shown in Figs. 10, 12 and 13 and therein labeled positions A, C, and D, respectively, likewise correspond to arcs A, C, and D of the cam track 59 as indicated in Fig. 9.

Now directing attention more particularly to Fig. 8, when the valve plunger 51 has assumed position B, the hydraulic pressure supply pipe is placed in communication with pipe 65 leading to the foot valve 66, pipe 67, and the rod end of the ejector cylinder 14. Pressure supply is also in

communication with pipe 68 to the rod end of the lift cylinder 13; and pressure supply also leads through the pipe 69 to the rod end of the plunger cylinder 12. The foot valve 66 is set at a pressure of about two hundred (200) pounds per square inch in order that the ejector cylinder 14 will be closed before pressure is admitted to the head end of the link cylinder 10. It will thus be seen that when the valve plunger 51 is in position B that (1) the plunger 21 is withdrawn, (2) the metal reservoir 19 is raised to its uppermost position, (3) the ejector pins 16 are in closed position, and (4) the link cylinder 10 is closed and locked to the die mechanism.

Since the revolving cam track 59 turns in a counterclockwise direction as indicated by the arrow in Fig. 9, the next position to which the valve plunger 51 moves is position D. In position D the pressure supply pipe 52 is placed in communication with the pipe 69 to the rod end of cylinder 12, with the pipe 73 through the pipe 74 to the head ends of the slide cylinders 34 and 35, to the two-way check valves 75 and 76, and to the head end of the reservoir lift cylinder 13; and also in communication with the pipe 71 through the foot valve 72 to the rod end of the link cylinder 10. It will thus be seen at position D that (1) the pressure is maintained upon the rod end of the plunger cylinder retaining the plunger 21 in withdrawn position, (2) the closure slides 25 and 26 are moved to their lowermost positions, (3) since the check valve 75 is set at about two hundred (200) pounds per square inch pressure will next be admitted to the head end of the lift cylinder 13 tending to force the metal reservoir 19 on its downward stroke, but, inasmuch as the locking pressure is still exerted between die plate 7 and the end plate 4, the metal reservoir 19 will be retained in position until enough pressure is built up against the check valve 72 (which is set at about four hundred (400) pounds per square inch), starting the link cylinder piston on its backward stroke and opening the locked plates 7 and 4; (4) when the link cylinder piston has passed the opening 77 in the wall of the cylinder 10 pressure will be admitted to the head end of the ejector cylinder 14 through the pipe 77' and the ejector pins 16 will be moved to their outward position.

The valve plunger 51 in its next movement assumes position C, as shown in Fig. 12. In position C, hydraulic pressure is admitted through the pipe 52 to pipe 68 to the rod end of the reservoir lift cylinder 13, pressure is admitted to pipe 69 to the rod end of plunger 12, and pressure is admitted to pipe 61 to the rod end of the link cylinder 10. It will thus be seen that in position C (1) the plunger 21 is maintained in withdrawn position, (2) the link mechanism and dies are maintained in open position, (3) the ejector pins remain in outward position and, (4) the metal reservoir 19 ascends to its uppermost position in conjunction with the upward movement of the closure slides 25 and 26. The last mentioned contemporaneous movement of the slides 25 and 26 is accomplished automatically by means of the construction indicated in Fig. 5, in which the slide cylinders 34 and 35 together with their connecting passages to the metal lift cylinder 13 have been resolved into a common plane for the purpose of convenience in description. In Fig. 5 it will be seen that pipe 68 communicates with the rod end of the lift cylinder 13 and also with the passages 78 and 79 which, in turn, lead to the rod ends of the slide cylinders 34 and 35, respectively. A pair of check valves 80 and 81 are placed in the passages 78 and 79 so that when pressure is admitted through the pipe 68, it will not be possible for any fluid flow into the cylinders 34 and 35 until the lower end of the piston 17 has passed the openings in the wall of the cylinder 13. When the piston 17 has reached such position, viz., after the metal reservoir 19 has proceeded partially upon its upward stroke, fluid pressure will then be conducted by means of the passages 82 and 83 to the rod ends of slide cylinders 34 and 35, so that the closure slides 25 and 26 will accompany the metal reservoir 19 in its passage between the liquid level of the melting pot and the bottom of the plates 7 and 4.

Again referring to Fig. 5, the purpose of the check valves 80 and 81 is to prevent immediate fluid passage to the rod ends of cylinders 34 and 35, but to permit a return passage in the opposite direction when the slides 25 and 26 are on their downward stroke.

In the chronological sequence of operations, the valve plunger 51 next moves from position C to position B, the function of which has already been described.

The last stage of the cycle of hydraulic control involves the movement of the valve plunger 51 from position B to position A. In position A, hydraulic pressure is maintained upon the pipes 68 and 65 and initially supplied through the pipe 70 to the head end of the plunger cylinder 12. The effect of such valve movement to position A is to (1) maintain the dies in locked position, (2) maintain the metal reservoir 19 in slides 25 and 26 in uppermost position and, (3) to force the plunger 21 into and through the metal reservoir 19, thus completing the cycle of operations.

It should be noted that in each of the above described valve positions that those pressure lead pipes which are not placed in communication with the hydraulic pressure supply pipe 52, are in communication with the return pipes 53 so that the fluid may be properly exhausted from each operating cylinder.

It will thus be seen that the above described automatic control means consisting of the rotary cam track 59 and the four-way valve 50 operates to effect a predetermined and co-related movement of the hydraulic actuating system. Inasmuch as the above described machine is contemplated to be operated at a rate capable of producing two hundred and fifty (250) castings an hour, the following table is included for the purpose of illustrating the relative time intervals consumed by each of the valve positions:

	Arc	Time
	°	*Sec.*
Valve Position A—Plunger shoots metal	50	2
B—Plunger withdrawn, casting solidifies	62	2.5
D—Die opens, metal reservoir descends	100	4
C—Metal reservoir ascends	38	1.5
B—Die closes	62	2.5
Total	312	12.3
Valve movements	48	1.9
Total	360	14.4

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided

those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a die casting machine, the combination of a pressure plunger, openable die blocks positioned in spaced relationship in respect to said plunger, a sprue opening in one of said blocks, a melting pot located adjacent said plunger and said die blocks, a container for fluid metal movable from said melting pot to a position in registry with and in the space between said plunger and said sprue opening, an opening in said container for the reception of said plunger, an opening in the other end of said container for ejection of metal, and a pair of reciprocable closure plates adapted to cover said last-named openings when said container is withdrawn from said melting pot.

2. In a die casting machine, the combination of a pressure plunger, openable die blocks positioned in spaced relationship in respect to said plunger, a sprue opening in one of said blocks, a melting pot located adjacent said plunger and said die blocks, a container for fluid metal movable from said melting pot to a position in registry with and in the space between said plunger and said sprue opening, an opening in said container for the reception of said plunger, an opening in the other end of said container for ejection of metal, and a pair of reciprocable closure plates adapted to cover said last-named openings when said container is withdrawn from said melting pot, hydraulic pressure means for moving said plunger, said die blocks, said container and said closure plates, and a single control valve for supplying hydraulic pressure to said moving means in a predetermined cycle of operation.

3. In a die casting machine, means for extracting individual charges of metal from a main supply source comprising the combination of a die plate, a second plate spaced from and parallel to said plate, a melting pot, a fluid metal container movable between said plates and into said melting pot, openings in opposite ends of said metal container, movable closure members for said openings when said container is moving between the ends of said plates and said melting pot, means for moving said container and said closure members, automatic means for actuating said closure member moving means after said container moving means has begun its stroke, and a pressure plunger disposed in the face of said second plate and insertable through said metal container.

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