

Sept. 13, 1955

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2,717,433

METAL CASTING MACHINE

Filed July 28, 1949

4 Sheets-Sheet 1

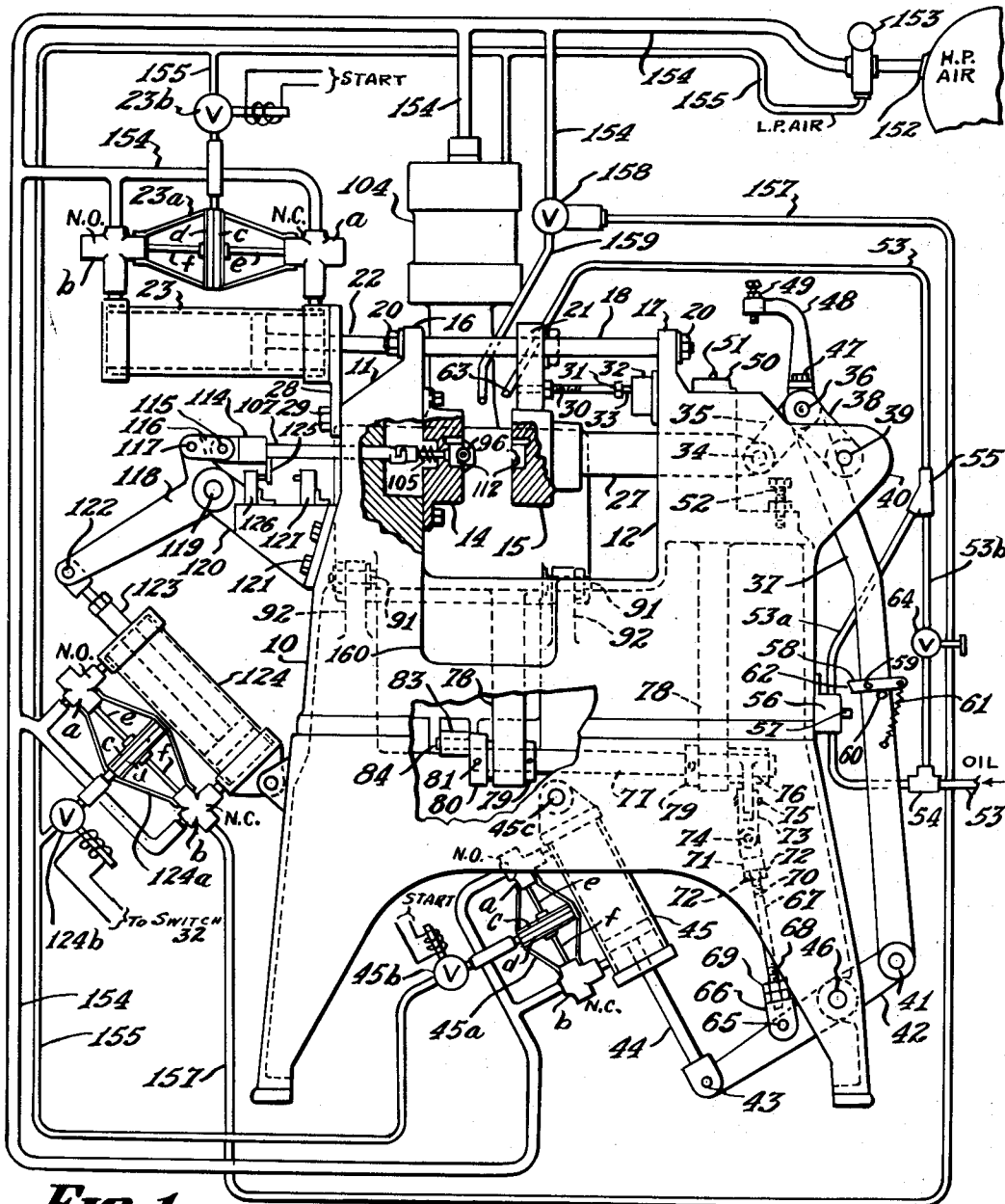


FIG. 1.

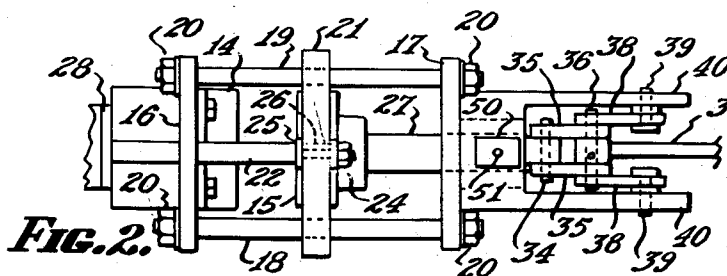


FIG. 2.

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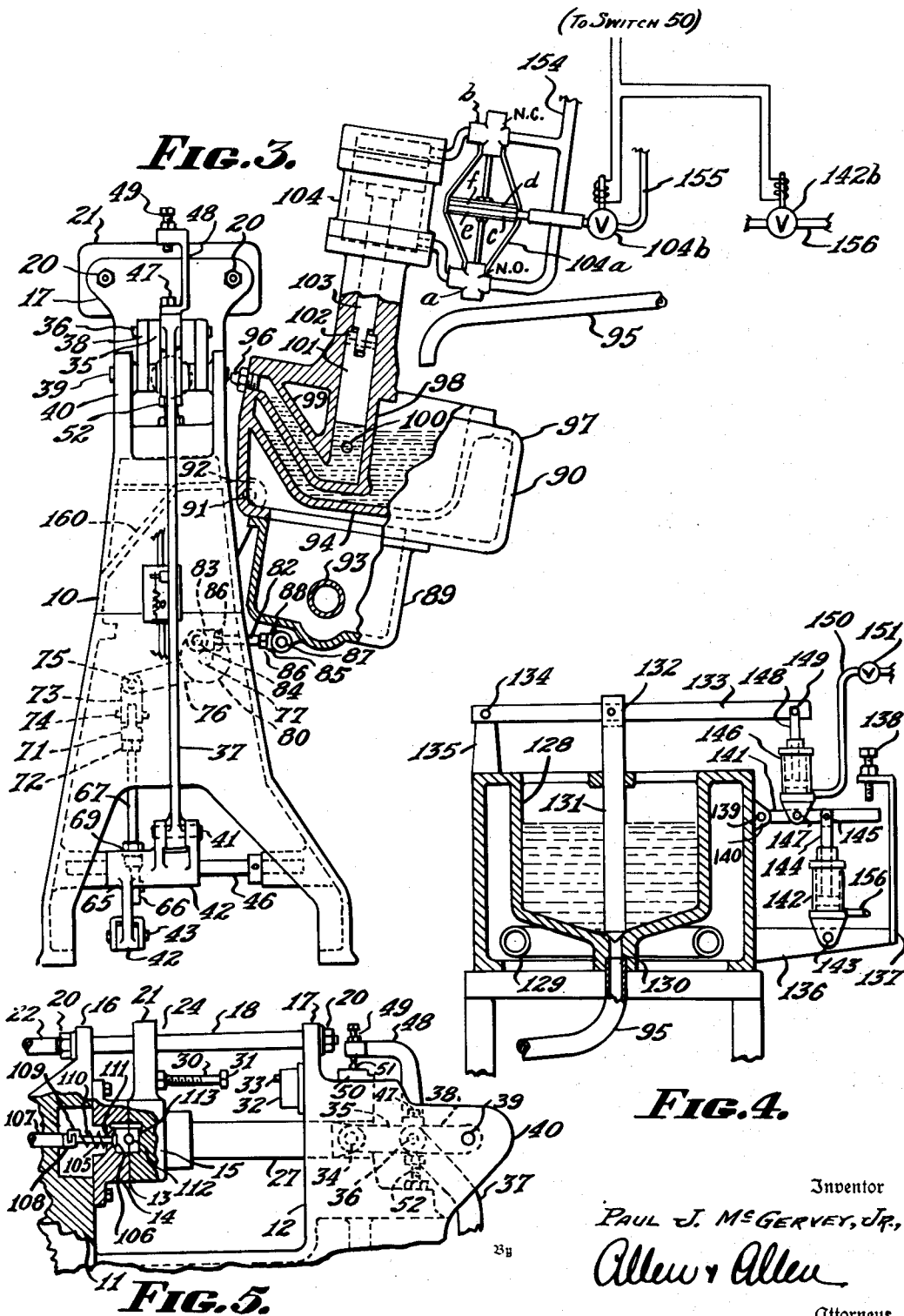
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**2,717,433**

METAL CASTING MACHINE

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4 Sheets-Sheet 2



Sept. 13, 1955

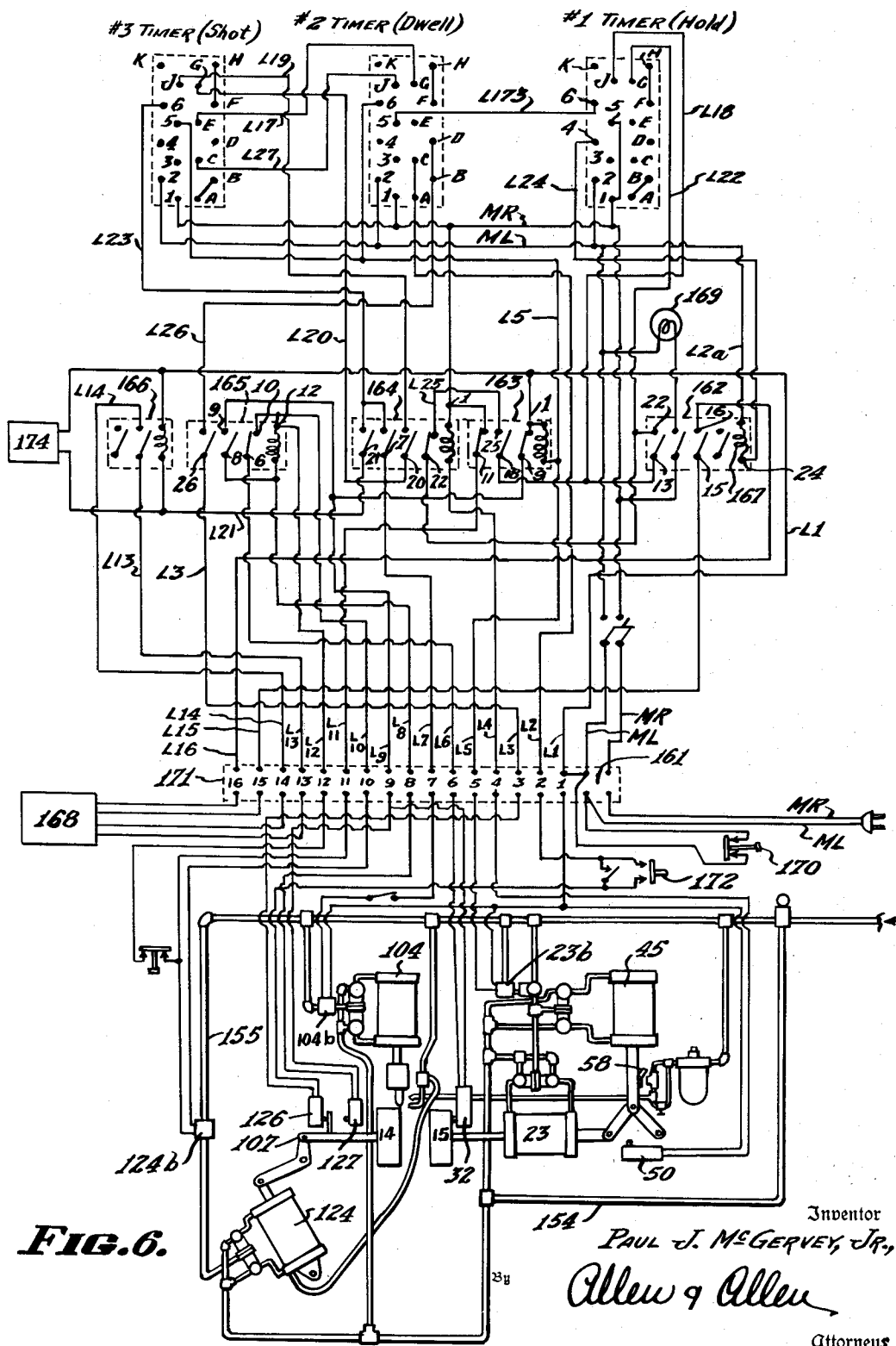
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METAL CASTING MACHINE

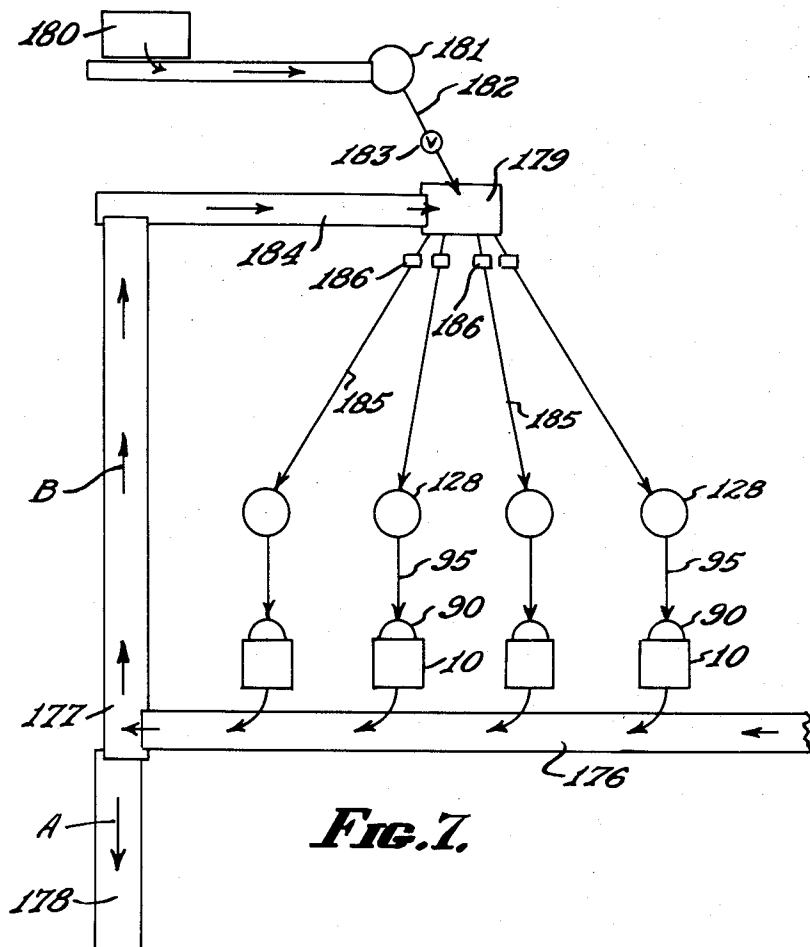
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4 Sheets-Sheet 3



**2,717,433**

4 Sheets-Sheet 4



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1

2,717,433

## METAL CASTING MACHINE

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Application July 28, 1949, Serial No. 107,158

45 Claims. (Cl. 22—70)

This invention relates to a machine for the rapid and uniform pressure casting of metal, and an assembly for the continuous production of such castings, said assembly including a plurality of said machines.

This metal casting machine is unique in that it produces pressure castings at a rate of 800 to 1200 shots per hour—and this with a great saving in labor costs. Prior to the present invention it was considered unusually excellent to get as many as 300 shots per hour. Thus, to the best of my knowledge, the present invention provides a rate of production that is fully four times as great as that previously obtained.

In addition to having obtained a faster rate of production, I have, with this invention, greatly improved the quality of the castings. Furthermore, die wear is negligible. By way of example it should be noted that prior to this invention a die constructed for the casting of eight small lead bushings about  $\frac{1}{2}$ " by  $\frac{3}{4}$ " each, would hold up only for about 750,000 shots, after which time it would have to be completely overhauled. Using essentially the same type die in my new machine and process I have run over five million shots with little visible sign of die wear, every indication being that this die is good for many more shots before needing reconditioning.

Thus, as has been indicated, some of the greatest drawbacks and handicaps of present pressure casting machines known to me and which I have overcome to a large degree are the high labor costs connected therewith, the extreme die wear, the slow rate of production and the uneven and mediocre quality of the castings obtained.

An even greater fault existing in the machines known to me is the poor safety factor, not only as to the operator, but also as to the machine and casting.

Consequently it is an object of my invention to provide a machine for the rapid and uniform pressure casting of metal with greatly increased safety to the operator and machine.

Another object of my invention is to provide a machine which will provide for a much higher production of cast articles with reduced labor requirements.

A further object of my invention is to provide a machine for producing metal castings which will greatly decrease wear and tear on the die member.

A still further object of my invention is to provide a machine for the rapid production of castings of uniformly high quality.

A further and important object of my invention is to provide an assembly for the continuous production of pressure castings, said assembly to include a plurality of my new metal casting machines.

In the accompanying drawings, forming a part of this application, and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a front elevation with parts broken away, certain parts in section, and including a diagrammatic illustration of pneumatic means associated with my machine,

2

Figure 2 is a fragmentary plan view showing the guide means for the movable die part,

Figure 3 is an end elevation taken from the right side of Figure 1 with parts broken away and certain parts in section,

Figure 4 is a conventional sectional view of a source of lead supply for the lead pot illustrated in Figure 3,

Figure 5 is a fragmentary front section showing the die in closed position,

Figure 6 is a diagrammatic sketch of my machine as tied in with the various control circuits there illustrated.

Figure 7 is a diagrammatic view of an assembly for the continuous production of pressure castings, said assembly including a plurality of my new metal casting machines.

In the drawings, wherein for the purpose of illustration is shown an embodiment of my invention, of which I shall first describe a single machine, the numeral 10 indicates the frame of such machine embodying the principles of my invention. The frame 10 is provided with a U-shaped opening in which the die parts are positioned. The portion of the frame forming one side of the U-shaped opening is indicated by the numeral 11, the other side by the numeral 12.

The die is indicated generally at 13 (see Figure 5) and consists of a stationary part 14 and a movable part 15. The stationary half 14 of the die 13 is fixed to the frame member 11.

Ears 16 and 17 are provided on the frame members 11 and 12 respectively. Guide rails 18 and 19 extend between the ears 16 and 17 and are fixed in position by means of nuts 20 threaded on the outer ends of said rails. Fixed to the movable die part 15 is a bracket 21 slidably mounted on the guide rails 18 and 19. The piston rod 22 of the die closing cylinder 23, to be later described in greater detail, is secured to the bracket 21 by the nut 24 and washer 25 (see Figure 2), said rod being turned down as at 26 to thus form a shoulder on the rod 22 and thereby provide a positive attachment of said rod to the bracket 21. The piston rod 22 is arranged for slidable movement in the ear 16.

The movable die part 15 is fixed on a shaft 27 slidably mounted in the frame member 12. A bracket 28 is bolted to the frame member 11 as at 29 to thus support the cylinder 23.

Adjustably mounted in the bracket 21 is a threaded arm 30 carrying a contact button 31. A switch 32 provided with a contact button 33 is fixed to the frame member 12. When the die part 15 is in its full open position the buttons 31 and 33 will be in contact with one another. The relationship of this switch 32 to the operation of my machine will be described later.

Pivoted to the shaft 27 by a pin 34 are the ends of a pair of links 35. The other ends of the links 35 are pivoted at 36 to one end of a lever 37. Also pivoted at 36 are the ends of a pair of links 38, the other ends of said links 38 being pivoted at 39 to lugs 40 of the frame 10. At its other end the lever 37 is pivoted at 41 to one end of a lever 42. Pivoted at the other end of the lever 42, by a pin 43, is the piston rod 44 of the die locking cylinder 45. The lever 42 is pivoted to the frame 10 at 46 and the die locking cylinder 45 is mounted on the frame 10 at 45c.

Bolted to the upper end of the lever 37 as at 47 is an arm 48. An adjustable, threaded contact 49 is positioned at the free end of the arm 48. A switch 50 provided with a contact button 51 is fixed to the frame member 12. When the die part 15 is in its fully closed position the contact 49 will strike the button 51 of the switch 50 (see Figure 5). The function of this switch will be described in detail further on in this specification. A set screw 52 is positioned in the frame 10 to act as a stop for the links 35 and

3

38 and the lever 37 when the die part 15 is in full closed position. This will be best seen in Figure 5.

Oil is admitted under pressure into the pipe line 53, see Figure 1, said line being divided to form the lines 53a and 53b. The lines 53a and 53b are coupled to the line 53 at 54 and 55. A valve 56 having an actuator 57 is stationed in the line 53a and fixed to the frame 10. A contact arm 58 is pivoted to the lever 37 at 59. A stop pin 60 is provided in the lever 37 to prevent clock-wise movement of the arm 58. A spring 61 is fixed to the right-hand end of the arm 58 and to the lever 37 to thus normally hold the arm 58 against the stop 60. The left-hand end of the arm 58 is provided with a cam surface 62.

Thus when the lever 37 is depressed by the action of the movable die part in closing, the cam surface 62 of the arm 58 strikes the actuator 57 of the valve 56, thus admitting oil through the line 53a, back into the line 53, and out through a spray nozzle 63 located adjacent the die 13. This arrangement makes possible the oiling of the die parts on each closing of the die. A hand operated valve 64 is provided in the line 53b for use in the event it is desired to apply an extra spray of oil to the die. The valve 64 is normally closed.

Pivoted to the link 42 at 65 is a member 66 adapted to receive a rod 67 threaded at 68. A lock nut 69 secures the rod 67 to the member 66. The rod 67 is threaded at 70 in a direction opposite to that at 68. A member 71 is adapted to receive the rod 67 as threaded at 70 and secured by a lock-nut 72, thus permitting adjustment of the rod 67. The member 71 is pivoted to another member 73 at 74, the members 71 and 73 thus comprising a conventional knuckle joint. The member 73 is pinned at 75 to a lever 76 which is fixed to a shaft 77 journaled in bearings 78 of the frame 10. Collars 79 are pinned to the shaft 77 and serve to position it between its bearings 78. A disc 80 is pinned to the shaft 77 at 81. A rod 82 (see Figure 3) is threaded for positioning in a member 83 which is pivoted at 84 to the disc 80. The rod 82 is also threaded at its other end, but in a direction opposite to that at the first mentioned end, for positioning in a member 85. Locknuts 86 hold the rod in its desired position.

The member 85 is pivoted at 87 to a lug 88 extending from a heating unit indicated generally at 89. The heating unit may be of any conventional type for use in heating a pot of molten metal. I have indicated my metal heating pot generally at 90, it being fixed immediately above the heating unit 89. The united heating unit and metal holding pot are pivoted to the frame 10 by pins 91 in lugs 92. The particular heating unit I have shown, by way of illustration only, is a gas unit and it is to be understood that it may be regulated to keep the molten metal at any desired temperature.

Flames from the heating element 93 flare up around the bottom 94 of the metal holding pot 90 to thus heat the metal therein. Molten metal is introduced into the pot 90 through a conduit 95 leading from a supply source to be later described in greater detail.

Within the metal holding pot 90 there are provided means to inject lead into the die 13 through a nozzle 96. Before describing these means, however, it should be noted that the arrangement just described, i. e. starting with the member 66 pivoted at 65 to the lever 42 and following through to the pivot 91, at which point the combined heating unit and metal holding pot are hung on the frame 10, serves to bring the injection nozzle 96 to the die 13 when it is fully closed. Thus when the lever 37 is forced down by the action of the shaft 27 when the die part 15 is closed by the piston rod 22 and cylinder 23, the lever 42 is swung about its pivot 46 in a clock-wise direction. This movement of the lever 42 actuates the rod 67 which moves the lever 76 thus turning the shaft 77 and disc 80 fixed thereto. Movement of the disc 80 causes the rod 82, which is pivoted to the disc 80, to thrust forward, i. e. in a rightward direction as seen in Figure 3, thus causing the heating unit and melting pot to rock about the pivot 91, thereby bringing the nozzle 96 into injection position.

4

This arrangement, therefore, serves to bring the injection nozzle 96 into injection position when the die is closed, and to remove it from injection position when the die is opened.

Referring again to the combined heating unit and metal carrier 89—90, there is provided an exit 97 in the wall of the unit 90 for escaping gases and air. Within the metal holding pot as defined by the wall 94 there is fixed a chamber 98. Extending from the chamber 98 to the nozzle 96 is a conduit 99. The chamber 98 is perforated as at 100 so that molten metal may enter the chamber from the confines of the pot 94. A plunger 101 is nicely fitted in the chamber 98 for slidable movement therein. Fixed to the plunger 101 as at 102 is the piston rod 103 of the metal injection cylinder 104. Thus when the cylinder 104 is actuated, in a manner to be later described, the rod 103 forces the plunger 101 to the bottom of the chamber 98. When the plunger passes the perforations 100 the metal within the chamber is forced through the conduit 99, out the nozzle 96 and into the die 13.

Referring now to Figures 1 and 5 and the stationary part 14 of the die 13, it should be noted that the die part 14 is provided with knock-out or ejection pins 105. These pins are mounted for slidable movement in the part 14. At their right-ward ends the pins 105 are provided with small heads 106 to thus prevent these pins from being too far withdrawn and also to prevent metal from seeping around the pins. At their other ends the pins 105 are coupled to a rod 107 by the coupling links 108 and 109. A spring 110 surrounding the pin 105 between the coupling 109 and a wall 111 formed by a recess in the die part 14 serves to maintain the pins in proper position for convenient handling of the die as best seen in Figure 5. A channel 112 for the entrance of lead into the die 13 is provided, a part of this groove 112 being in each of the parts 14 and 15 of the die 13. The article forming cavity is indicated generally at 113. It should be understood that I have shown only one form of a die that may be used in my machine and that any conventional die having provision for some type of ejection pin along the lines I have indicated would be perfectly suitable.

The rod 107 is positioned in a member 114, see Figure 1, which is pivoted at 115 to a short link 116. The link 116 is pivoted at 117 to the end of the short arm of a bell crank 118. This lever 118 is pivoted at 119 to the bracket 120 which is bolted to the frame 10 at 121. The end of the long arm of the lever 118 is pivotally connected at 122 to a piston rod 123 working in the casting-eject cylinder 124, later to be more fully described. Fixed to the member 114 is a contact arm 125. Suitably mounted on the bracket 120 are a pair of switches 126 and 127 adapted to be actuated by the contact arm 125. Thus when the rod 107 is caused to move by the cylinder 124 through its piston 123 and the linkage 118 and 116 to its eject position the contact arm 125 will actuate the switch 127, and when the rod 107 returns to non-eject position, the contact arm 125 will actuate the switch 126. The function of these switches will be later described.

Figure 4 shows a metal melting unit adapted for use in my machine. The unit consists of a metal holding pot 128 and a heating element 129. The pot 128 is provided with an orifice 130 which permits molten metal to flow out of the pot into the conduit 95. A plug element 131 is provided for the orifice 130. The plug 131 is pivotally fastened at 132 to a lever 133 which is pivoted at one end as at 134 to a bracket 135 fixed on the pot 128. Extending from one side of the pot 128 is a bracket 136. This bracket 136 is provided with an L-shaped extension 137. Adjustably mounted in the end of this extension 137 is a set screw 138. Pivoted at 139 to a lug 140 on the side of the pot 128 is a lever 141. A cylinder 142 is pivoted at 143 to the bracket 136, the piston 144 of said cylinder being pivotally connected to the lever 141 at 145. Another cylinder 146 is pivotally connected at 147 to the lever 141, the piston 148 of said lever being

5

pivoted at 149 to the lever 133. The extent of movement of the lever 141 is regulated by the set screw 138 against which it will abut on its upward movement.

Thus when the cylinder 142 is actuated, in a manner to be shortly described, the piston 144 moves the lever 141 which in turn, through the cylinder 146 and piston 148, moves the lever 133. Upward movement of the lever 133 causes the plug 131 to be pulled from the orifice 130 thus permitting molten metal to pass out of the pot 128 and into the conduit 95 which leads to the metal heating unit 90. The cylinder 146 and piston 148 are normally in a locked position. This cylinder 146 is, however, provided with an air line 150 and hand operated valve 151 so that it may also be used to directly actuate the lever 133 when this is desired.

Thus far I have explained the operation of the various elements making up a mechanical structure adaptable to carry out the objects of my invention but have omitted description of certain parts thereof. This description will now be supplied.

It should be here noted that each of the cylinders 23, 45, 104, 124 and 142 is of a pneumatic type. For their operation I have provided both high pressure and low pressure air lines. Each of these pneumatic cylinders and pistons, with the exception of 142 which is connected in series with one of the other cylinders as will be explained later, is provided with a diaphragm operated by pneumatic pressure which pressure is, in turn, controlled by a solenoid valve. The high pressure lines feed to the cylinders through valves which are actuated by the various diaphragms. The diaphragms, however, operate on low pressure air supply. Solenoid valves in the low pressure air lines control the actuation of the various diaphragms. The various solenoid valves are actuated in definite timed relationships with one another as will be shown later when the electrical circuits are more fully explained. Thus in operation the solenoid valves act to supply the various diaphragms with low pressure air which in turn causes them to actuate the cylinder valves to supply the cylinders with high pressure air and thus actuate the various pistons already described.

In the drawings, see Figure 1, high pressure air from a suitable supply source not shown is introduced into the line at 152. At the pressure regulating valve 153 high pressure air is passed into the line 154 and low pressure air into the line 155. It should be noted that each of the pneumatic cylinders 23, 45, 104 and 124, and their respective diaphragms 23a, 45a, 104a and 124a is similarly constructed to the other. Thus, for the sake of uniformity, I will designate like parts of each with like letters. Each cylinder is provided with a valve *a* and *b*, one at either end. Each of these valves regulates the admission of high pressure air into the cylinder and is either normally open or normally closed, as indicated by the markings N. O. and N. C. respectively, when its diaphragm is in closed position. Each of the diaphragms contains plates *c* and *d* between which the low pressure air is admitted by their respective solenoid valves 23b, 45b, 104b and 124b thus causing said plates to separate, this separation causing pins *e* and *f* to actuate the valves *a* and *b* to thereby control the introduction of high pressure air into the various cylinders. It is to be understood that these diaphragms and solenoid valves are of conventional design and are easily adapted for use in my machine.

The cylinder 142 is supplied with air through a line 156 which is operated by a solenoid valve 142b connected in series with the solenoid valve 104b which operates the diaphragm 104a. By this arrangement molten metal is supplied to the pot 90 simultaneously with the injection of metal into the die 13 thus making for great uniformity in the control of the lead supply. The weight of the apparatus shown in Figure 4 is relied upon to exhaust the cylinder 142 after the completion of the air intake through the line 156.

Leading from the valve *b* of the diaphragm 124a is an

6

air line 157 which terminates at a pilot delay valve 158. Also leading into the pilot delay valve 158 is a source of high pressure air 154. The line 159 extends from the valve 158 to a point adjacent the die 13. When the valve *b* of the diaphragm 124a is opened—as it will be when the cast articles are to be ejected—air bleeds into the line 157 and actuates the pilot delay valve 158. When the valve 158 is thus actuated a blast of air is sent through the line 159. This blast of air aids in expelling the ejected castings completely from the die so that they will tumble down the slide 160 and onto a conveyor belt, and also to blow any loose chips off the faces of the die 13.

At the start of the operation, which will now be described, still referring to Figures 1 to 5, the pistons within the cylinders 23, 45, 104, 124 and 142 are in the position shown in dotted lines. Thus the die 13 is in its full open position in which the contact button 31 carried by the movable die part 15 is in contact with the button 33 of the switch 32, and the knock-out pins 105 are in their non-eject position in which the contact arm 125 is in contact with the switch 126. As will be explained in discussing the wiring diagram the machine must be in this position before it can be started.

When the machine is started by energizing the solenoid valve 23b the movable die part closes for a predetermined time and is maintained in locked position by the cylinder 45 which was actuated by the solenoid 45b which is also in the starting circuit. As the die part 15 moves into closed position the die faces are sprayed with oil due to the action of the arm 58 carried by the lever 37 in striking the button 57 of the switch 56, as explained above. Also, as the die part 15 closes, the pot of molten metal 89—90 is brought into position due to the action of the linkage 37, 42, 67, 76, 77, 80 and 82 as explained above. When the die part 15 reaches its fully closed position the contact 49 carried in the arm 48 fastened to the upper end of the lever 37 contacts the button 51 of the switch 50. The switch 50 controls the solenoid valve 104b which therefore actuates the cylinder 104 to thus inject metal into the closed die 13 by the action of the plunger 101 in the chamber 98.

After a predetermined time the die part 15 is returned to its open position due to the timed action of the valve 23b and in doing so it causes the switch 32 to again be actuated. This sets up another relay in the circuit and causes the solenoid valve 124b to be energized. On energization of this valve the knock-out pins move to eject position thus loosening the cast articles in the die. These cast articles are blown from the die by the air blast through line 159 as explained above. When the pins reach their eject position the contact arm 125 contacts the switch 127 and thereafter the pins return to their non-eject position, the arm 125 contacts the switch 126 and the complete operation described is immediately repeated.

The operation described will be more clearly understood by an examination of the wiring diagram of Figure 6. In this figure those valves and switches which appear in Figures 1 to 5 retain their same identifying numerals.

#### Electrical control circuit—general

As seen in Figure 6, the main power input lines are indicated at MR and ML. A double pole single throw switch, indicated generally at 161, constitutes the master switch for the control circuit. The lines MR and ML may be plugged into a suitable current source as indicated.

Three timers, which will be referred to as the hold timer, the dwell timer and the shot timer, are indicated in dotted lines at the top of Figure 6. These timers are of conventional design. Each of these timers is provided with posts 1 to 6 inclusive and also with posts A to H inclusive and post J. Each of the number 1 posts

7

are connected to the line MR; each of the number 2 posts to the line ML. The posts 1 and 2 on each of these timers are connected through vacuum tubes (not shown). When the switch 161 is thrown and current thus admitted into the system—and after a slight warm up period of several seconds has been allowed—these timers are able to function.

Certain characteristics of these timers will here be considered. In each timer post A is shunted to post B and post F is shunted to post H. Normal post connections are 5 to 4 and C to E. When, however, the timer is running, the post connections are 5 to 6 and C to D.

The timer, when connected as above described, will act in the following manner:

1. If posts J and G are connected before the vacuum tube is warm, the timer will not start until the posts J and G have been broken and then reconnected;

2. The timer will run for a set time when the posts J and G are connected (or reconnected as the case may be) and will remain on "on" position until J and G are broken;

3. When J and G are broken during set time, the timer will stop at the end of the elapsed time;

4. The set time will be repeated when posts J and G are subsequently reconnected;

5. If posts J and G are broken and reconnected during a timing cycle, and A and B are broken when the time runs out, the timer will start when A and B are reconnected; and,

6. If J and G are not broken and reconnected during a timing cycle, and A and B are broken when the time runs out, the timer will not start when A and B are reconnected.

Also provided in the control circuit are five relays of conventional construction. These are indicated in dotted lines at 162, 163, 164, 165 and 166. Their operation will be fully described as the control circuit is developed.

A connecting board, indicated in dotted lines at 171, having stations 1-16 is also provided in the control circuit. The lines L1, L2, L3 . . . L16, to be more fully discussed later, are respectively connected to these various stations.

#### *Electric control circuit—start*

When the switch 161 is thrown, a circuit is completed through the hold timer (which is in off position) as follows: Line MR to post 1, by shunt to post 5, to post 4 (as explained above, normal post connections are 5 to 4), through line L24 to energizing coil 167 of relay 162, and through line L2a to line ML, thus completing the circuit.

When the above circuit is completed, the relay 162 is closed, which results in the following things happening:

1. A circuit is completed through posts 15 and 16 on the relay 162 to a buzzer on the recorder 168;

2. A circuit is completed through the 60-watt bulb 169 which thereupon lights; and,

3. A circuit is completed through the posts 13 and 22 of relay 162, thus connecting posts J and G—but, as indicated above, the hold timer will not yet start since this has all taken place before the vacuum tube was warmed.

At this stage of the operation the momentary stop button 170 is pushed, thus momentarily breaking all circuits, and then released, thus allowing the cycle to repeat up to this point. When the cycle is repeated, connection is made between the poles 13 and 22 a second time, and this in turn reconnects posts J and G, thus starting the hold timer as above explained.

The following happens simultaneously with the above from the time the switch 161 is thrown until the momentary stop button 170 is pushed:

A circuit is completed through lines ML and L1 to post 9 of relay 163, continuing through line L9 to the now closed microswitch 32 (located behind the mov-

8

able die part 15), through line L6 and post 10 of relay 165; then through line L10 to the solenoid valve 124b (thus ejecting any lead which may be in the die) and completing through line L11, post 11 of relay 163 and main line MR;

When the ejector 107 moves to eject position (due to actuation of valve 124b as above described), the microswitch 127 is closed thus completing a circuit through lines M1 and L1 to post 9 of relay 163, continuing through line L9 to the now closed microswitch 127, then through line L8 to post 12 of relay 165, thus energizing this relay, and completing through lines L12 and L11 to post 11 of relay 163 and thence through to line MR;

When relay 165 is energized as above described, the connection between posts 6 and 10 is broken thus allowing the ejector 107 to return to non-eject position. This results in microswitch 127 being opened, thus breaking the circuit just established through relay 165. This relay 165, however, continues to be energized through the following circuit (all of this still happening simultaneously with the first described operations as noted above): lines ML and L1 to post 9 of relay 163, through line L9 to post 8 of relay 165, and completing through the energizing coil of lines L12, L11, through post 11 of relay 163 and thence to line MR. The ejector 107, when it returned to non-eject position, closed the normally open microswitch 126.

#### *Hold timer starts*

As above explained, when the momentary stop button 170 is released, the posts J and G of the hold timer are reconnected and this timer starts. This results in the connection between posts 5 and 4 (hold timer) being broken, thus de-energizing relay 162 and disconnecting the recorder 168, light 169 and posts J and G on the hold timer. A connection is made, however, between posts 5 and 6 of the hold timer.

#### *Dwell timer starts*

When start button 172 is pushed the following circuit is completed: From post A of the dwell timer through line L2 and start button 172 to microswitch 126, continuing through line L3 to relay 165, and completing through line L26 to post B, thus starting the dwell timer.

When the dwell timer is thus started its posts C and E are disconnected and its posts C and D are connected. This completes a circuit from A to C to D to B. Also, posts 5 and 4 are disconnected and posts 5 and 6 are connected, with the result that the following circuits are completed:

A. From line MR to posts 1, 5 and 6 on the hold timer, through line L173 to post 5 on the dwell timer, then through post 6 and line L5 to the solenoid valve 23b, which causes the die part 15 to be moved to closed position, and completing through line L1 to line ML. The die part 15 is locked in closed position by cylinder 45—its valve 45b (not shown in Figure 6) also being in this starting circuit.

B. From line MR to posts 1, 5 and 6 on the hold timer, through line L173 to post 5 on the dwell timer, then through post 6 and line L5 to the energizing coil for relay 163 and completing through line L1 to ML.

At this point relay 163 opens relay 165 and completes a repeat connection of the hold timer as follows: from post J of the hold timer through line L18 to posts 18 and 25 of relay 163, through line L25 to post 22 of relay 164, and completing through line L22 to post G of the hold timer.

The closing of the die part 15 results in the extension of the die locking linkage to effect the closure of microswitch 50, thus completing the following circuit:

From line ML through line L1 and the now closed microswitch 50, through line L4 and the energizing coil

of relay 164 to its posts 1, thus closing relay 164, and completing through MR.

#### Shot timer starts

The hold timer starting circuit has been broken through post 25 of relay 163, to post 22 of relay 164, see above, and a connection thus made through the following circuit: From post J of the shot timer through line L19 to post 20 of relay 164, and completing through line L20 to post G of the shot timer—thus starting this timer.

When the shot timer starts posts C and E are disconnected thus breaking the starting circuit on the dwell timer through lines L27 and L17 to posts J and G of the dwell timer. Posts 5 and 4 (shot timer) are disconnected and posts 5 and 6 are connected.

A circuit is completed from line L5 to posts 5 and 6 on the shot timer, continuing through line L23 to post 7 on relay 164, then through line L7 to the lead injector solenoid valve 104b (which forces lead into the die) and through lines L1 and ML.

A circuit is also completed from shot timer post 6 through line L23 to post 21 of relay 164, continuing through line L21 to a counter 174, and through lines L1 and ML.

In addition there is a circuit from post 21 of relay 164 through line L21 and the energizing coil of relay 166 to its post 1 (thus closing relay 166) and through lines L1 and ML.

When relay 166 closes a circuit is completed through lines L13 and L14 to recorder 168, thus recording the shot.

#### Shot timer time completes

When shot timer ends posts C and E are connected. This results in the connection of posts J and G of the dwell timer through lines L17 and L27. Posts 5 and 6 are opened and this stops the lead shot, returns the lead injection cylinder to original position, and opens relay 166 to recorder.

#### Dwell timer time completes

Posts C and D, when dwell timer runs out, are disconnected and posts A and B opened. Posts 5 and 6 are disconnected and relay 163 opened, thus opening lines to start the hold timer circuit. Also, solenoid valves 23b and 45b (which regulate the closing and locking cylinders 23 and 45 respectively) are opened, thus opening the die and also microswitch 50. When microswitch 50 opens relay 164 is opened and the starting circuit of the shot timer is broken.

When relay 163 opens, a circuit is completed from lines M1 and L1 to post 9, relay 163, through line L9 to microswitch 32 (now closed), continuing through line L6 to post 10, relay 165, then through line L10 to solenoid valve 124b (working the lead eject cylinder 124), and completing through line L11, post 11 of relay 163 and line MR.

Due to the actuation of valve 124b as just described, the ejector rod 107 moves to eject position thus closing microswitch 127. This completes a circuit from lines ML and L1 through post 9 of relay 163, through line L9 and the now closed switch 127, continuing through line L8 to post 12 on relay 165 (thus closing this relay) and completing through lines L12 and L11 to post 11 of relay 163 and thence to MR.

#### Relay 165 closes

The energization of relay 165 opens posts 6 and 10 which results in the lead eject rod 107 returning to its non-eject position—thus opening microswitch 127 and breaking the energized circuit to relay 165. This relay, however, remains energized through the following circuit: From lines ML and L1 through post 9 of relay 163 and line L9 to posts 9 and 8 of relay 165, completing

through lines L12 and L11 to post 11 on relay 163, thence to line MR.

The ejector rod 107, when it returns to non-eject position, closes the normally open microswitch 126 thus completing a circuit from dwell timer post A through line L2 and the now closed microswitch 126, continuing through line L3 to post 26 on relay 165, and completing through line L26 to post B of the dwell timer—thus starting this timer.

#### Continuous cycle

The above outlined cycle—starting with that part of this description entitled "Dwell timer starts"—will repeat continuously, except that the start button 172 does not have to be pushed again. (The single pole single throw switch under the start button is now closed, which allows the circuit to complete and the dwell timer to start.)

#### Interrupted cycle

It is a distinct feature of my invention that if lead or foreign matter should become wedged between the die parts 14 and 15—holding them open—the shot timer will not function. This prevents the spraying of molten metal between the partly open dies into the area around the machine. This safety factor is controlled as follows:

1. The die part 15 starts to close in its normal cycle order but, due to the die's being held open, the linkage between the die closing and die locking cylinders does not complete its travel. The microswitch 50 thus is not closed and relay 164 therefore does not become energized—this, of course, resulting in the shot timer not starting.

2. The dwell timer runs out (no metal having been "shot" in the meantime, as just explained) and the die part 15 thus allowed to return to open position. Relay 163 is de-energized. The dwell timer cannot re-start because the connection between J and G has not been broken and closed.

3. a. When relay 163 becomes de-energized, the connection between posts 18 and 25 on relay 163 is broken, as also is the connection between posts J and G on the hold timer.

b. When relay 163 becomes de-energized the following circuit is completed: From lines ML and L1 to post 9 on relay 163, through line L9 to the now closed microswitch 32 (this switch, normally open, is closed when die part 15 moves back to open position), then through line L6 to post 10 on relay 165, continuing through line L10 to solenoid valve 124b (thus causing the ejector rod 107 to move to eject position) and completing through line L11 to post 11 on relay 163, thence to line MR.

4. The ejector rod 107, when it reaches its eject position, closes the normally open microswitch 127 and thus completes the following circuit: From lines ML and L1 to post 9 on relay 163, through line L9 to the now closed switch 127, continuing through line L8 and the energizing coil of relay 165, and completing through lines L12 and L11, post 11 of relay 163, and line MR.

5. Energization of relay 165 breaks the connection between its posts 6 and 10 thus allowing the ejector rod 107 to return to non-eject position. In relay 165, however, connection is now made between lines L8 and L9 and also between lines L3 and L26.

6. When the ejector rod 107 starts back it breaks the circuit through microswitch 127 and line L8 of relay 165. Relay 165, however, remains energized through the following circuit: From lines ML and L1 to post 9 of relay 163, through line L9 to posts 9 and 8 of relay 165, continuing through the energizing coil of relay 165—thus keeping this relay energized—and completing through lines L12 and L11 to post 11 of relay 163, thence to MR.

7. The ejector rod 107, when it reaches its non-eject position, closes the normally open microswitch 126 and

11

thus completes the following circuit: From post A on the dwell timer through line L2 to the now closed switch 126, and completing through line L3, relay 165 and post B of the dwell timer.

8. The dwell timer will not start since the connection between J and G was not momentarily broken as it is in the ordinary cycle.

9. The hold timer runs out, thus breaking the circuit between its posts 5 and 6 and establishing a circuit between its posts 5 and 4. This circuit is as follows: From MR to post 1 on the hold timer, thence to posts 5 and 4, continuing through line L24 and coil 167 of relay 162, thus energizing this coil and relay, and completing through line L2a of ML'.

10. Energization of relay 162 results in the connection of its posts 15 and 16, thus starting the buzzer on recorder 168. Also, a circuit is completed through line MR, relay 162, the light bulb 169 (thus lighting it) and line ML. A circuit was also completed from post J on the hold timer through line L18 to posts 13 and 22 of relay 162, and completing through line L22 to post G of the holder timer.

The hold timer will not start up again until the momentary stop button 170 is pushed and released or the double pole single throw switch 161 is opened and then closed. No other timer can start until the hold timer starts. Thus I have provided a machine for the rapid production of metal castings which will run continuously when all is going well but which will be stopped automatically and the workmen warned—by sight and sound—should any part of the operation be interrupted.

In considering the above circuits the following things should be noted: The post connections of the five relays are shown in their normal position, i. e., normally closed or normally open. Thus in relay 162 all four sets of post connections to the left of coil 167 are normally open. In relay 163 post 9—1 is normally closed, post 18—25 is normally open and the post at 11 (leading into MR) is normally closed. In relay 164 the post at 22 is normally closed, and the three remaining sets of post connections are normally open. In relay 165 the post connection at 6 is normally closed and the two remaining sets of post connections are normally open. And in relay 166 both sets of post connections are normally open.

Also, in considering the operation of my apparatus it should be noted that switches 126 and 127 are normally open, switch 32 is normally open and switch 50 is normally open.

At 175 I have shown a normally closed hand ejector switch.

Referring now to Figure 7, there is shown that embodiment of my invention wherein a plurality of the metal casting machines just described is incorporated into a general assembly for the continuous production of pressure castings. In this figure, those parts of the lead machine just described which appear in this figure are given the same identifying numerals, although the showing of Figure 7 is, of course, more or less diagrammatic. Thus, in Figure 7 there is shown a plurality of the lead casting machines 10, each shown as being provided with the tilting lead pot 90, and the stationary melting pot 128, from which metal flows to the pot 90 by means of the conduit 95.

Positioned in front of the battery of lead casting machines 10 so as to receive the finished product and sprue which is ejected from the machines 10 along the slide 160 provided for each, is a suitable conveyor 176. This conveyor may well be of the endless belt type and constantly in motion as long as the machines are in operation. The finished product and sprue will move in the direction indicated by the arrows in Figure 7. Such products and sprue are carried by the conveyor 176 to another conveyor 177 which is so arranged as to separate the products from the sprue. In that case wherein the finished product is more or less round, or cylindrical, in

12

form, this separator conveyor 177 may conveniently be an upwardly inclined vibrating endless belt conveyor. Thus, when the finished product and sprue are deposited upon the conveyor 177 by the conveyor 176, the round or cylindrical finished products will fall by gravity against the vibrating movement of the conveyor 177. The sprue, however, being flat will adhere to the endless belt 177 and therefore continue in the direction of the arrows as indicated at B in Figure 7. The direction of movement of the finished product is indicated by the arrow at A in Figure 7. It is to be understood that the precise form of the means for separating the finished product from the sprue is not a binding limitation on the general embodiment of my invention. The finished product will be transported by conveyor 178, or other suitable means, to its next stage of production. The connection between the sprue and the castings is broken by the impact of the parts falling at two different places in the system, first, as the parts are blasted from the die onto the slide 160 and, second, as the parts are caused to dance on the vibrating conveyor.

In the general operation of my metal casting assembly, it should be noted that the metal which goes into the individual metal casting machines is obtained from three primary sources. These sources comprise the sprue above described, metal salvaged from defective parts, or otherwise obtained from scrap throughout the plant, and metal in its pig form, such as pig lead or the like. These three products, that is the sprue, the salvaged metal and the pig metal, are brought into an elevated centrally located melting pot 179, from which molten metal is distributed to the various intermediate melting pots 128, from which latter pots the molten metal is delivered to the metal casting machine as earlier described.

At 180 I have indicated a suitable machine for separating salvage metal from the scrapped parts. It is my intention that this separating machine will be in constant operation during the operation of the battery of metal casting machines 10. Salvage metal obtained from the separating machine 180 is conveyed by any suitable means to a melting pot 181. The molten metal is delivered from the pot 181 to the centrally located pot 179 through a conduit 182 having a control valve 183 therein.

The sprue which has been separated from the finished product is carried by the conveyor 177 to another conveyor 184 so positioned as to empty the sprue into the centrally located melting pot 179. Thus, when the battery of metal casting machines is in operation, the centrally located pot 179 is constantly receiving sprue obtained during the casting of the various articles. Furthermore, molten metal is constantly being produced at the station 181. An operator located in the vicinity of the pot 179 controls the admission of salvage metal thereto by actuation of the valve 183 as desired. Pig metal is introduced into the pot 179 by this operator. In this manner the proper proportions of pig metal, salvage metal and sprue may be maintained continuously throughout the operation of the battery of machines 10. Molten metal is conducted from the pot 179 to the individual melting pots 128 through a series of conduits 185, each having a valve 186 provided therein. The pot 179 and the operator just mentioned are so positioned above the machines 10 that the operator may easily note when it is necessary that more metal be introduced into the pot 128. At such times the operator will simply discharge more metal from the pot 179 to that particular pot 128 which needs the metal by actuating the proper valve 186. It is to be understood that it is within the scope of my invention to provide timing mechanism in association with the valves 186 and the pots 90 and 128 so that such valves will be automatically actuated at predetermined times.

I have thus devised an assembly of novel metal casting machines such that will produce a constant stream of finished products, at the same time utilizing the sprue

obtained with the finished product and metal salvaged from other sources. Such controls as I have provided both in connection with each individual metal casting machine 10 and also in connection with the system as a whole, make possible the production of higher quality castings at lower cost and with less personnel requirements.

It is to be understood that the form of my invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of my invention, or the scope of the subjoined claims. I do not intend to be limited to the particular embodiment of my invention herein shown and described except in so far as is pointed out in the claims.

Having thus described my invention, I claim:

1. A machine for the rapid production of pressure castings which comprises a frame, a die comprising two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, a pressure injector for forcing molten metal into said die, said injector being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting said cylinder and piston with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to said valve control members, said valve control members being actuated by expansion of said diaphragm, said diaphragm having a connection with said low pressure conduit, and means for controlling the application of low pneumatic pressure to said diaphragm through said connection whereby to actuate said expandable diaphragm to move said valve control members and thus actuate said injector piston by high pneumatic pressure, said controlling means including a regulator valve in said connection, said regulator valve being operatively associated with said movable die part whereby said diaphragm is actuated according to the position of said movable die part.

2. The machine of claim 1 including a lubricator for said die in operative association with said movable die part.

3. The machine of claim 1 in which said control means includes means to prevent actuation of said injector when said die is open.

4. A machine for the rapid production of pressure castings which comprises a frame, a die comprising two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, a pressure injector for forcing molten metal into said die, an ejector for forcing cast metal out of said die, said ejector being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting said cylinder and piston with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to said valve control members, said valve control members being actuated by expansion of said diaphragm, said diaphragm having a connection with said low pressure conduit, and means for controlling the application of low pneumatic pressure to said diaphragm through said connection to actuate said expandable diaphragm to move said valve control members and thus actuate said ejector piston by high pneumatic pressure, said controlling means including a regulator valve in said connection, said regulator valve being operatively associated with said movable die part whereby said diaphragm is actuated according to the position of said movable die part.

5. The machine of claim 4 in which said control means

includes means to prevent actuation of said ejector when said die is closed.

6. The machine of claim 4 including a lubricator for said die in operative association with said movable die part.

7. The machine of claim 4 including a nozzle for directing a jet of air into said die to assist in the ejection of cast metal from said die.

8. The machine of claim 7 in which said nozzle is provided with control means in operative association with said movable die part.

9. The machine of claim 8 in which said last mentioned control means includes means to prevent actuation of said nozzle when said die is closed.

10. A machine for the rapid production of pressure castings which comprises a frame, a die comprising two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, a pressure injector for forcing molten metal into said die when closed, an ejector for forcing cast metal from said die when open, said injector and said ejector each being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting each of said cylinders with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to each pair of said valve control members, each pair of said valve control members being actuated by expansion of the said diaphragm to which it is connected, each of said diaphragms having a connection with said low pressure conduit, and means for controlling the application of low pneumatic pressure to each of said diaphragms through said connections to actuate said expandable diaphragms to move said pairs of valve control members and thus actuate said injector piston and said ejector piston by high pneumatic pressure, said controlling means including a regulator valve in each of said connections, each of said regulator valves being operatively associated with said movable die part whereby each of said diaphragms is actuated according to the position of said movable die part.

11. The machine of claim 10 in which said control means includes means to prevent actuation of said injector when said die is open and means to prevent actuation of said ejector when said die is closed.

12. The machine of claim 11 including a nozzle for directing a jet of air to assist in the ejection of cast metal from said die and means associated with said movable die part to prevent actuation of said nozzle except when said die is open.

13. The machine of claim 11 in which said movable die part is provided with means to prevent its closing except when said ejector is withdrawn from said die.

14. The machine of claim 10 including a lubricator for said die in operative association with said movable die part.

15. The machine of claim 10 including a nozzle for directing a jet of air into said die to assist in the ejection of cast metal from said die, and a lubricator for said die, said nozzle and said lubricator being in operative association with said movable die part, and a control system including means to prevent actuation of said injector when said die is open, means to prevent actuation of said ejector when said die is closed, means to prevent actuation of said air nozzle when said die is closed, and means to prevent the closing of said die except when said ejector is withdrawn from said die.

16. A machine for the rapid production of pressure castings which comprises a frame; a die comprising at least two relatively movable parts positioned in said frame, at least one of said relatively movable parts having an open position and a closed position; means for moving said last mentioned part from one of its positions to the other,

15

said means including a piston working in a cylinder; a pressure injector for forcing molten metal into said die, said injector including a piston working in a cylinder; an ejector for forcing cast metal out of said die, said ejector having an eject position and a non-eject position; means for moving said ejector from one of its positions to the other, said means including a piston working in a cylinder; a supply of high pressure; a supply of low pressure; a pair of valves for each of said cylinders connecting same with said high pressure supply; opening and closing valve control members for each pair of said valves; an expandable diaphragm for each pair of valve control members, each pair of said valve control members being actuated by expansion of its respective diaphragm, each said diaphragm having a connection with said low pressure supply; a regulator valve at each connection whereby to control the admission of low pressure to each said diaphragm; and a control system including operative connections between said regulator valves and said movable die part whereby actuation of each of said diaphragms is governed by the position of said movable die part, said control system including means to prevent said movable die part being moved from its open position except when said ejector is in its non-eject position.

17. The machine of claim 16 in which said control system includes means to prevent said ejector being moved from its non-eject position except when said movable die part is in its open position.

18. The machine of claim 17 in which said control system includes means associated with said metal injecting means to prevent injection of molten metal into said die except when said movable die part is in its closed position.

19. The machine of claim 17 in which said machine is provided with a nozzle for directing a jet of air to assist in the ejection of cast metal from said die, said control system including means to prevent actuation of said nozzle except when said movable die part is in its open position.

20. The machine of claim 16 in which said control system includes means associated with said metal injecting means to prevent injection of molten metal into said die except when said movable die part is in its closed position.

21. The machine of claim 16 in which said machine is provided with a nozzle for directing a jet of air to assist in the ejection of cast metal from said die, said control system including means to prevent actuation of said nozzle except when said movable die part is in its open position.

22. A machine for the rapid production of pressure castings which comprises a frame; a die comprising at least two relatively movable parts positioned in said frame, at least one of said relatively movable parts having an open position and a closed position; means for moving said last mentioned part from one of its positions to the other, said means including a piston working in a cylinder; a pressure injector for forcing molten metal into said die, said injector having a connection with a piston working in a cylinder; an ejector for forcing cast metal out of said die, said ejector having an eject position and a non-eject position; means for moving said ejector from one of its positions to the other, said means including a piston working in a cylinder; a supply of high pressure; a supply of low pressure; a pair of valves for each of said cylinders connecting same with said high pressure supply; opening and closing valve control members for each pair of said valves; an expandable diaphragm for each pair of valve control members, each pair of said valve control members being actuated by expansion of its respective diaphragm, each of said diaphragms having a connection with said low pressure supply; a regulator valve in each said connection whereby to control the admission of low pressure to each said diaphragm; and a control system including operative connections between said regulator valves and said movable die part whereby actuation of each of said diaphragms is governed by the position of said movable die part, said control system including means to prevent

16

said ejector being moved from its non-eject position except when said movable die part is in its opened position.

23. The machine of claim 22 in which said control system includes means associated with said metal injecting means to prevent injection of molten metal into said die except when said movable die part is in its closed position.

24. The machine of claim 22 in which said machine is provided with a nozzle for directing a jet of air to assist in the ejection of cast metal from said die, said control system including means to prevent actuation of said nozzle except when said movable die part is in its open position.

25. A machine for the rapid production of uniform pressure castings which comprises a frame; a die comprising at least two relatively movable parts positioned in said frame; means for moving a movable part between an open position and a closed position to thereby open and close said die; a supply of casting metal for said die; means to move said supply into casting position as the die is closed and out of casting position as the die is opened; a pressure injector for forcibly injecting casting metal into said die, said injector being operated by a piston working in a cylinder; a conduit leading from a supply of high pneumatic pressure; a conduit leading from a supply of low pneumatic pressure; a pair of valves connecting said cylinder with said high pressure conduit; a valve control member for each of said valves whereby each said valve is opened and closed; an expandable diaphragm connected to said valve control members, said valve control members being actuated by expansion of said diaphragm, said diaphragm having a connection with said low pressure conduit; a regulator valve in said connection; and a control system including an operative connection between said regulator valve and said movable die part whereby the application of low pneumatic pressure to said diaphragm is governed by the position of said die part, said control system including means to prevent actuation of said regulator valve when said movable die part is out of its closed position.

26. The machine of claim 25 in which the means for moving the supply of casting metal comprises a cam shaft actuated by said movable die part.

27. A machine for the rapid production of pressure castings which comprises a frame, a die comprising at least two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, a pressure injector for forcing molten metal into said die, said injector being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting said cylinder with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to said valve control members, said valve control members being actuated by expansion of said diaphragm, said diaphragm having a connection with said low pressure conduit, a regulator valve in said connection, and a control system including an operative connection between said regulator valve and said movable die part whereby actuation of said diaphragm and said pressure injector is governed by the position of said movable die part, said control system including means to prevent actuation of said regulator valve when said die is open, and additional means to lock to said movable die part in closed position during the injection of molten metal into said die.

28. The machine of claim 27 in which said locking means is operatively associated with said control system.

29. The machine of claim 28 including a timing device associated with said movable die part and said locking means.

30. The machine of claim 29 in which said timing device includes means to keep said die closed for a short time after said injector is actuated.

31. A machine for the rapid production of pressure

17

castings which comprises a frame, a die comprising at least two relatively movable parts positioned in said frame, opening and closing means for at least one of said relatively movable die parts, said opening and closing means including a piston working in a cylinder, a pressure injector for forcing molten metal into said die, said injector being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting each of said cylinders within said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to each pair of said valve control members, each pair of said valve control members being actuated by expansion of its respective diaphragm, each of said diaphragms having a connection with said low pressure conduit, a regulator valve in each of said connections, and an electrical control system including an operative connection between each of said regulator valves and said movable die part.

32. The machine of claim 31 including switch means located in a circuit including each of said regulator valves, and means to actuate said switch means when said die is closed, said switch means being normally open.

33. The machine of claim 32 including a timer for said injector and located in the circuit including said regulator valves, said timer being started when said switch is closed.

34. A machine for the rapid production of pressure castings which comprises a frame, a die comprising two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, said opening and closing means including a piston working in a cylinder, a pressure injector for forcing molten metal into said die when closed, an ejector for forcing cast metal out of said die when open, said injector and said ejector each being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting each of said cylinders with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to each pair of said valve control members, each pair of said valve control members being actuated by expansion of its respective diaphragm, each of said diaphragms having a connection with said low pressure conduit, a regulator valve in each of said connections, and electrical control circuits connected to each of said regulator valves and said movable die part whereby the application of low pressure to each of said diaphragms is controlled by the position of said movable die part, application of low pressure to said diaphragms through said regulator valves resulting in the actuation of the various pistons to effect operation of said opening and closing means, said injector and said ejector.

35. The machine of claim 34 including switch means located in a circuit including said regulator valve for said ejector diaphragm, and means to actuate said switch when said die is opened, said switch being normally open.

36. The machine of claim 34 including switch means located in a circuit including said regulator valve for said injector diaphragm, additional switch means located in a circuit including said regulator valve for said ejector diaphragm, means to actuate said first mentioned switch means when said die is closed, and means to actuate said additional switch means when said die is opened, both said switch means being normally open.

37. The machine of claim 36 in which the means which actuate said first mentioned switch means comprises mechanism actuated by said movable die part and the means which actuate said additional switch means comprises an electrical circuit having a third switch means therein, said third switch means being actuated by said movable die part when in its open position.

18

38. The machine of claim 36 including a timer for said injector and located in the circuit including said injector, said timer being started when said first mentioned switch is closed.

39. A machine for the rapid production of pressure castings which comprises a frame, a die comprising two relatively movable parts positioned in said frame, opening and closing means for a movable part of said die, said opening and closing means including a piston working in a cylinder, a pressure injector for forcing molten metal into said die, said injector being operated by a piston working in a cylinder, a conduit leading from a supply of high pneumatic pressure, a conduit leading from a supply of low pneumatic pressure, a pair of valves connecting each of said cylinders with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed, an expandable diaphragm connected to each pair of said valve control members, said valve control members being actuated by expansion of said diaphragm, each of said diaphragms having a connection with said low pressure conduit, a regulator valve in each of said connections, electrical control circuits including said regulator valves, switch means located in a circuit including the regulator valve for said injector diaphragm, means actuating said switch means when said die is closed, said switch being normally open, a timer for said injector located in the circuit including said switch means and the said regulator valve for the injector diaphragm, said timer being started when said switch is closed whereby said injector is actuated for a predetermined time, and a timer for said movable die part located in the circuit including the regulator valve for said movable die part diaphragm, said last mentioned timer being started when said machine is started whereby said die is closed for a predetermined time, said last mentioned timer acting to hold said movable die part in closed position for a time exceeding that for which said first mentioned timer is set.

40. A machine for safe and rapid production of uniform metals castings, comprising a frame; a die positioned in said frame, said die having two relatively movable parts, a movable part having an open position and a closed position; means for moving the movable part between its said positions, said means including a piston working in a cylinder; a pressure injector for forcing metal into said die, said injector being operated by a piston working in a cylinder; an injector for loosening cast articles from said die, said ejector having an eject position and a non-eject position; means for moving said ejector between its two positions, said means including a piston working in a cylinder; a conduit leading from a supply of high pneumatic pressure; a conduit leading from a supply of low pneumatic pressure; a pair of valves connecting each of said cylinders with said high pressure conduit, a valve control member for each of said valves whereby each said valve is opened and closed; an expandable diaphragm connected to each pair of said valve control members, each pair of said valve control members being actuated by expansion of its respective diaphragm; each of said diaphragms having a connection with said low pressure conduit; a regulator valve in each of said connections; and an electrical control circuit including timing elements associated with each of said regulator valves, said timing elements including means to actuate the various regulator valves in such order as to successively cause the movable die part to move to its closed position for a predetermined time and then to return to its open position, said injector to inject metal into said die during a portion of said predetermined time, said ejector to move to its eject position after said predetermined time and then to return to its non-eject position, and said movable die part to thereafter again return to its closed position and the cycle above recited to be repeated.

41. The machine of claim 40 in which the movable die part must be in its open position and the ejector in its

non-eject position before the successive steps may be initiated:

42. The machine of claim 41 in which the movable die part, if it fails to close all the way and does not make contact with said actuator, will return to its open position and stop: 6

43. The machine of claim 41 in which the said timing elements are so arranged that if the movable die part fails to reach its closed position it will not make contact with the actuator for the pressure injector control valve, and thus will return to its open position at the end of said predetermined time without any metal having been injected into said die: 10

44. The machine of claim 43 in which the said timing elements are so arranged that if the ejector fails to reach its eject position it will return to its non-eject position and stop: 15

45. The machine of claim 43 in which the said timing elements are so arranged that if the ejector fails to return to its non-eject position from its eject position the movable die part will not leave its open position. 20

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