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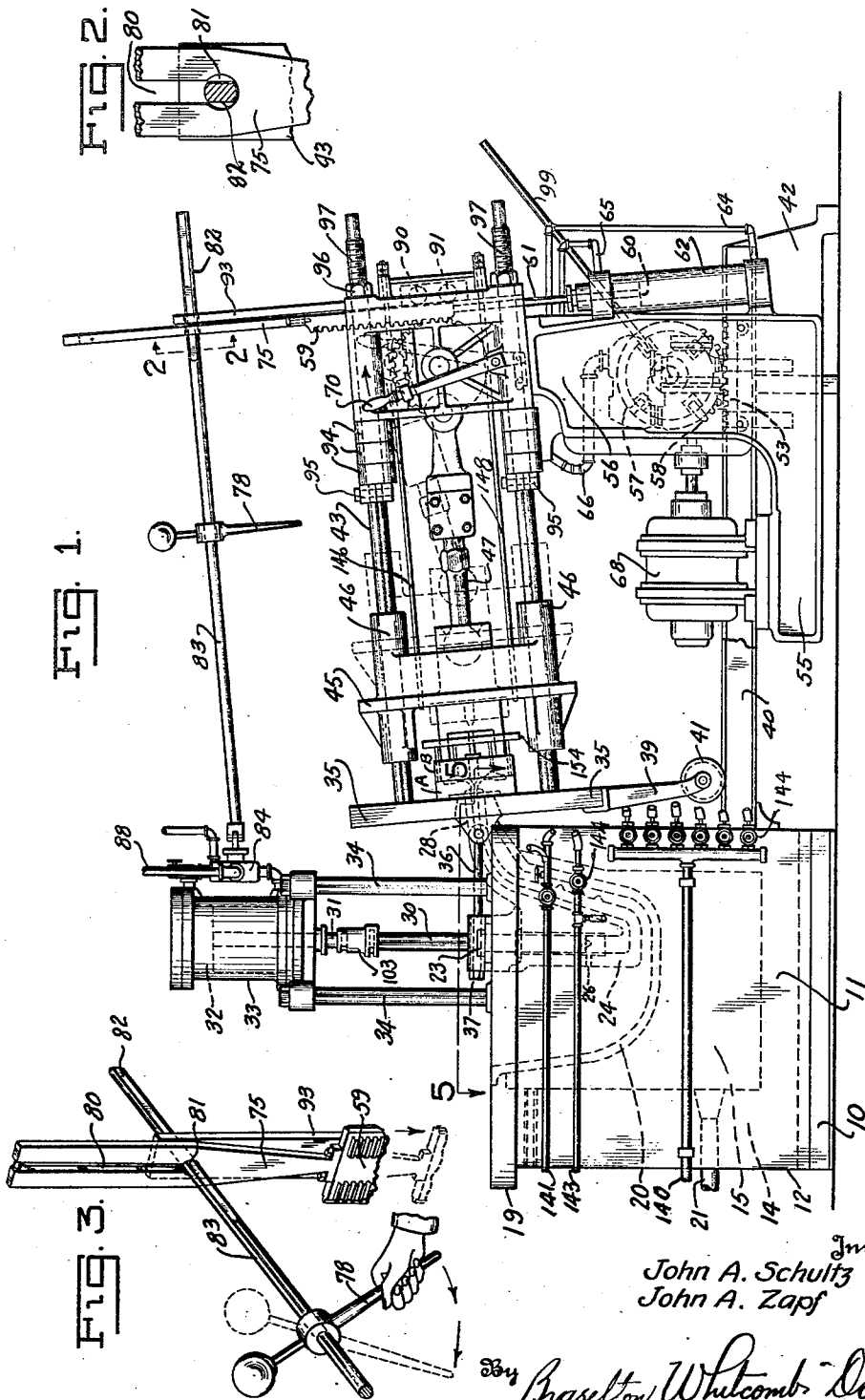
J. A. SCHULTZ, JR., ET AL

2,108,080

METHOD FOR CASTING METALS

Filed March 19, 1934

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

FIG. 4.

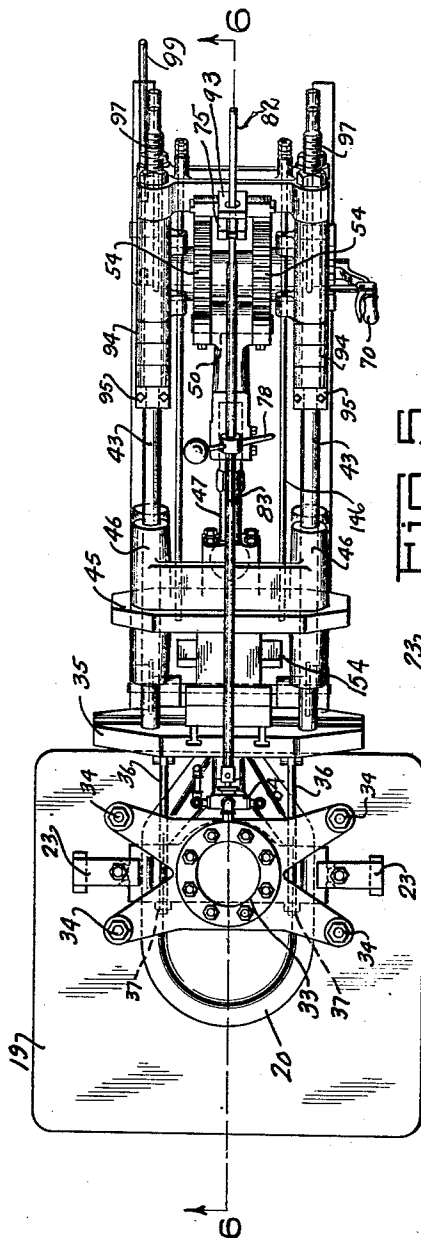
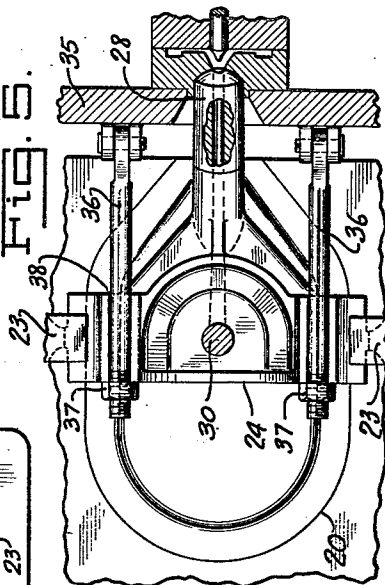


FIG. 5.



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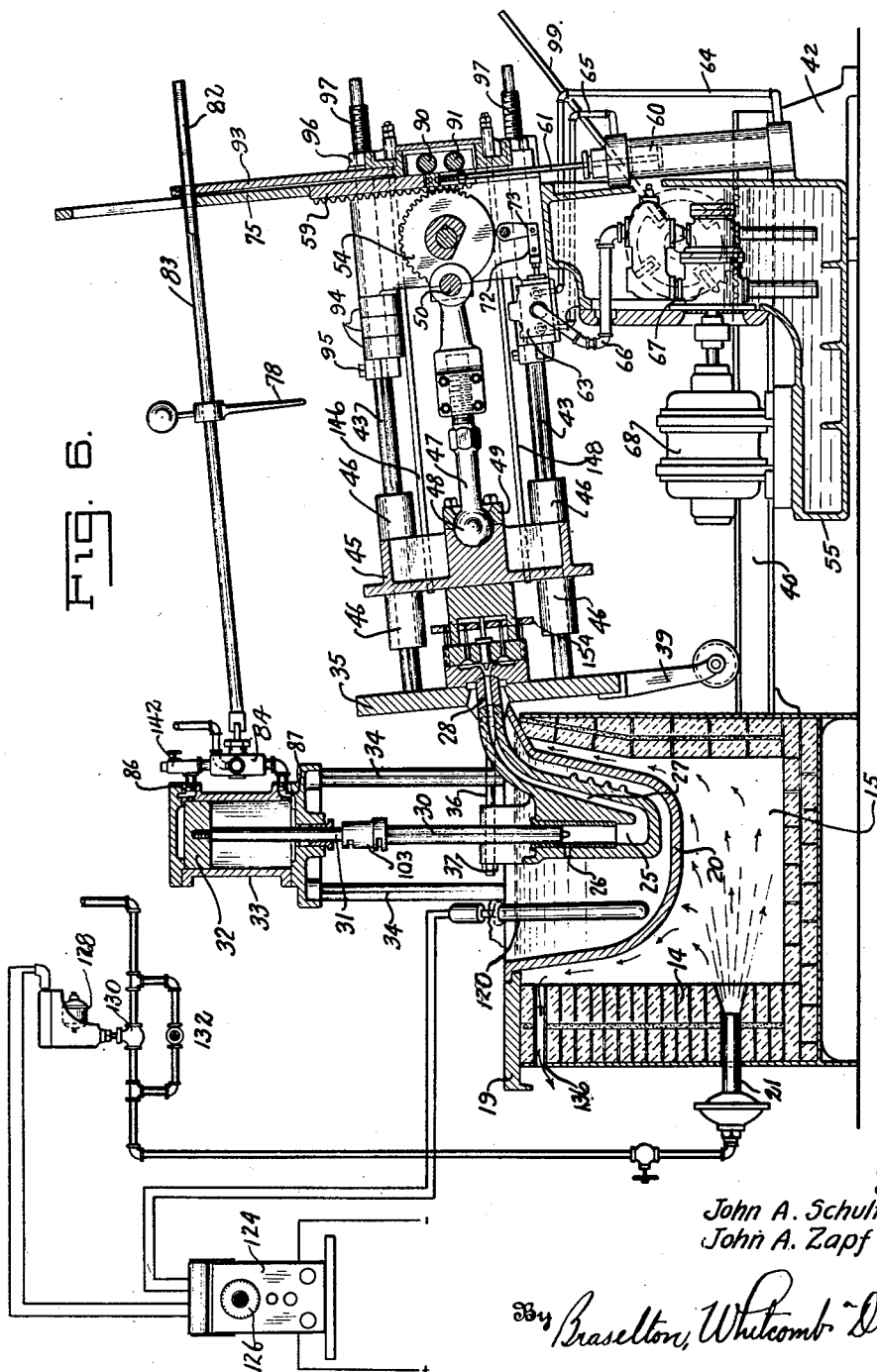
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4 Sheets-Sheet 3



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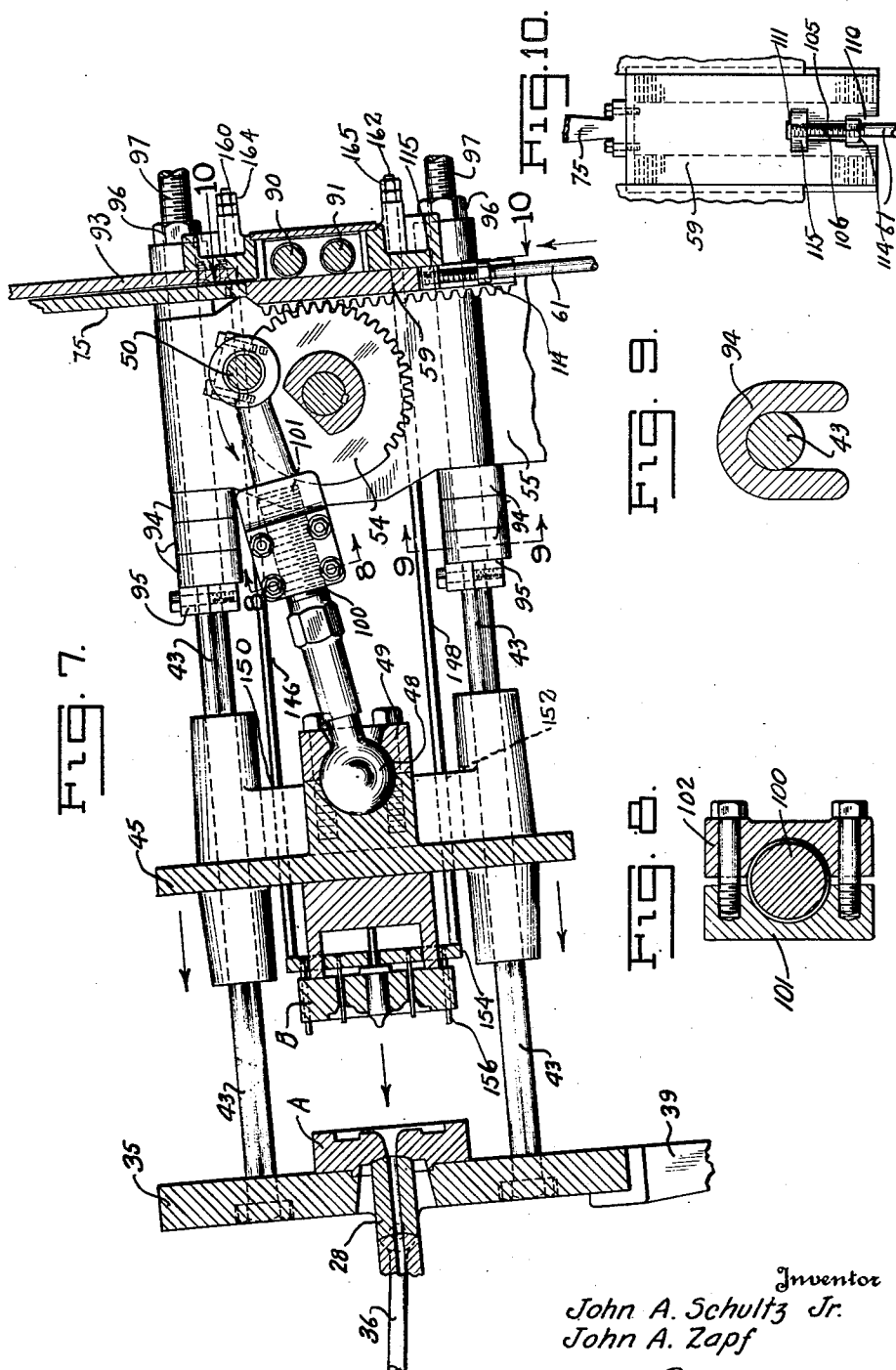
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METHOD FOR CASTING METALS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,108,080

METHOD FOR CASTING METALS

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Application March 19, 1934, Serial No. 716,248

2 Claims. (Cl. 22—200)

This invention relates to the art of making castings from molten metal and particularly to an improved method and apparatus used for making castings under pressure.

One of the objects of the invention is to provide a simple and efficient means operated by suitable pressure whereby thin section castings can be cheaply and rapidly made by persons unskilled in the art.

Another object of the invention resides in an improved method of producing castings by forcing the metal to be cast at a temperature substantially that of its plastic state into a mold using a comparatively high pressure per unit of area and maintaining the mold area in contact with the metal to cast at a substantially uniform low temperature.

Another object of the invention is the provision of a method which increases the efficiency of the machine for larger scale production.

Another object of the invention is the provision of an improved arrangement to retain at all times in fixed cooperative relation with the dies the metal forcing and delivering means so that changes in temperature or pressure due to displacement of the metal does not affect such cooperative relation.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawings of a form of the invention.

Figure 1 is a side elevational view of the machine of the invention;

Figure 2 is a detailed sectional view taken substantially on the line 2—2 of Figure 1;

Figure 3 is a view showing in detail certain parts of one of the safety features of the invention;

Figure 4 is a top plane view of the machine shown in Figure 1;

Figure 5 is a sectional view taken substantially on line 5—5 of Figure 1 showing the cooperative relation existing between the die holding plate and the molten metal charging and delivering means;

Figure 6 is a sectional view taken substantially on the line 6—6 of Figure 4;

Figure 7 is a detailed sectional view showing the die operating mechanism;

Figure 8 is a detailed sectional view taken substantially on the line 8—8 of Figure 7;

Figure 9 is a detailed sectional view taken substantially on the line 9—9 of Figure 7;

Figure 10 is a detailed sectional view taken substantially on lines 10—10 of Figure 7.

We have illustrated our invention as incorporated in a die casting machine, but it is to be understood that we contemplate the use of our invention wherever the same may be found to be applicable. It is to be understood that we do not wish to limit the same to the disclosure shown in the drawings, but that the same is used for illustrating purposes only.

The method of our invention in one of its aspects includes forcing into a mold or die the metal to be cast at a temperature slightly higher than its melting point or at a temperature where the metal could be termed as being at its "plastic state", using, under such condition, for injecting the metal into the die a pressure not less than one thousand pounds and not greater than two thousand pounds per square inch; the die casting mold being kept at substantially low temperature preferably at a temperature that does not exceed sixty percent of the temperature of the injected metal.

As a practical illustration of the method of our invention we have found after considerable research and experimentation that with zinc base non-ferrous alloys having a melting point of 735° Fahrenheit by forcing the metal into the die or casting mold at a temperature ranging from 750° to 800° that is substantially at a temperature ranging from 3 to 10 percent higher than that of the melting point, employing an injecting pressure of 1600 pounds per square inch; and retaining the mold area in contact with the cast metal at a temperature ranging from 375° to 400°, that is a temperature which is relatively lower than that of the injected metal, we have found that the most satisfactory results are obtained when the temperature is not higher than 60 percent of the injected metal temperature. Careful tests show that the average tensile strength of castings produced by our method is increased by more than 10 percent over castings produced by any other method, the casting thus produced being non-porous and of remarkable high density and we are capable of producing castings of greater uniformity all held within closer dimensional limits than those produced heretofore. In addition by following this method we have been able to successfully and cheaply make in large scale production castings of extremely thin wall sections having as low as 0.013 inch in wall thickness. Thus it can be seen that by our

method the main defects and disadvantages present in die castings heretofore produced are obviated.

The process of the invention may be carried out by the utilization of machines of several types, and while we have disclosed the invention as being carried out in connection with a die casting machine using fluid pressure, it is to be understood that we contemplate the utilization of our process with all kinds of machines whenever the same is found to be applicable, the machine disclosed herein being illustrated as one of the embodiments by which our method can be successfully carried in practice.

Referring to the drawings and particularly to Figures 1, 4 and 6, the die casting machine illustrated as one of the embodiments by which the method of the invention can be carried out and other features of our invention comprises a frame 10 having a base portion 11 forming the outer metallic casing of furnace 12 which is provided with a lining of fire brick 14 forming a fire or furnace chamber 15. The furnace chamber 15 is closed at its upper end by a metallic plate 19 serving to support a metal reservoir or melting pot 20 which extends downwardly from the plate within the furnace chamber 15, the melting pot 20 being heated by suitably regulated means conveyed through the furnace walls by means of a pipe 21 in order to maintain the metal in the reservoir in a molten condition at the desired temperature. Located within the melting pot 20 is the supplemental pot or pressure delivery chamber 24 preferably of a gooseneck configuration which is substantially immersed in the molten metal and is removably secured in fixed relation to the melting pot 20 by means of clamps 23 secured to plate 19. Member 24 is provided with a lateral connecting opening 26 whereby the molten material passes to a cylindrical bore or duct 25 connected by means of passage 27 to the delivering orifice or spout 28. In order to force the molten metal into the dies, the cylindrical bore 25 of member 24 is adapted to snugly receive a member or piston 30 which is adapted to be moved by means of rod 31 secured to a reciprocating piston 32 located within the cylinder 33. Cylinder 33 is fixedly supported upon plate 19 by means of a plurality of upright supports 34.

Adjacent to the furnace 12 in proper spaced relation is a relatively stationary die holding plate 35 which is suitably supported and removably secured to supplemental pot or pressure chamber 24 by means of hinged members or eye bolts 36 having a threaded end portion adapted to receive nuts 37. Pressure chamber 24 is provided with projecting portions having suitable grooves 38 as shown in detail in Figure 5, which serve to receive bolts 36 and cooperating nuts 37 for the purpose of urging the molten delivering means of member 24 in proper positive engagement with the die holding plate 35. The die holding plate 35 is provided with extending leg portions 39, each carrying a wheel 41 engaging horizontal supports 40 secured at one end to the walls of the furnace 12 by suitable brackets and at the other end by suitable supporting members or base support 42. This arrangement and type of support for the die holding plate 35 permits the proper adjustability of the same with respect to pressure chamber 24 and also permits that the die holding plate be removed for repairs or change of dies, by the simple expedient

of untightening or loosening nuts 37, permitting bolts 36 to be removed from grooves 38.

In the form of the embodiment illustrated in the drawings, the dies or molds preferably used are of the sectional type consisting of at least two relatively movable members, means are provided for supporting one of the die members relatively stationary and moving the other relative thereto. The latter means comprises a supporting and guiding frame 43 formed of a plurality of rods secured at one end to the relatively stationary die holding plate 35 and at its other end by a subframe 55. A movable die holding plate 45 as particularly illustrated in Figures 1, 4, 5 and 6 is provided with bosses or integral projections 46 having openings through which passes the members 43 thus supporting the die holding plate 45 in proper alignment and guiding it in its relative motion with respect to die holding plate 35.

The die holding plate 45 is connected to an adjustable movable link 47 formed into two cooperating threaded portions, one of said portions terminating into a spherical end 48 which is received in a centrally located boss formed integral with die holding plate 45 forming a ball joint connection permitting the proper motion of member 47. The adjustable connecting link 47 is removably secured to plate 45 by means of a removable bracket 49 having at one end an opening of similar contour to the spherical end of member 47 and having at its other end a frustrum opening in order to permit oscillatory motion of member 47. Member 47 serves as a pressure equalizing device for the proper actuation and cooperative engagement of the relatively stationary die member carried by die holding plate 35 and the cooperating die element carried by the movable die holding plate 45. Pressure equalizing member 47 is pivotally carried at its other end by a stub shaft 50 eccentrically carried by and between two oscillating members or gear segments 54 journaled by suitable shafts on sub-frame 55 which is also provided with suitable openings to receive guiding members 43. Frame 55 is adjustably supported in horizontal members 40 by means of a depending portion 56 upon which is journaled wheels 57 having a gear section 58 engaging the toothed rack 53 supported on members 40.

Movement of the die holding plate 45 towards and away from die holding plate 35 is accomplished through the movement of pressure equalizing member 47 caused by the oscillatory movement imparted to gear segments 54. Motion is imparted to gear segments 54 through the reciprocatory movement toothed rack 59 in engagement therewith, this reciprocatory movement being accomplished by the action of a piston 60 connected to the toothed rack 59 by means of a rod 61, piston 60 being located within the pressure cylinder 62. Movement of piston 60 within the pressure cylinder 62 is obtained through the use of a suitable pressure, preferably fluid pressure, the latter being controlled through suitable connecting valves located within the distributing chamber 63 which serves to connect either side of piston 62 through conduits 64 and 65 located at each of its extremities. Any fluid pressure can be used, but in the present instance we employ oil under pressure, the same being supplied to the distributing chamber 63 through a conduit 66 from a suitable oil pressure pump 67 driven by an electric motor 68 both being supported upon a depending portion of sub-frame 55. Portion of

the pump 67 and particularly the inlet conduits are located in the oil supply chamber forming part of the lower most portion of sub-frame 55. The oil under pressure produced by pump 67 is controlled through the actuation of the suitable valves located within distributing chamber 63 containing suitable valves for establishing the connection of fluid to either side of the cylinder 62, through conduits 64 and 65, this control being accomplished through the use of a lever 70 which can be manually or mechanically operated, movement of lever 70 is transmitted to the distributing chamber 63 by suitable links 72 and 73.

With the object of insuring the safety of the operator and preventing that molten metal be displaced from the pressure chamber 24 to the dies when the same are out of proper engagement, we provide interlocking means between the pressure actuating means for pistons 32 which serves for forcing the molten metal into the dies, and the operating means controlling the movable die holding plate 45, so that, the piston 32 can not be moved from its normal upper position unless the dies are in fixed cooperating relation. This interlocking means embraces the use of an upperly projecting member 75 fixedly carried by toothed rack 59 which coacts with the control 78 of admission valve 84 which controls the injection of fluid under pressure to cylinder 33 for the operation of piston 32, which as hereinbefore described imparts movement to plunger 30 for charging the molten metal into the dies.

Member 75, as particularly shown in Figures 2 and 3, is provided with a narrow slot 80 terminating into a circular opening 81. Slot 80 accommodates the side or parallel walls 82 of the rectangular section formed at one end of rod 83 adjacent to the portion to which is fixed the manual control or operating handle 78. The rectangular section of rod 83 is supported on a circular opening formed on upwardly projecting member 93 carried by sub-frame 55 which serves also as guiding means for member 75. The other end of rod 83 is connected to valve 84, the latter being actuated by rod 83 through the movement of handle 78. Valve 84 serves to connect at will either conduit 86 or 87 located at top and bottom of cylinder 33 to the source of fluid pressure (not shown) supplied through pipe 88. As particularly shown in Figure 3, due to the intimate coaction of slot 80 and the side walls 82 of rod 83, member 78 cannot be moved unless the rectangular portion of rod 83 is located within the circular opening 81 present in member 75. It should be noted that the circular opening 81 will only be in registration with rod 83 when the piston 60 and rack 59 are at their uppermost position, which takes place when the dies proper are in cooperative engaging relation. Under such condition, member 78 can be moved to either direction to control valve 84 for the injection of fluid under pressure to actuate piston 32. If, however, the dies are not in proper cooperative relation, or rack 59 is not at its uppermost position, such actuation cannot take place. This safety feature is of material importance as the molten metal is never displaced from the melting pot 24 by member 30 unless the dies are in proper engaging relation, thus preventing the metal from being splashed, causing injuries to the operator. The proper engagement of the toothed rack 59 with segmental gear 54 is accomplished by the provision of rollers 90 and 91 bearing against the rear face of the toothed rack member 59, these

rollers being journalled on the side walls of sub-frame 55.

For the purpose of using dies of different types in order to produce castings of different sizes and contours, the principal instrumentalities forming the machine of our invention are capable of relative motion, and the sub-frame 55 and the element carried thereby for this purpose is capable of adjustment with respect to the die holding plate 35, so that the movement imparted to toothed rack 59 by piston 60 to oscillate the pressure equalizing member 47 is not interfered with. Sub-frame 55 is held in position with respect to die holding plate 35 through the use of stops 95 in the form of clamps fixedly secured to rods 43, which coact with spacers in the form of U-shaped members 94 particularly shown in Figure 9, and nuts 96 coacting with the threaded portions 97 of members 43. By the use of spacers 94 which number and position can be changed with respect to the front or rear face of sub-frame 55 the position of such sub-frame and elements carried thereby can be moved as a unit thus permitting that dies of different depth can be carried by the die holding plate 35 and 45.

In order to facilitate the movement of sub-frame 55 we have provided a lever 99 which coacts with wheels 57 journalled upon projecting portions 56 of sub-frame 55. The wheels 57, as hereinbefore pointed out, have segmental gear sections 58 which engage the toothed rack 53 carried by the supporting members 40. Movement of the lever 99 will serve for changing the relative position of sub-frame 55 with respect to die holding plate 35. For the purpose of providing an accurate adjustment and proper engagement of the die holding members carried by the die holding plates 35 and 45, respectively, the pressure equalizing member 47 consists of two sections, each provided with threaded cooperating portions 100 and 101, respectively. Adjacent to the threaded portion 101 is a clamp 102, the latter serving to hold these portions in proper adjusted position preventing relative motion thus the desired length of member 47 is retained.

As particularly illustrated on Figure 10 an adjustable connection is present between rack 59 and its actuating rod 61, this connection consisting in forming on 59 a slot 105 adapted to snugly receive the threaded end 106 of rod 61, the slot 105 serving to connect openings 110 and 111 which accommodate respectively nuts 114 and 115 coacting with the threaded portion 106 of rod 61 in this manner relative adjustment is obtained between rod 61 and rack 59 for the purpose of accurately timing the point of closure of the dies in the cycle of operation and this connection presents the further advantages that the rack 59 has the required liberty of movement to adjust itself automatically in its guide eliminating the necessity of a front bearing for toothed rack 59.

A special advantage of our invention consists in that the temperature of the melting pot 20 and molten material container therein, as well as that of the pressure discharge chamber 24, is maintained uniform throughout the cycle of operation of the machine. In order to accomplish this result, as particularly shown in Figure 6 of the drawings, a pyrometer 120 is immersed into the molten metal and through suitable wiring the same is connected to a temperature selector 124, the temperature selector being provided with a manual temperature setting device 126 for the purpose of controlling the current generated by pyrometer 120. The temperature selector 124 is

connected to a suitable source of energy and in turn serves to energize a relay (not shown) for the purpose of opening or closing the circuit of an electric motor 128 directly connected to the fuel supply valve 130. It can be seen that any change in temperature will, in the present instance, change the electromotive force generated by pyrometer 120 and will in turn actuate motor 128 for the purpose of regulating the flow of fuel to pipe 21 terminating in the furnace chamber 15. We provide a by-pass 132 around valve 130 for the purpose of permitting manual regulation of the fuel delivered to chamber 15. The wall of furnace chamber 15 is provided with an opening 136 for the purpose of allowing the escape of burned gases, and aiding in proper combustion and circulation of the heat supplied.

In order to control the temperature of surface of contact of the die with the molten metal, the machine is provided with suitable cooling medium conveyed by means of suitable pipes 140, 141 and 143 to manually controlled outlets adapted to be connected by flexible conduits to the die proper. The proper number of effective conduits and the amount of cooling medium can be regulated manually by valves 144, thus keeping the dies at all times at a predetermined substantially uniform low temperature. It can be seen that by the type of support of the pressure chamber 24 within the melting pot 20, the change of the pressure chamber can be effected any time without troublesome and time requiring work, and that the pressure and the amount of metal forced to the dies can be changed by the simple expedient of substituting the pressure chamber and the cooperating metal displacing member or plunger actuated by means of piston 32. This can be accomplished by the use of removable coupling 103 attached to the piston rod 31, this type of arrangement permitting different types of metal displacing members to be used.

It should be noted that the delivering means of pressure chamber 24 are so positioned with respect to the melting pot 20 that a portion of the passage 27, as well as spout or nozzle 28, are located just above the edge of the melting pot and of the normal level of the molten metal contained therein so that this portion partakes of the heat applied thereto so that a very small amount of metal is solidified in spout 28, the return stroke of plunger 30 acts to withdraw any molten metal from conduit 27 to the level of the molten material on melting pot 20, thus leaving conduit 27 clear, and that it should also be noted that opening 26 of member 24 used for admitting molten metal to duct 25 for its injecting into the die proper is located below the normal level of the molten metal so that the metal injected into the die is at all times pure and free from dross and other impurities. We have provided means to cushion the return stroke of the piston 32 actuated by fluid pressure for the purpose of controlling the rapidity of movement and at the same time the drawing back the metal in conduit 27 when the metal displacing member 30 is raised by means of piston 32, this means being in the form of a valve 142 which permits the slow ejection of the air when the piston is returned to its upper-most position.

In order to automatically eject castings when the same are formed in the die members, sub-frame 55 supports rods 146 and 148 which are received in openings 150 and 152 respectively on the movable die holding plate 45. These rods serve the purpose of engaging the die ejecting plate 154

carrying a plurality of knockout pins 156. As particularly illustrated in Figure 7, when the die holding plate 45 is moved away from die holding plate 35, the rods 146 and 148 engage the die ejecting plate 154, causing relative motion between the die and the ejecting plate whereby the knockout pins 156, engage the casting thereby aiding in the removal of the castings from the die member. The rods 146 and 148 are capable of adjustment in sub-frame 55 by the use of threaded portions 160 and 162 coaxing with nuts 164 and 165.

The operation of the machine as hereinbefore described, could be summarized as follows. One complete cycle of the operation is now described. Assuming that the machine is in the position shown in Figures 1 and 6, wherein the sectional dies are in proper engagement the manual operating lever 78 which serves to actuate the admission valve 84 moved from the full line position to the dotted line position in the direction of the arrows as shown in Figure 3, this movement will permit the injection of fluid under pressure to the upper portion of cylinder 33 whereby piston 32 will be moved downwardly, transmitting such motion through coupling 103 to member 30, the latter forcing the metal contained in ducts 24 and 27 through nozzle 28 into the sectional dies, the actuation of member 78 can be accomplished in this instance due to the fact that the rectangular portion of 83 is in registration with the circular opening 81 of member 75 due to the fact that the sectional dies are in proper engagement and toothed rack 59 is in its upper-most position.

The pressure exerted by the fluid medium in cylinder 33 forces at a comparatively high pressure per unit of area the molten metal through the displacement of member 30 in the die and holds the same until it hardens and the casting is formed. During this casting operation, the die holding plate 35 has been firmly locked and detained in fixed position with respect to the nozzle or spout 28 of pressure chamber 24 through bolts 36 as hereinbefore pointed out.

When the casting has hardened, the operating lever 78 is moved to its full line position whereby fluid pressure is admitted at the lower end of the cylinder 33 and at the same time the pressure at the upper end of piston 32 is released. As soon as the casting has been hardened and with manual operating lever 78 in its normal original position, the movable die holding plate 45 is moved to the position indicated in dotted lines in Figure 1 to cause the ejection of the casting. Movement of the die holding plate 45 is accomplished through the manipulation of lever 70 in the direction indicated by the arrow whereby movement is transmitted to the distributor chamber 63 through links 72 and 73 whereby the oil under pressure is supplied through conduit 65 to the upper extremity of pressure cylinder 62, causing the downward movement of piston 60 carrying the toothed rack 59 this movement of the rack 59 is permitted due to the fact that the rectangular portion of rod 83 is in proper registration with slot 80 of member 75. The downward movement of rack 59 causes the rotation of segmental gear 54, rotating the latter in a clockwise direction whereby pressure equalizing member 47 moves die holding plate 45 to the position indicated by dotted lines in Figure 1, separating the elements A and B of the sectional die, thus movement of plate 45 causes that the ends of rods 146 and 148 engage casting ejecting

plate 154 thereby forcing the knockout pins 156 to eject the casting from the dies.

In order to cause the engagement of the die elements A and B, for the purpose of stating the cycle of operation the die holding plate 45 is moved from the dotted line position to the full line position. This movement is accomplished through the manipulation of lever 70 in the opposite direction as the one indicated by the arrow, this movement causing the interconnection of conduit 64 with the oil under pressure and forcing piston 60 to its uppermost position whereby the segmental gear member 54 is moved in a counterclockwise direction as indicated by the arrows in Figure 7, causing the movement of die holding plate 45 towards the relatively stationary die holding plate 35, whereby the engagement of the sectional die members A and B is established. Movement of toothed rack 59 permits the proper registration of the circular opening 81 of member 75 with the coating portion of manipulating rod 83 upon which is fixedly secured the manipulating lever 78. The machine is now ready for another operation. From the above description, it can be seen that the rate of the operation of the machine and the rapidity of the cycle is only dependent on the rate of cooling of the medium in the die proper and that the rapidity of the cooling can be effected by the use of a suitable cooling medium.

The apparatus disclosed herein forms the subject matter of our co-pending application Serial No. 120,112, filed January 11, 1937.

It is apparent that, within the scope of the invention modifications and different arrangements may be made other than is herein disclosed, and

the present disclosure is illustrative merely, the invention comprehending all variations thereof.

What we claim is:

1. The method of making castings from zinc-base material which comprises maintaining the material to be injected into a die at substantially a temperature ranging from three per cent to ten per cent higher than the material melting point; injecting said material into the die at a pressure per square inch of not less than one thousand three hundred pounds, and not greater than two thousand pounds; and providing the rate of radiation of the die to maintain a uniform temperature at the die area in contact with the material not to exceed sixty per cent of the temperature of the injected material, the temperatures being determined according to Fahrenheit scale.

2. The method of making castings from zinc-base material which comprises maintaining the material to be injected into a die at substantially a temperature ranging from slightly above the melting point to ten per cent higher than the material melting point; injecting said material into the die at a pressure per square inch of not less than one thousand three hundred pounds, and not greater than the order of two thousand pounds; and maintaining the rate of heat radiation of the die so as to provide a substantially uniform temperature at the die surface in contact with the material not to exceed sixty per cent of the temperature at which the material is injected, the temperatures being determined according to Fahrenheit scale.

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