

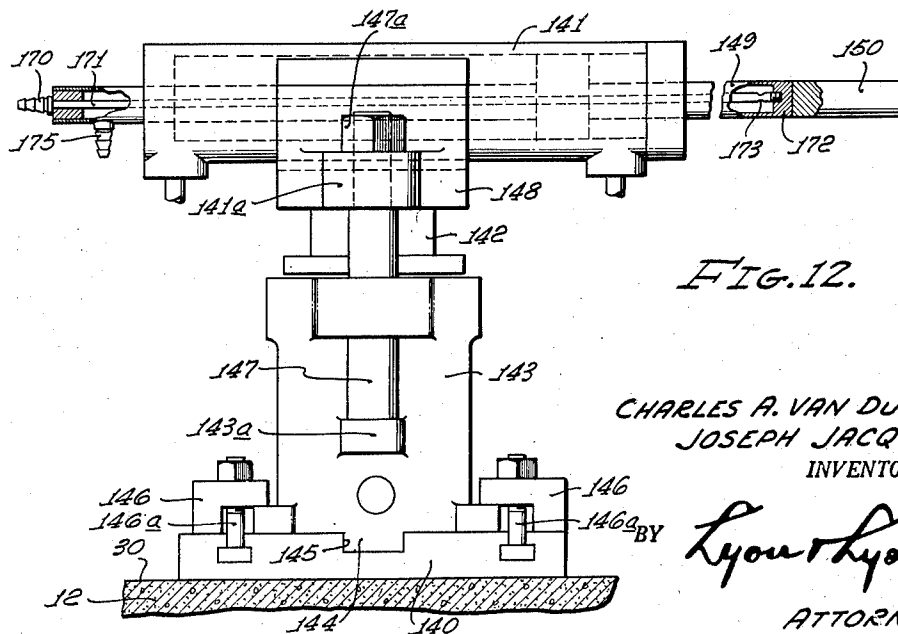
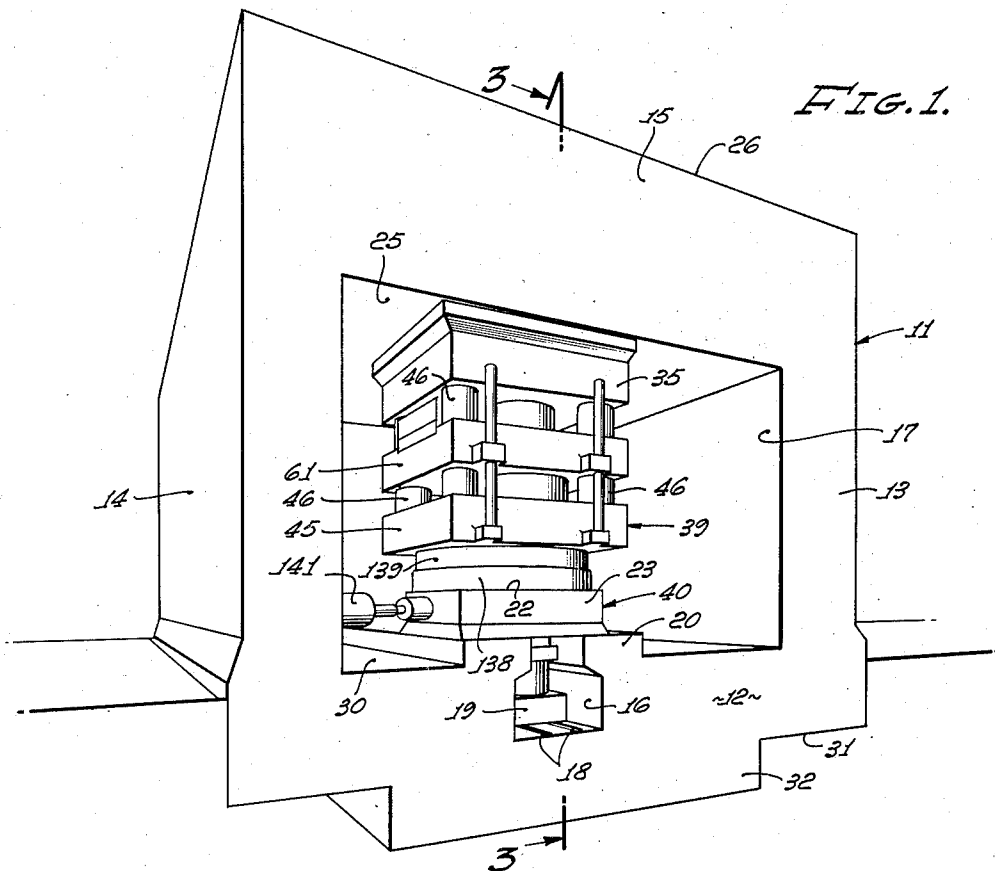
Dec. 9, 1958

C. A. VAN DUSEN ET AL
DIE CASTING MACHINE

2,863,187

Filed May 31, 1956

11 Sheets-Sheet 1



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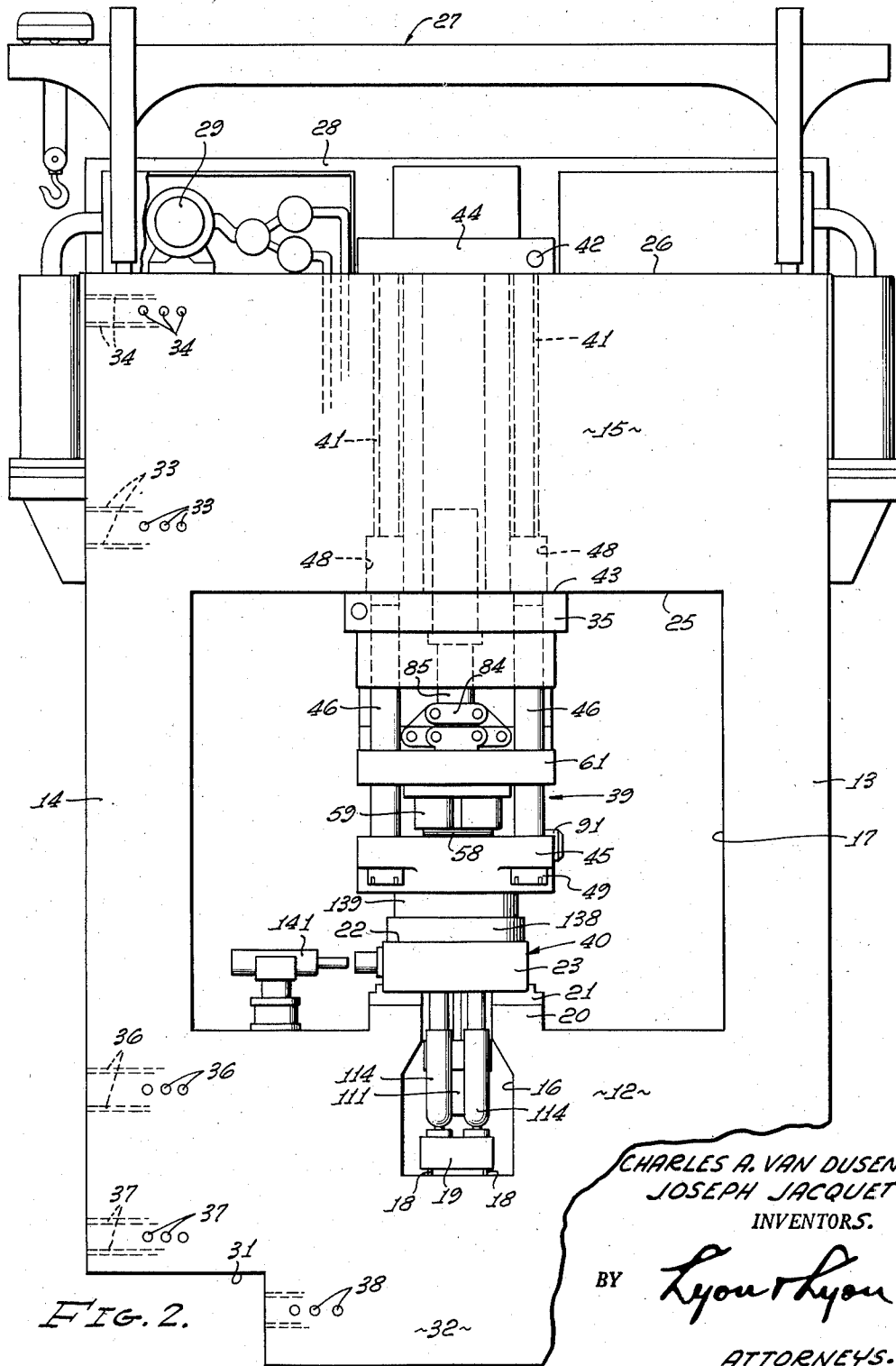
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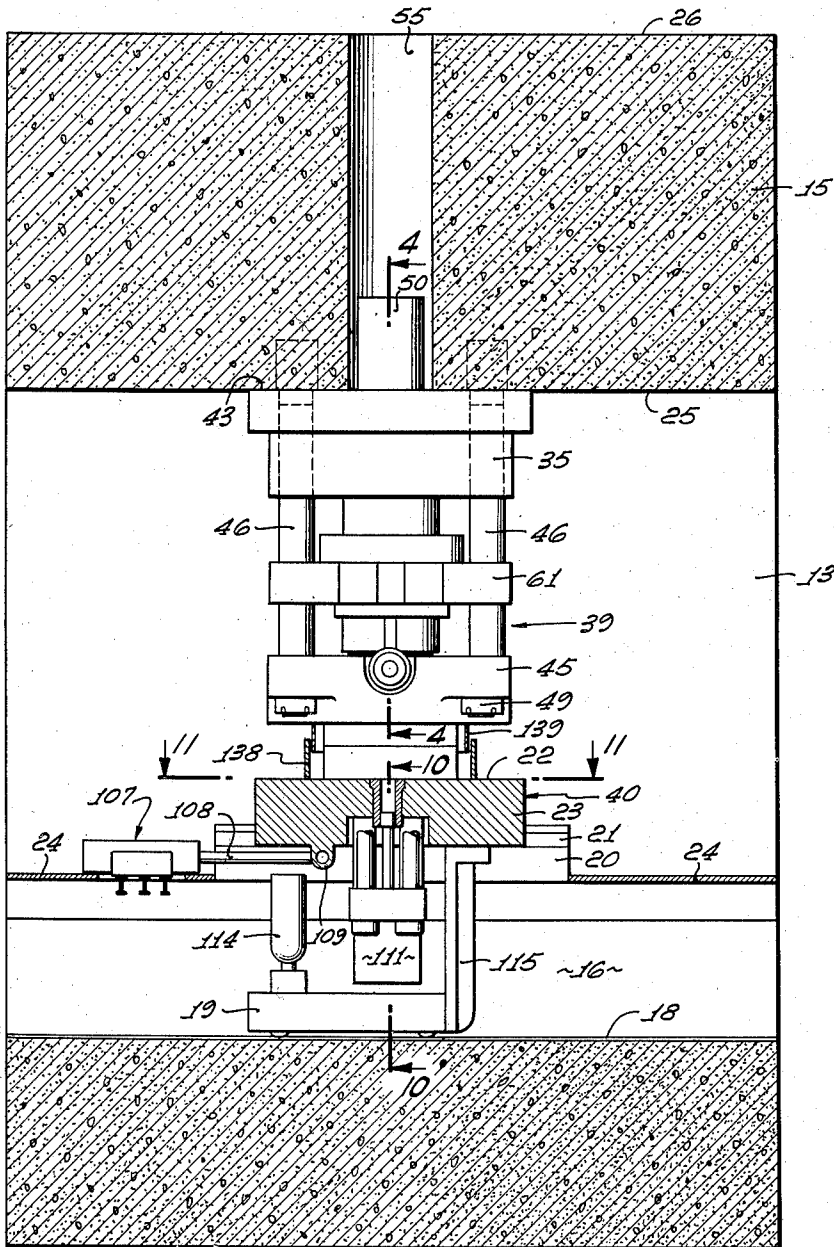
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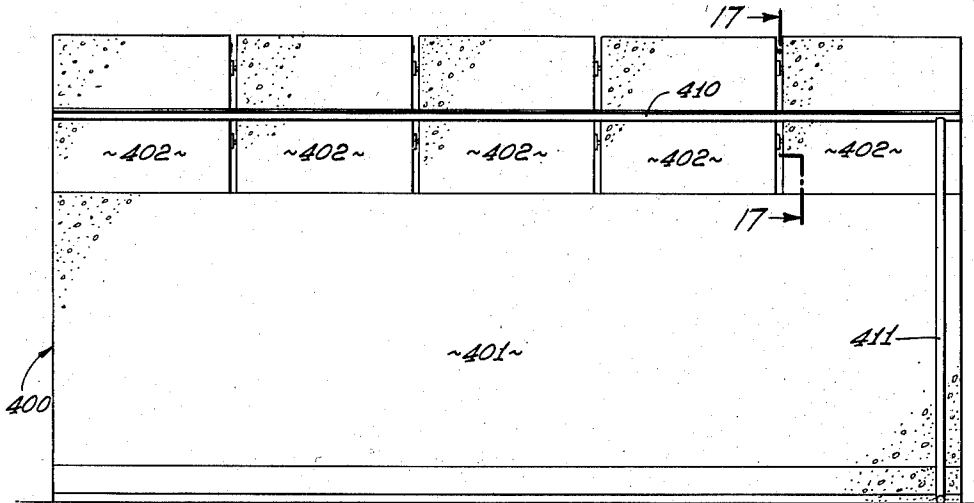


FIG. 16.

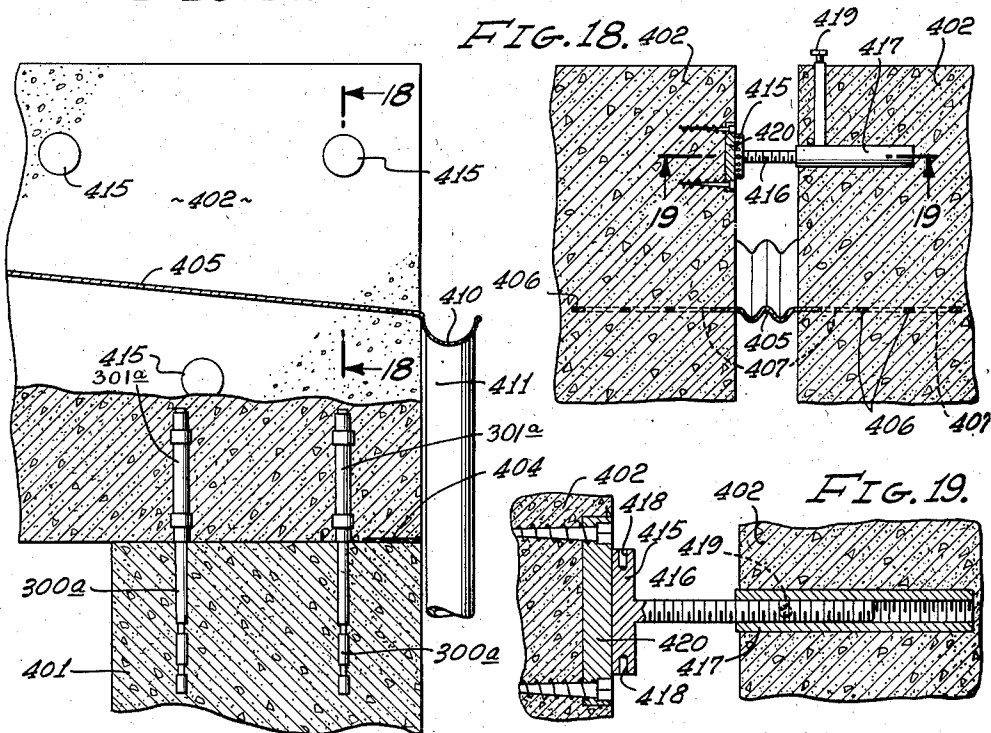


FIG. 17.

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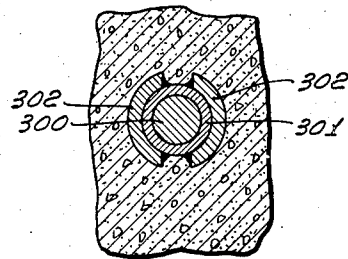
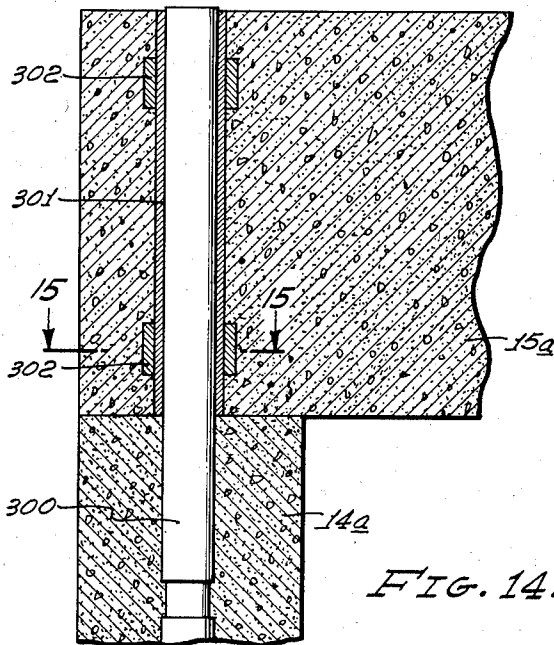
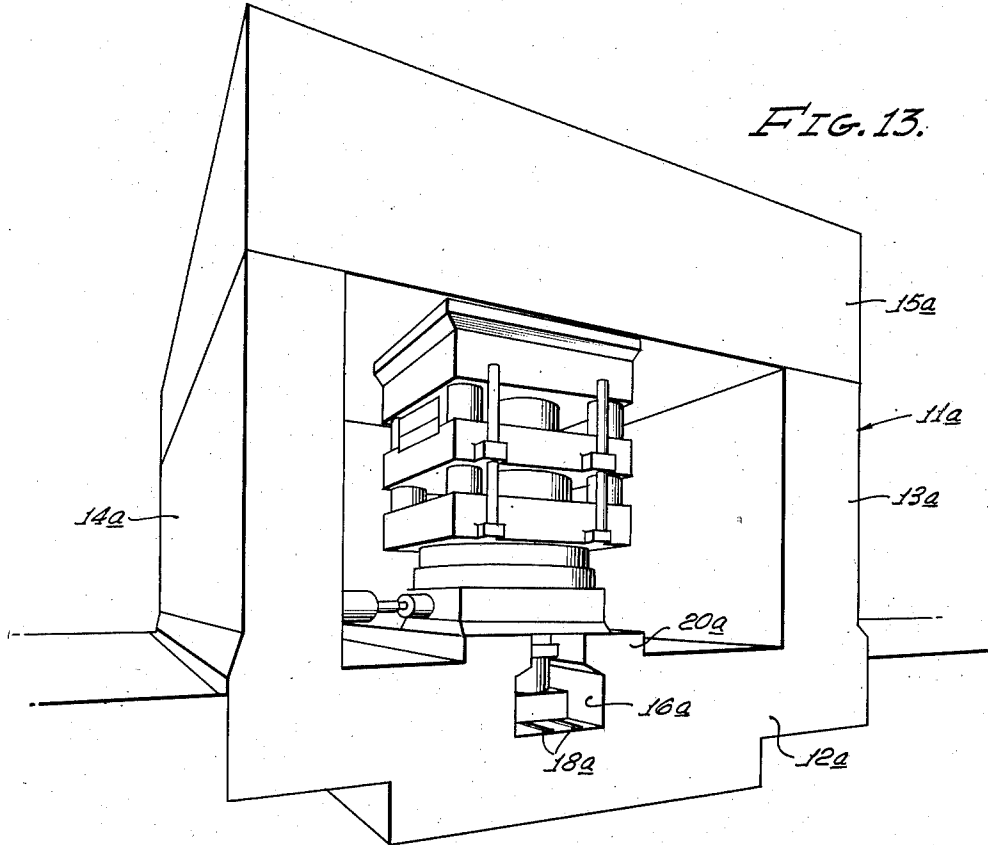
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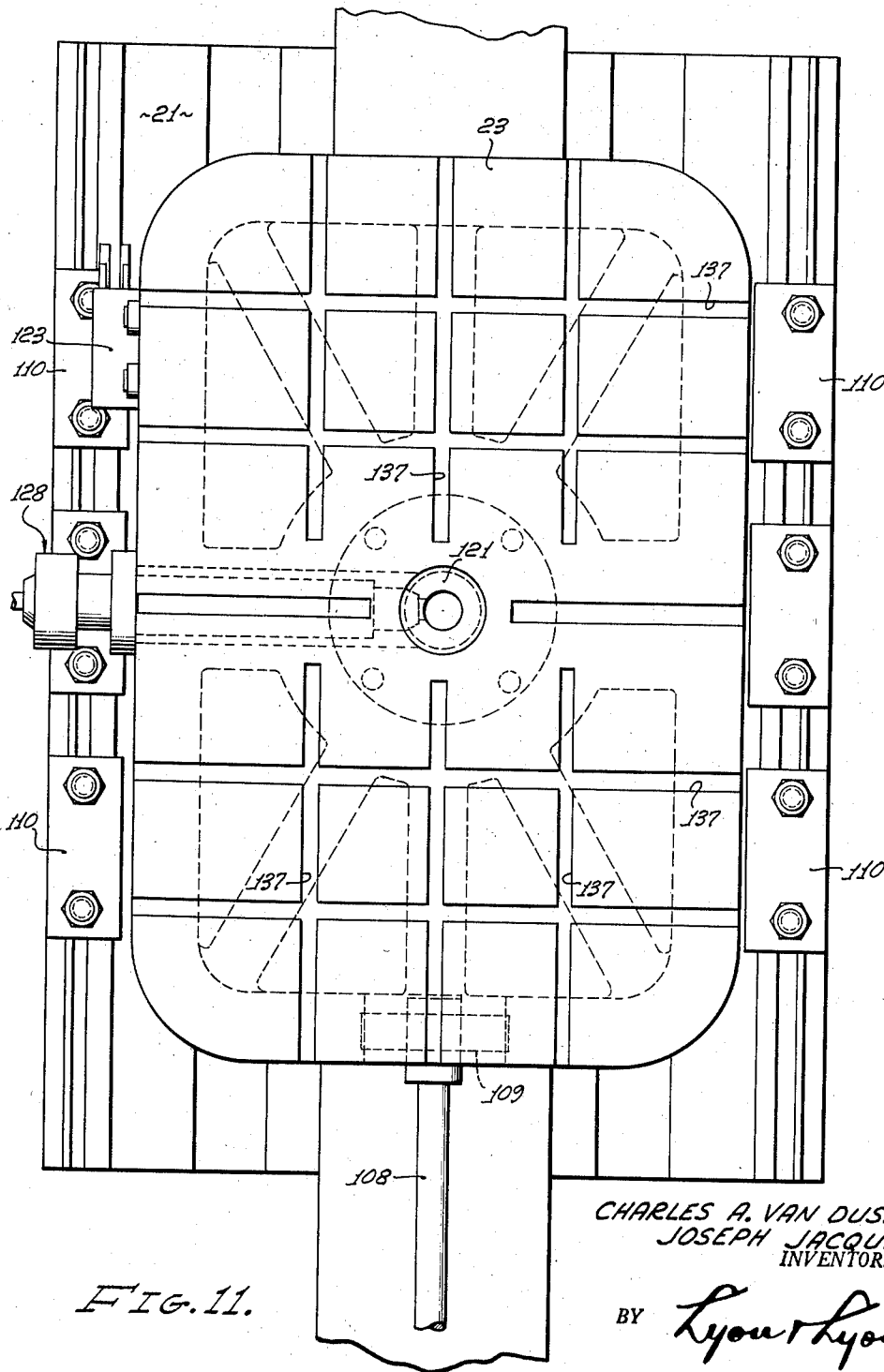
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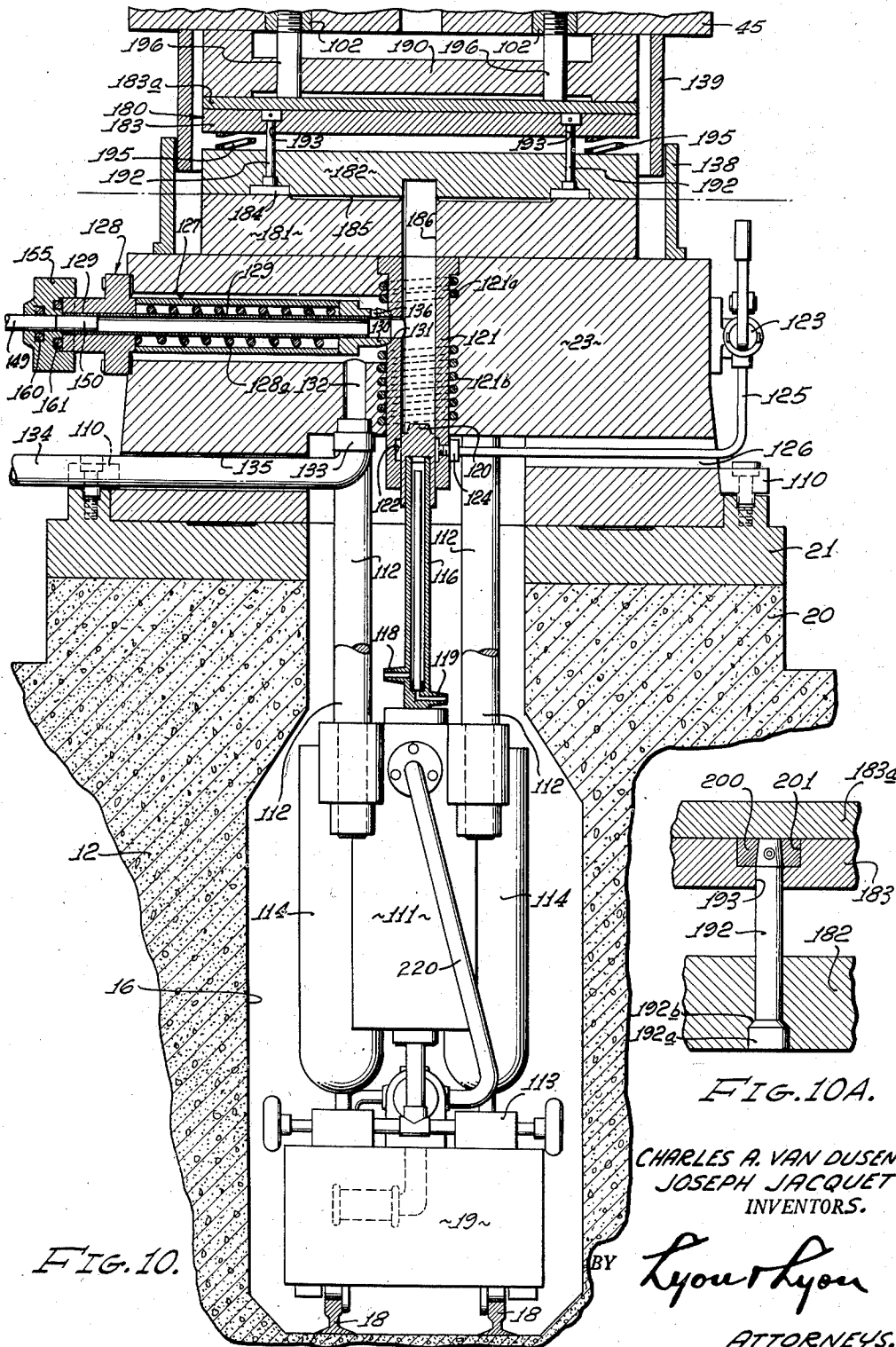
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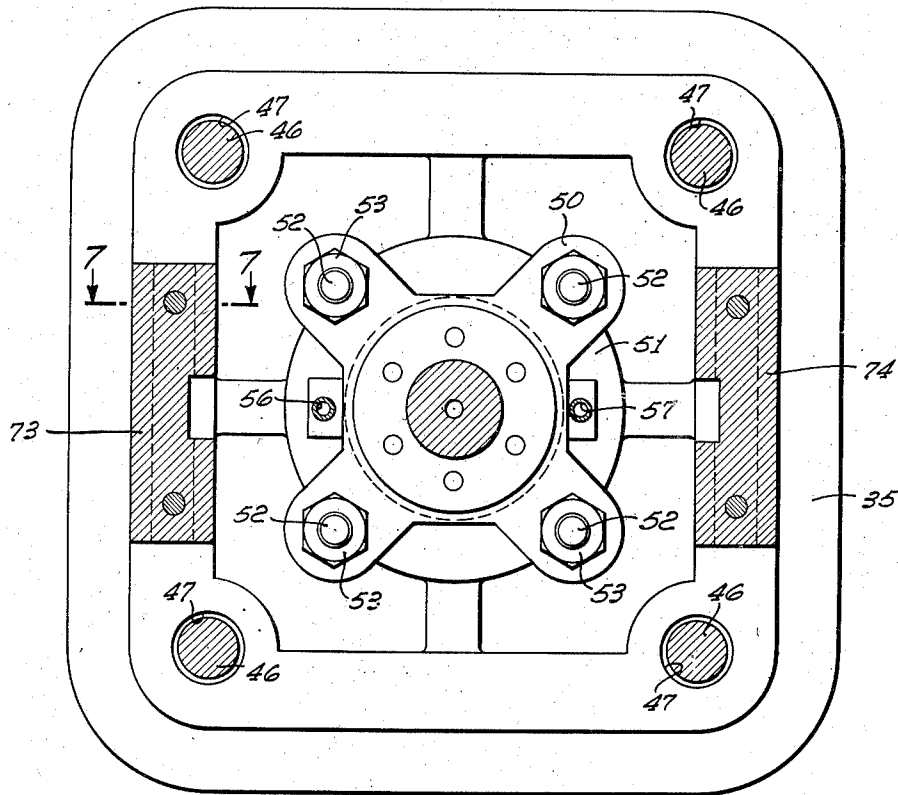


FIG. 6.

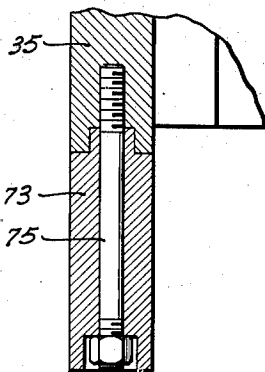


FIG. 7.

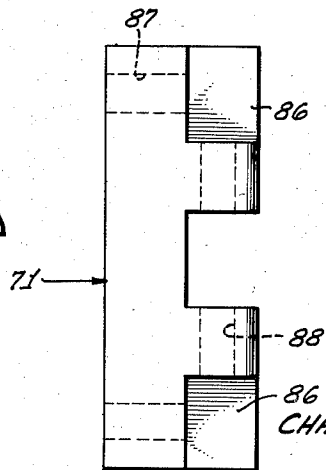


FIG. 8.

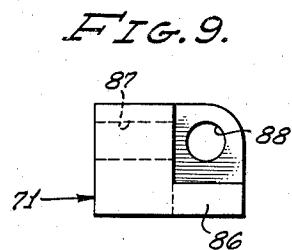


FIG. 9.

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11 Sheets-Sheet 9

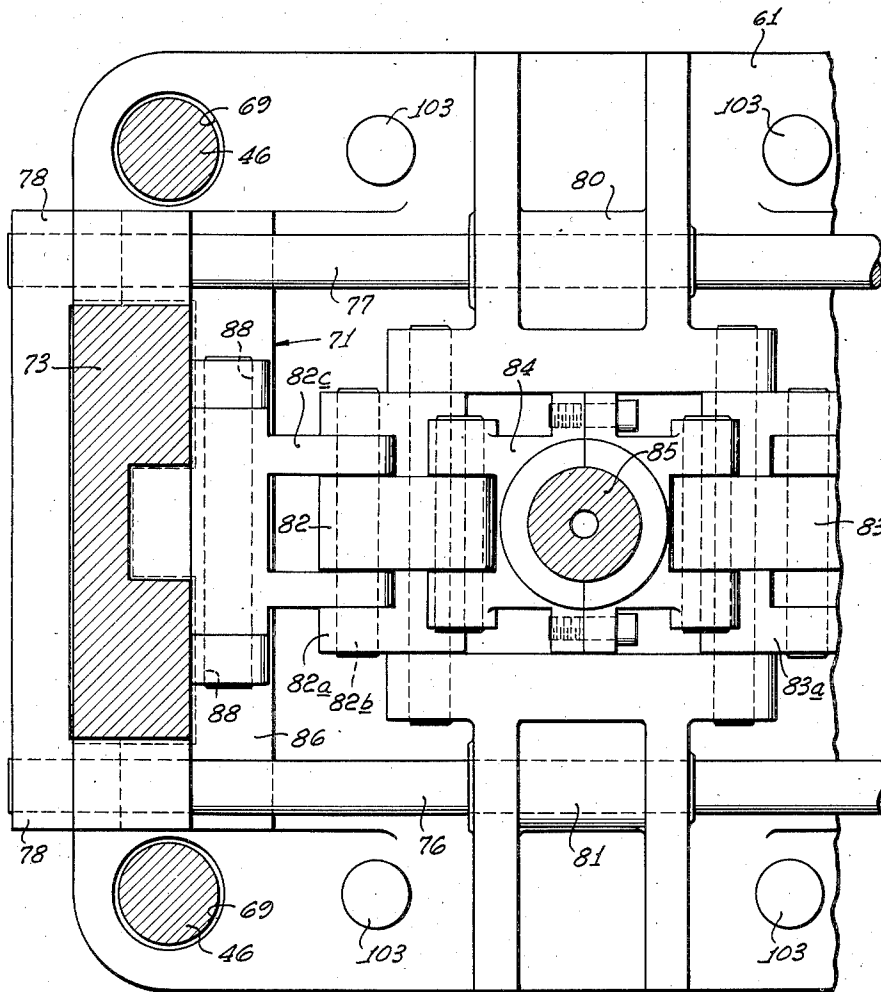


FIG. 5.

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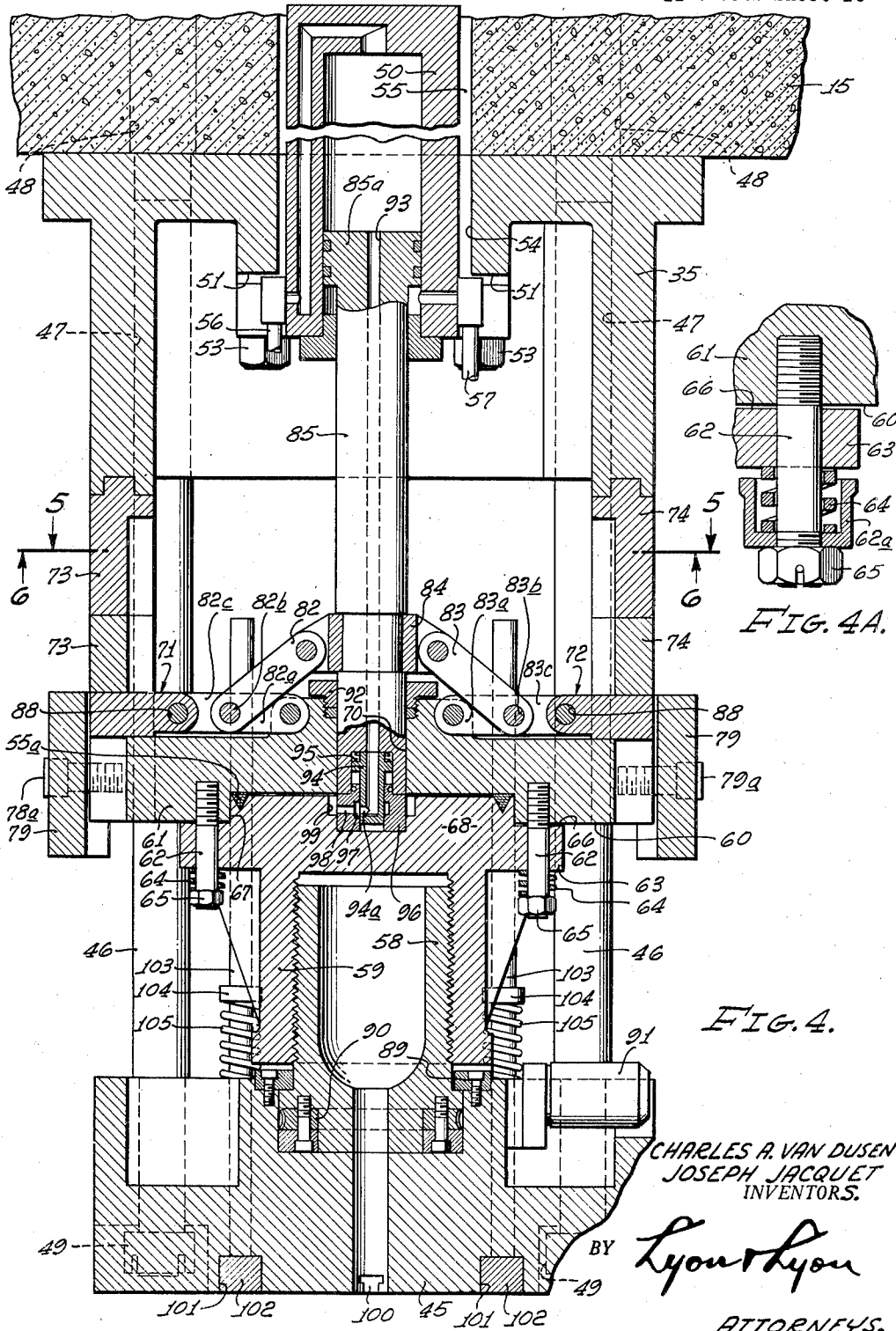
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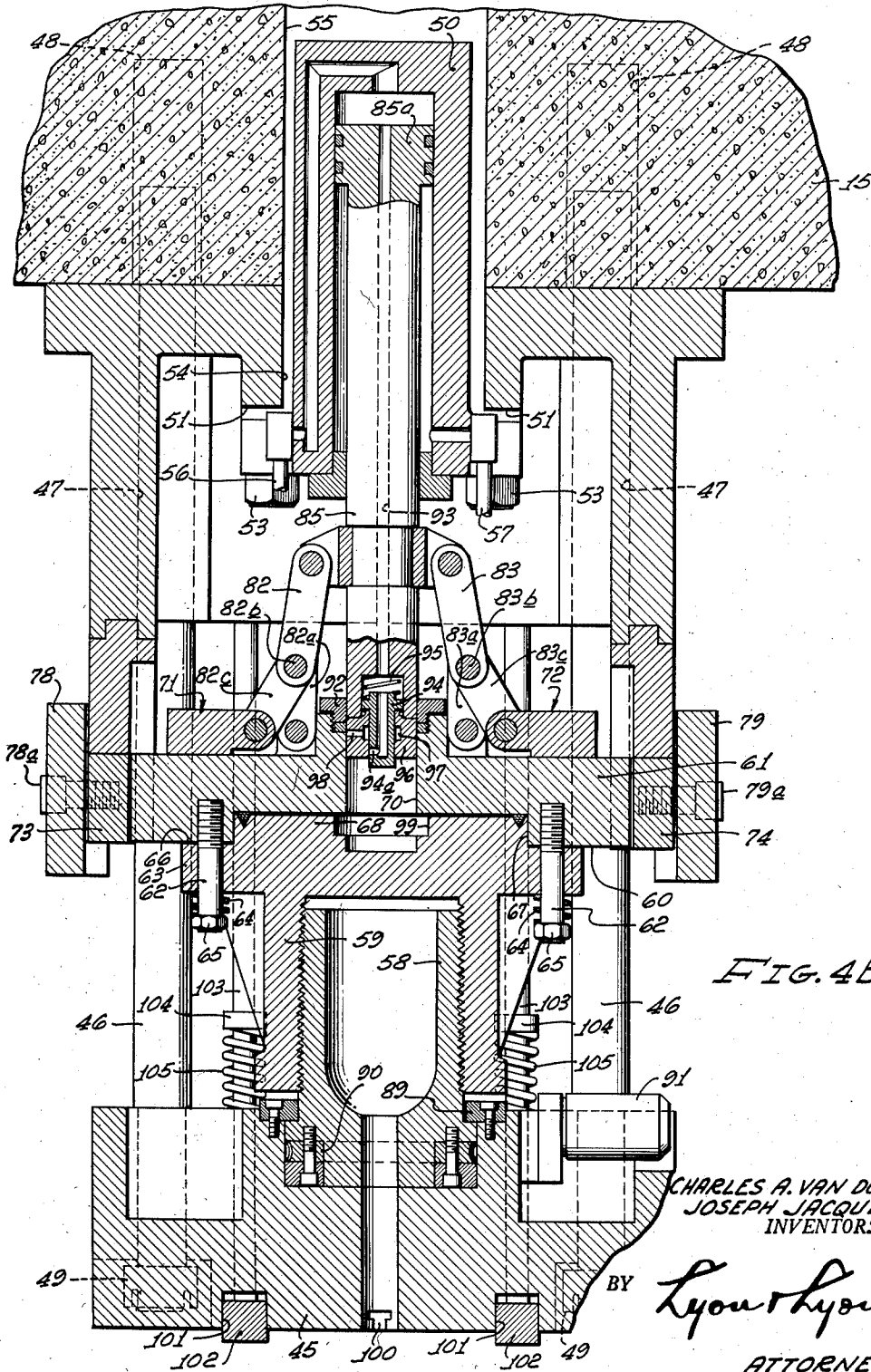


FIG. 4B.

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DIE CASTING MACHINE

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Application May 31, 1956, Serial No. 583,422

14 Claims. (Cl. 22—68)

This invention relates to the die casting art and has particular reference to a novel die casting machine.

This invention is directed to the provision of open-throat vertical molding die casting machines of conventional and/or large capacities and to such a machine having a frame formed of a structural mass such as reinforced concrete, the upper parts of the structure being utilized as a dead weight to resist the forces of the machine mechanism and the structure being such as to permit location of the machine components within a large clear area.

The nature of the machine of this invention is such that very large-capacity machines can be built which are not possible with the present conventionally-designed die casting machines. The invention is equally advantageous for the die casting of metal or plastics.

Conventional capacity die casting machines, which utilize tie rods to resist the machine forces, are impaired by poor utilization of their full platen area. The fact that the tie rods obstruct at least the corners of the machine platen, seriously interferes with the ease of manipulation and handling the part to be cast.

In the die casting process, the die gate through which the molten metal is fed into the die is not always symmetrically located along the geometric center of the die cavities but, in order to allow for even distribution of heat through the die, the cavities are symmetrically arranged in respect to the mass of material by which they are surrounded. Often the gate is off-center about the principal axis of the die. In order to keep the principal axis of the die along the axis of the machine to prevent eccentric loading, the metal sleeve located within the platen must be off center to connect the gate of the die. In a conventional machine the platen carries two locations and the metal sleeve is moved from one to the other according to the eccentricity of the die gate. The amount of displacement is always constant and is not very large, also the metal sleeve has to be moved and with it independently the entire metal injection components, including the hydraulic shot cylinder and power unit.

The capacity of a die casting machine has been limited by the sizes of the component parts. Typical machine construction utilizes tie rods which must be of high strength steel to withstand the forces of the machine and to hold together the two end components. As the tonnage capacity grows very large, these tie rods get up to enormous sizes in diameter and length. Such large sized steel components take large sized foundry and machine capacity just to make the parts of the machine. Further, large cavities or impressions in the die of large capacity die casting machines allow for air entrapment, impairing the soundness of the part to be produced.

As the capacity of the machine grows larger, the part to be cast also comes to large sizes and weights, introducing relatively large volumes of molten charges into the metal sleeve of the machine. Consequently, heating

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furnaces and conveyors for the molten metal grow proportionately larger and this means increase of time to deliver the charge from the furnace into the die casting machine.

In the die casting process, it is of the utmost importance that the molten metal be brought to a proper temperature in a furnace and then quickly ladled into the metal sleeve of the machine. Because it has a great influence upon injection speed, which is one of the most important factors in the die casting process, proper heat content of the molten charge has to be kept under close limits; therefore, it is a good practice to avoid long travel for the molten charge after ladling it out of the furnace. The most ideal conditions for a die casting machine are met when the heating element is an integral part of the machine, as it is in a hot chamber die casting machine which is commonly used for zinc and lead alloy castings.

Accordingly, one of the principal objects of this invention is to provide a novel die casting machine which is not subject to the above and other disadvantages of the prior art, and which accomplishes the objectives set forth above and hereinafter.

An object of the invention is to provide a wide throat, vertical die casting machine.

Another object of the invention is to provide a die casting machine having 360° access in the horizontal plane to the die platen, in order to have a maximum of freedom in utilization of the machine.

Another object of the invention is to provide a novel die casting machine of either conventional or large capacity.

Another object of the invention is to provide a die casting machine wherein the forces of the machine are resisted by the weight of a mass rather than resisted by tie rods.

Another object of the invention is to provide a die casting machine wherein the forces of the machine are resisted by a large and thick structural mass such as reinforced concrete which has sufficient bulk to be rigid.

Another object of the invention is to provide a die casting machine contained within a concrete frame wherein the weight of the upper slab, which is freely carried by the wall of the frame, plus the weight of the upper components of the machine is more than sufficient to resist the forces exerted by the machine.

Another object of the invention is to provide a die casting machine frame which is earthquake and bomb resistant.

Another object of the invention is to provide a die casting machine so constructed that the bed of the machine can be transversely moved along one of the horizontal axes of the machine.

Another object of the invention is to provide a die casting machine so constructed that the lower platen of the machine is larger in one direction than the upper platen to allow for large off-center gating on the die held between the two platens.

Another object of the invention is to provide a die casting machine wherein the oil tank, motor, pump, accumulator and valves to operate the injection end of the machine are located beneath the lower platen of the machine and are carried by a rail car which is attached to the platen through a vertical beam fastened to the two components.

Another object of the invention is to provide a die casting machine of large capacity with a plurality of injection shot cylinders located underneath the lower platen of the machine wherein the power injection unit is carried by a rail car dependent on the lower platen through two vertical beams fastened to it.

Another object of the invention is to provide a die casting machine construction wherein the crown, hydraulic cylinder and upper platen of the machine, as one complete unit, is dependently carried by a structural mass, having a thickness sufficient to be rigid to resist the force placed thereon in the center by the load in the machine.

Another object of the invention is to provide a die casting machine wherein overload in the machine is resisted by an excess of weight capacity of the upper mass rather than resisted by the strength of the structural frame.

Another object of the invention is to provide a wide throat die casting machine which utilizes an integral induction furnace.

Another object of the invention is to provide a die casting machine wherein the charge is a cylindrical precut slug which is melted down within a cera-metallic crucible lining of an electric induction furnace, the heating being accomplished by an induced electric current within the metal being melted.

Another object of the invention is to provide a die casting machine wherein an integral electric induction furnace is directly connected to the injection metal sleeve of the machine, so that the molten metal may be quickly rammed into the metal sleeve through a ceramic-tipped plunger of an independent hydraulic cylinder.

Another object of the invention is to provide a die casting machine wherein a vacuum device is used to produce a vacuum within the die impressions and within the melting chamber of the induction furnace simultaneously.

Another object of the invention is to provide a die casting machine using a cold charge comprising a precut slug melted under vacuum to promote clean metal and absence of oxidation or gas porosity.

Another object of the invention is to provide a die casting machine wherein the die is enclosed within two independent thick cast steel rings which fit each into the other on closing position of the die casting machine, providing a shield to protect the operators from flash-out of molten metal.

Another object of the invention is to provide a die casting machine which utilizes a booster hydraulic cylinder of a large diameter and very small stroke, requiring the introduction of only a relatively small volume of oil into the booster components so that the compressibility ratio times volume of oil is very small, having, when divided by the relatively large cylinder area, a very small amount of fluid elastic deflection in the vertical direction.

Another object of the invention is to provide a die casting machine wherein a booster cylinder is used to lock the two halves of the die, and to stress the machine members by a force which is more than sufficient to resist the total load due to impact or thermal loading, the booster piston having a limited amount of universal action to compensate for unparallelism due to local and uneven thermal stress within the die and due to any lack of parallelism in the die faces.

Other objects and advantages of this invention, it is believed, will be readily apparent from the following detailed description of preferred embodiments thereof when read in connection with the accompanying drawings.

In the drawings:

Figure 1 is a perspective view of a preferred form of die casting machine embodying the invention.

Figure 2 is a front elevation thereof.

Figure 3 is a sectional view taken substantially on the line 3—3 of Figure 1, the gantry crane and upper power unit being removed for clarity of illustration.

Figure 4 is a sectional view taken substantially on the line 4—4 of Figure 3, illustrating the upper components of the machine.

Figure 4A is a fragmentary sectional view on an enlarged scale, taken from Figure 4 and illustrating the means for securing the booster cylinder assembly to the platen assembly.

Figure 4B is a view similar to Figure 4, but illustrating the machine in the open position.

Figure 5 is a fragmentary sectional view taken substantially on the line 5—5 of Figure 4.

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

Figure 7 is a fragmentary sectional view taken substantially on the line 7—7 of Figure 6.

Figure 8 is a top plan view of one of the sliding shoe elements.

Figure 9 is an end view of one of said sliding shoe elements.

Figure 10 is a sectional view taken substantially on the line 10—10 of Figure 3.

Figure 10A is a fragmentary sectional view on an enlarged scale, taken from Figure 10 and illustrating details of one of the die ejector pins.

Figure 11 is a top plan view of the lower component of the machine, taken substantially on the line 11—11 of Figure 3.

Figure 12 is a front elevation of the independent hydraulic feeding cylinder.

Figure 13 is a perspective view of a modified form of the die casting machine of this invention.

Figure 14 is a fragmentary vertical sectional view, illustrating the connection between the top slab and the vertical side frame members.

Figure 15 is a sectional view taken substantially on the line 15—15 of Figure 14.

Figure 16 is a side elevation of a further modified form of the invention.

Figure 17 is a sectional view taken substantially on the line 17—17 of Figure 16.

Figure 18 is a sectional view taken substantially on the line 18—18 of Figure 17.

Figure 19 is a sectional view taken substantially on the line 19—19 of Figure 18.

Referring now to the drawings, Figures 1, 2 and 3 illustrate the general construction of the machine. The machine includes a frame 11 which generally comprises a base or bottom slab 12, side walls 13 and 14, and a top slab 15 defining a wide-throat opening 17. In this embodiment the entire frame 11 is made from reinforced concrete, the slabs and side walls being integral to form a monolithic structure. The base 12 has horizontal dimensions and thickness sufficient to withstand the bearing load for the soil or rock on which it is rested. The base is provided with a trench 16 which runs along the longitudinal horizontal axis, perpendicular with respect to the vertical plane of the frame opening 17. Rails 18 are provided on the horizontal bottom of the trench. A rail car 19 is movable on the rails 18 and carries the hydraulic injection power unit.

The base 12 is provided with a central horizontal raised portion 20 forming a foundation for the bed 21 of the lower component of the machine, which includes the lower platen 23. The foundation 20 is high enough so that the horizontal upper surface 22 of the lower platen 23 is easily accessible to a man of average height. The horizontal opening of the trench is partially covered by a flooring 24. The bottom slab 12 has a horizontal upper surface 30 which forms the working floor of the machine. The lower surface 31 of the bottom slab carries a highly reinforced and integral slab rib 32, the strength of which is designed to compensate for the high bending stress concentration occasioned by the trench 16.

The top slab is provided with reinforced steel 33 which extends in two directions and is placed under tension and locked into the concrete so that the lower portion of the top slab is prestressed in compression in two generally perpendicular directions in the horizontal plane. The upper portion of the slab has similarly reinforced concrete 34 in two directions and placed under tension locked into the concrete so that the upper part of the top slab is prestressed in compression in two generally perpendicular

directions in the horizontal plane. This arrangement enables the top slab to withstand greater flexural forces set up by the machine and improves the ability of the concrete slab to take the bearing load from the crown 35 of the machine. It also permits thinner slabs giving more span for the same weight of slab than would otherwise be possible.

The bottom slab 12 is similarly prestressed in compression with reinforced steel 36 and 37 which extends from each side of the trench 16 in two perpendicular directions in a horizontal plane. The lower portion of the slab 12 is also prestressed in compression by reinforcing steel 38.

The top slab is supported by the walls 13 and 14 which are made of reinforced concrete to withstand the load placed upon them.

The top slab is heavy enough to take up the rated tonnage capacity of the machine plus at least 10% overweight to compensate for overload.

The concrete frame 11 houses the complete die casting machine which embodiment has two separate components, the upper end or clamping die mechanism 39, and the lower base and injection mechanism 40.

The upper component of the instant machine is supported from the upper slab by means of cables 41. The cables run vertically through apertures in the top slab 15 and are fastened by suitable fastening means near the upper surface 26 of the slab. The apertures may be formed in any suitable manner, such as by casting pipes (not shown) into the slab as it is formed. In installing the upper component, it may be assembled on the floor of the machine. Winches 42 carrying additional lengths of cables may be placed in position on the upper surface 26. The cables on the winches may be payed out and run down through the apertures in the top slab 15. The cables on the winches may be then fastened to the cables 41 which are attached to the crown 35 of the upper end of the machine. The winches may then reel in the cables until the upper component is in position with the upper surface 43 of the crown 35 against the lower surface 25 of the slab 15. The cables 41 may be fastened by fastening means 44 to the top slab 15 and then the winches removed if desired.

Figures 4-9 show the upper component 39 of the instant die casting machine, comprising an upper platen 45 guided for vertical reciprocation by four columns 46 which run upward through matching bronze sleeved bores 47 into the crown 35. Four blind holes 48 in the slab 15 allow for retraction of the columns 46 when they are in ascending motion when the machine is on opening operation. The columns 46 are rigidly secured into the upper platen 45 by nuts 49. The upper crown 35 carries a double acting hydraulic cylinder 50 which is rested against the crown face 51 and maintained in position thereagainst by studs 52 and nuts 53 (see Figures 4 and 6).

The hydraulic cylinder 50 extends upward vertically through a large diameter central bore 54 in the crown which matches the opening 55 provided in the center of the slab 15. Fluid connections 56 and 57 are provided on the lower end of the hydraulic cylinder for easy access to the valving components and maintenance of the hydraulic cylinder.

The upper platen 45 carries concentrically about its vertical central axis an adjusting screw 58 for adjustment of the vertical height between the platens to accommodate different die heights. The acme threaded part of the screw 58 is screwed into the female matching bore of a booster element 59. The booster 59, generally cylindrical in shape, is maintained against the lower face 60 of a secondary platen 61 by a number of studs 62 screwed into the platen 61 and extending downwardly through matching holes drilled in the collar 63 of the booster. For every stud there is a compression spring 64 and nut 65 to exert upward pressure under the lower surface of the collar 63 and, when acting all together, 75

the springs exert a sufficient upward force to bring the upper face 66 of the collar into contact with the lower face 60 of the platen 61. Preferably, as shown in Figure 4A, a cup spacer 62a is provided for each stud to limit the deflection of the springs 64 under load during upward movement of the platen 45.

The lower face 60 has a large diameter cavity 67 which forms the booster cylinder and in which fits the upper cylindrical portion 68 of the booster 59, the portion 68 comprising the booster piston. A high pressure-resisting V packing 55a is provided for oil tightness between the lateral surfaces of the cavity 67 and piston 68. The secondary platen 61 has also four bronze sleeved bores 69 which are aligned with the columns 46, which go through and guide the secondary platen along their vertical axes. The platen 61 also has an open bore 70 concentrically located about the cavity 67 and along the center of the platen 61.

A pair of sliding shoes 71 and 72 are provided to move transversely on the upper machined horizontal face of the secondary platen 61 for transmitting the machine forces from the platen 45 through the secondary platen 61 and crown 35 to the top slab 15. When the stroke is down (machine closed) the sliding shoes are positioned outwardly and under the strut spacers 73 and 74. It will be understood that the clearance between the shoes and the strut spacers is less than that between the cup spacers 62a and the lower surface of the collar 63 to prevent overstressing of the studs 62.

The strut spacers are maintained vertically parallel to each other along two sides and upon the lower vertical face of the crown 35. Each strut spacer fits the crown through a dado joint, and fastening means is provided by several studs 75 screwed up into the base of the crown 35 (see Figure 7). As illustrated in Figure 4, the strut spacers 73 and 74 have been shown made in two sections. Such design will permit more versatility to obtain larger die spacing when necessary. However, this particular embodiment will impair the travel of the stroke which becomes shorter proportionately to the height of the removed lower section of the strut spacer.

The sliding shoes 71 and 72 are free to move horizontally and are guided by two rods 76 and 77 which extend parallel to each other transversely above the upper horizontal face of the secondary platen 61. The rods 76 and 77 are supported at their ends by two large brackets 78 and 79 which are fastened to the secondary platen 61 by means of studs 78a and 79a. The rods 76 and 77 extend through two bored bosses 80 and 81 which are integral parts of the platen 61.

The sliding shoes 71 and 72 are simultaneously operated through a linkage mechanism which includes two links 82 and 83 pinned to the clevis bracket 84. The clevis bracket 84 is formed in two halves which enter into a neck of the piston rod 85. Two other U-shaped links 82a and 83a of the linkage mechanism are pivoted at one end to the pins 82b and 83b on the platen 61, and are pinned at the other end to the links 82 and 83. A third pair of links 82c and 83c are pinned at one end to the links 82, 83 and 82a and 83a, respectively, and at the other end to the shoes 71 and 72. The sliding shoes have a large thick base area 86 to minimize high stress concentration upon their resting surface on the platen 61. Two bronze sleeved bores 87 are provided in the shoes for the rods 76 and 77. A bore 88 is provided in the shoes for location of the link pins for the links 82c and 83c. To allow retraction of the secondary platen 61 in the upward direction, clearance is provided between the platen 61 and the spacers 73 and 74, as illustrated in Figure 5 by the dotted line surrounding the hatched surface of the strut spacer 73.

The adjusting screw 58 has its lower part located in the platen 45 and maintained in place by a retainer ring 89. The lower end of the adjusting screw 58 is provided

with a worm gear 90 having a worm on the drive shaft thereof driven by an electric motor 91.

The piston rod 85 extends vertically downwardly from the piston 85a within the double acting hydraulic cylinder 50 and penetrates into the secondary platen 61 within the open bore 70. The piston rod 85 is designed to remain within the bore 70 when the stroke is up. Packing 92 is provided for oil tightness between the piston rod 85 and bore 70.

The end of the piston rod 85 carries a valve to direct the flow of oil into the booster components. Thus, the piston is provided with a hole 93 drilled all the way through from one end to the other along the central axis. Hole 93 is counterbored for location of a valve stem 94 and spring 95. A cylindrical valve body 96 is fastened at the end of the piston rod 85, and is oil tight to prevent leakage when the stem 94 is down. The stem 94 has a drilled blind hole along its major axis and has a number of exhaust drill holes 94a. The valve body 96 is provided with a groove 97 and ports 98. All fits, for the making of the valve, should be in conformity with the tolerances commonly used for directional control valves, this in order to minimize leakage when the valve is closed. A counterbored cylindrical cavity 99 is provided on the upper part of the booster 59 to contain the valve body when the stroke is down. The purpose of this is to obtain the maximum length of the piston rod entering the secondary platen 61.

The lower horizontal face of the platen 45 is provided with a number of T slots 100 which are provided for clamping the upper half of the die in position, as will be described more fully below.

Two locations 101 for ejector bars 102 are also provided and run transversely perpendicular to the front side of the platen 45. Retainer actuating guides 103 maintain the ejector bars 102 in position through collar 104 and spring 105. On their way up, the retainer actuating guides 103 bumping against the lower horizontal face of the crown 35 operate the ejector bars 102, thus providing positive knock out action, as will be more fully explained below.

Figures 10-12 illustrate the design of the lower component or injection end 40 of the machine. The injection end of the instant die casting machine has a bed 21 in the form of two large slides which are rested on the concrete foundation 20. The bed 21 carries the vertically stationary lower platen 23 which can be moved in one direction by means of a hydraulic cylinder 107, as illustrated in Figure 3. The piston rod 108 of the hydraulic cylinder 107 is pinned upon the clevis 109 which is attached on the lower portion of the platen 23. A plurality of wedged clamps 110 (Figure 11) along two sides of the bed 21 keep the platen 23 rigidly positioned against transverse movement.

The hydraulic shot cylinder 111 is located beneath the platen 23 and attached to it by four columns 112 (see Figure 10). The hydraulic power unit 113 and nitrogen accumulator bottles 114 are carried by a rail car 19 which is also the oil tank for the power unit. As illustrated in Figure 3, the rail car is rigidly attached to the lower face of the platen 23 through a vertical beam 115 which is secured on one vertical side of the rail car 19.

Extending upwardly from the hydraulic shot cylinder, the instant die casting machine has a hollow plunger 116 which embodies an arrangement for circulating water through connections 118 and 119. This is to provide cooling to the ram.

The end of the plunger 116 carries the ram 120 which enters a metal sleeve 121, located in the center of the platen 23 and provided with a groove 122 which is connected to the grease pump 123 through coupling 124 and pipe 125 which extends through a core 126 of the platen 23. Auxiliary heating means comprising coils 121a and 121b surround the sleeve 121.

Extending from one side of the platen 23, a round core

127 is provided for location of the induction electric furnace 128 which is bolted and sealed against the perpendicular face of the platen 23. The induction electric furnace is provided with coil 128a and a cerametallic lining 129. When the induction furnace is assembled, the tapered part of the furnace nozzle 130 communicates with an opening 131 in the metal sleeve. As shown, core 127 is of larger diameter than the induction furnace 128. Drilled hole 132, coupling 133 and piping 134 running through a horizontal bore 135 in the platen 23 connect the core 127 to a vacuum pump (not shown) preferably mounted on top of the slab 15. In order to achieve vacuum in the die cavity and within the induction furnace crucible, an aperture 136 is provided to connect the bore of sleeve 121 to the electric induction furnace. The lower half of the die (described hereinafter) is clamped upon the upper horizontal face of the platen 23 by means of T-slots 137 and is mounted within the cast steel ring 138 with the upper telescopic part 139 which is adapted to enclose the upper half of the die.

Figure 12 illustrates the auxiliary hydraulic cylinder assembly which cooperates with the induction furnace for feeding slugs of the metal to be cast. It is obvious that this cylinder has to slide in one direction parallel to the sliding of the platen 23. For this purpose the auxiliary hydraulic cylinder 141 is rested on a base 140 laid and attached to the upper face 30 of the concrete slab 12. The hydraulic cylinder 141 is supported horizontally in a heavy bracket 143 bolted onto the head of a piston 142. A vertical cylinder 143 rests upon the base 140 and has on its lower horizontal surface a keyway 144 which fits key 145 in the base 140 along the major axis thereof. Clamps 146 and bolts 146a are provided to rigidly secure the whole unit in position.

The piston 142 is guided and its stroke is adjusted by guide post 147. As shown, the post is anchored to a boss 143a on the cylinder 143 and extends through an aperture in a boss 141a on the bracket 143, the upper end of the post being provided with a nut 147a. Such design permits the horizontal cylinder 141 to retract downward out of the way when feeding the induction furnace with the round precast slug, as will be described more fully below.

Operable within the hydraulic cylinder 141 is a piston rod 149 and a ceramic ram element 150 carried on the end of the rod. The ram 150 fits closely within the lining 129 of the induction furnace. The ram element extends through a cover member 155 on the outer end of the furnace 128. Suitable high-temperature seals 160 and 161, as illustrated in Figure 10, prevent leakage of air into the furnace when vacuuming the die.

Cylinders 141 and 143 are independently connected through flexible hose (not shown) to a low pressure hydraulic power unit (not shown) which can be located either on the top slab or rested on the floor 30 of the lower slab.

Diagrammatically illustrated in Figure 10 is a die assembly, generally indicated 180, adapted to be used with the machine of this invention. It will be understood that the specific die assembly shown is for purposes of illustration only and does not per se form a part of the present invention.

The die casting die 180 is split into two sections, a lower section or the cover die 181 and an upper section or ejector die 182. The cover die 181 is fastened to the stationary platen 23 of the casting machine by means of the T-slots 137 and does not move during the casting cycle. The ejector half 182 is mounted on the movable or upper platen 45 of the machine and carries an ejector plate formed in two parts 183 and 183a, for removal of the part from the die cavity 184 which is formed or machined in each half of the die. Runners 185 lead from the die gate 186 to the cavity. Both surfaces forming the parting line must be smooth and finished so that the die halves fit closely together. It is also apparent

that the two halves of the die must be in exact register when the die is closed, and the usual method of accomplishing this is to use dowel pins (not shown). The dowel pins are always positioned into the stationary or cover die member. The other components of the die include the die base 190 which is made of cast iron or cast steel and to which the ejector die 182 is mounted. In the simple type of die ejector shown, pins 192 are used to push the part from its cavity after the machine opens. These pins 192 are mounted in the ejector plate 183 and slide with a great deal of accuracy through holes 193 into the ejector die. The ejector plate is guided by means of dowel pins (not shown) located either on the die base or on the ejector die half. A plurality of strong springs 195 are interposed between the die half 182 and the ejector plate 183 to push the ejector plate upward when the machine is closed.

Ejector bumpers 196 are positioned at convenient places along the ejector bars 192 of the machine. When the machine opens, the ejector plate is pushed downwardly by the operation of the ejector bars which are forced downwardly automatically at a predetermined point by means of the rods 103 (Figure 4) which compress springs 105 through the collar 104.

In order to prevent air from re-entering the cavity when the vacuum has been accomplished, as will be described below, the ejector pins 192 are made air tight. Referring to Figure 10A, each of the ejector pins is provided with a tapered end which fits in a cap 200 located in counter-bore 201 in the ejector plate section 183. The heads 192a of the pins 192 have tapered surfaces 192b which are lapped against corresponding surfaces of the die half 182.

In operation of the machine of this invention, a suitable die such as the die 180 is first properly mounted in the machine. With platen 45 in the raised position, the cover die 181 is mounted on the face of the stationary platen 23. When the die gate 186 and the metal sleeve 121 are in exact register to each other, the cover die is securely fastened against the face of the platen 23.

Then the upper half of the die is mounted in position on the cover die which is already attached to the platen 23. In that position the die is carried by the platen 23 and is moved with it transversely to bring the central axis of the die along the central axis of the machine. This operation is performed by actuating the hydraulic cylinder 107 which operates the sliding of the platen 23 and the components attached to it, as indicated above. When the die is so positioned, the platen 45 is brought down slowly and the vertical height between the platen is adjusted by means of the adjusting screw 58. The upper part of the die is then securely fastened by means of the T-slots 100 against the face of the platen 45. The machine is then opened to permit mounting of the protector rings 138 and 139. The wedged clamps 110 are then tightened down rigidly to prevent motion of the stationary platen during the operation of the machine.

The feeding cylinder 141 is then manually or mechanically moved along its bed 140 and clamped down when it is brought into alignment with the induction furnace 128. Vacuum line 134 is connected to a high vacuum pump (not shown) through flexible hose or telescopic pipe (not shown) to allow for the displacement of the platen 23 without having to disconnect the air vacuum system.

The clamp operating cylinder operates as follows:

The piston 85a is advanced downward by gravity while the cylinder prefills through a prefill valve (not shown). A counter balance of back pressure under the lower face of the double acting piston prevents gravity drop of the moving weights supported by the piston. When resistance is encountered by the platen, pressure conducted through a branch line (not shown) operates a sequence valve (not shown) which is built into the prefill valve, and causes at the same time pressure flow from the pump 29 on the upper acting end of the piston.

The operation of the injection cylinder 111 is as follows:

Oil for the forward or injection stroke is supplied by a branch line 220 leading to nitrogen loaded accumulator bottles 114 which permit fast injection of metal by oil stored under pressure. The accumulators are charged by the pumping unit at a determined pressure which may be controlled by a relief valve.

Mechanical operation of the machine itself is as follows:

Starting with the machine open, as shown in Figure 4B, the platen 45 is up and in this position the intermediary platen 61 is in its upward position. The shoes 71 and 72 are in their inmost retracted position and the piston rod 85 and piston 85a through the linkage mechanism carries the weight of the components which it operates, that is: linkage, shoes, intermediary platen 61, booster 59, screw 58, platen 45, guide post 46 and the upper half of the die. In this position the stem 94 of the foot valve is down, and the oil flow from cylinder to booster is shut off.

Opening the back pressure circuit under the hydraulic cylinder 50 provides gravity downward motion of the piston and the components attached to it. Downward motion of the platen 45 and intermediary platen 61 proceeds until the platen 45 is stopped, that is, up to the moment where the two halves of the die are closed together.

At this point, through hydraulic operation of the cylinder 50, high pressure is built up on the upper face of the double acting piston 85a and the latter continues its downward motion. This motion causes the shoes 71, 72 to slide outwardly through the action of the toggle mechanism links 82, 83. The booster 59 and intermediary platen 61 are held close together by the action of the springs 64. Predetermined clearance has been left between the shoes 71, 72 and the strut spacer 73 and 74 so that shoes 71 and 72 are freely engaged under the strut spacers, and they come to rest when stopped by the brackets 78 and 79. In the final motion of the double acting piston, the stem 94 of the foot valve is raised upward and flow of oil begins into the booster cylinder, pulling apart the intermediary platen 61 and booster 59. The booster 59 is at rest and cannot go further down, so that the intermediary platen moves upward until this motion is resisted by the shoes under the strut spacers 73, 74. Then building up the pressure into the booster cylinder results in stressing in compression the holding components of the die. In this position the machine is closed and the dies are held tightly together under full maximum pressure for resisting the force of injection within the cavity.

The charge of the induction furnace is preferably a cold solid charge, which is made from extruded rod usually round in cross-section sawed accurately to length. The length and the weight of the slug is determined according to the weight of the part to be produced plus the weight of the excess metal necessary to fill the runners and the gate of the die. The diameter of the slug must be slightly smaller than the bore diameter of the furnace lining 129.

The operator pushes the slug into the induction furnace within the ceramic lining 129. This lining, for operation in an induction field, is preferably provided with small diameter conducting elements such as carbides, while the frequency of the induction furnace is kept low.

When long slugs are used, room between feeding cylinder and induction furnace may be insufficient, and difficulty of handling the slugs into the furnace is encountered. Accordingly, the feeding hydraulic cylinder is moved downwardly in order to clear the aperture of the induction furnace during handling of the slug.

After the slug has been placed within the induction field, the ram 150 of the feeding hydraulic cylinder is moved forwardly to plug the opening of the induction furnace, the seals 160 and 161 being provided for air tightness. Through grease pump 123 the operator crams

a charge of heavy grease around the plunger ram 122 so that air tightness is also provided at this end.

The high vacuum pump working throughout the operation of the press produces air vacuum in the die cavity and within the induction furnace while the melting of metal takes place. When the metal is melted and at the correct temperature for injection, the induction current is turned off and the feeding cylinder rams the molten charge into the metal sleeve on top of ram 120 which immediately rams the charge into the die by the action of injection cylinder 111 forcing the plunger upward. Ram 120 remains up while the metal chills in the die, and resumes its upward motion when the machine is opened to help ejection of the part from the cover die.

Opening of the machine proceeds in the following manner:

Decompression above the upper face of the double acting piston and into the booster cylinder allows the springs 64 to bring back the intermediary platen 61 against the booster 59. It should be pointed out that springs must be very stiff and their holding capacity has to be well larger than the weight of the components that they carry, so as to minimize their deflection on the upward motion of the machine. The system for limiting the spring deflection shown in Figure 4A is described above. The pressure is then shifted to the underside of the double acting piston to move it upward. The shoes are retracted by the toggle action and the stem valve 94 is pushed down by action of spring 95. When the shoes are back at their inmost retracted position, the upward motion of the piston is transmitted to the intermediary platen, booster and platen, the machine opens, guided by the guide posts 46 which also move up and retract into the holes 48 in the upper slab 15. At a predetermined position of the platen 45 on its way up, the rods 103 bump upon the lower edge of the crown, forcing the ejector bars 102 down. The bars operate the ejector plate of the die and through it the ejector pins to eject the finished part.

An important feature of the invention resides in the fact that the floor area of the machine frame 11 is larger than the space area occupied by the platen 23 of the machine and its accessory components.

The weight of the top slab is preferably at least 10 percent more than the rated capacity of the machine. For a 10,000 ton die casting machine, floor space is 50 feet by 80 feet, the walls 13 and 14 are 10 feet thick and the top slab is 26 feet high. A capacity of 5,000 tons is about the largest capacity die casting machine heretofore in operation in this country.

The structure for a 10,000 ton capacity die casting machine may also be the frame for a plurality of die casting machines. Thus:

10 machines of 1,000 tons=10,000 tons
5 machines of 2,000 tons=10,000 tons
3 machines of 2,000 tons+4 machines of 1,000 tons=10,000 tons.

The concrete frame 11 is not only the frame of the machine but it is also the building which houses one or several machines since it provides a weatherproof structure. The top concrete slab provides a bomb resistant shelter for the machine. Further, the mass of the entire concrete structure is earthquake resistant and thus several advantages are gained by the use of the concrete structure.

In the machine of this invention it has been seen that no tie rods are required to withstand the force of the machine which is resisted statically by the weight of the upper slab plus the weight of the upper component of the machine. When the capacity of the machine increases, only one, two or three dimensions of the upper slab change accordingly to match the increasing capacity of the machine.

By this means the mechanical components do not undergo large increase in size, and it can be said their

construction remains within the reach of the foundry and machine tool equipment available in this country. Frequently the configuration of the casting to be produced is such that it cannot be accommodated between tie rods of conventional machines, making it necessary to use a much larger machine than would otherwise be required to produce the art. Our machine, having no obstructions between the closing platens, permits any configuration desired. Our open throat gives the further advantage of enabling much larger platens than on conventional machines permitting dimensionally larger castings for each capacity as compared to conventional machines. Furthermore, our open throat and horizontal platens greatly facilitate placing and fastening the dies in the machine. While the instant machine is shown with only a single set of injection shot cylinders, furnace, ram and accessories, larger machines can be designed with multiple injection sets, thereby permitting much larger castings than would otherwise be possible.

Our machine provides for horizontally transversely moving the bed, giving a much wider range to centralize off-center gate and center of closing pressure of the die. Since dies can be rotated to place the gate and the center of closing pressure of the die on the transverse centerline of the bed, it is only necessary to traverse the bed on its horizontal axis to centrally position the die under the vertical center of force of the upper components before attaching same in the machine. It can therefore be understood that by increasing the length of the bed and the upper platen along the traverse axis of the machine to that shown in the instant design that any practical off-center location of the center of required closing pressure of the die can be accommodated. The instant design accommodates a much larger off center location than any conventional machine.

The center of closing pressure of the die is the point in the center of the area of the die cavity on the horizontal parting face of the die. The pressures of the hot fluid metal may be upwards of 30,000 p. s. i. in the die cavity. Any off-center position of the closing force increases progressively the tendency of the die to open under the enormous force of the internal die pressure. One of the greatest difficulties with conventional machines is the small range of off-center permitted by their limitations, frequently forcing the use of large machines to produce comparatively small castings. Practical limitations of size of conventional machines often require designs incorporating a multiplicity of castings where machines of the instant type permits casting in one piece.

The method of melting metal alloys in electric furnaces in which the heating is done within the metal itself provides several advantages not obtained with other methods. First, there is the absence of any combustion products, which promotes clean metal and absence of gas porosity. Second, the metal is continually circulated by the magnetic field which insures uniformity of compositions and prevents segregation of alloy constituents.

Finally, metals melted and cast under vacuum have superior qualities and can be molded in thinner sections. This process removes entrapped gases and prevents oxidation of the molten metal. Moreover, the vacuum in the die helps to prevent flushing out of material since no internal air compression can develop.

The structure of the upper component of the machine is also an important feature of the invention since it provides the following advantages:

First, the booster enables the utilization of a double acting piston designed only for lifting operation of the platen 45, and to operate by its vertical motion the toggle or linkage mechanism for location of the sliding shoes under the strut spacer of the machine. The double acting cylinder of this type of construction is relatively small compared to the large piston diameter of a straight hydraulic cylinder which would be used to resist the force of the molten injection into the die.

Second, the application of the pressure at the maximum rated capacity of the machine is centralized on a large area and well distributed about the die, so that the intermediary platen and the whole resisting structure of the machine is prestressed prior to the application of the load to prevent further deflection when the material enters the die.

Third, by using a relatively small double acting pressure piston and by providing a very small stroke of the booster cylinder, the volume of oil needed for the operation is also relatively small and the deflection due to the compressibility ratio of oil is almost negligible.

Fourth, the engagement of the sliding shoe in position is performed freely without any wedging action, clearance as large as $\frac{1}{8}$ inch is provided between the sliding shoe and the strut spacer during the engagement, so that no excessive wear will result in the moving parts.

Fifth, the booster provides also a small amount of universal action permitting the pressure to distribute evenly on the surface of the die.

The foot relief valve located at the end of the rod 85 is operated by the piston when it arrives at the end of its stroke.

In this construction, the toggle mechanism is easily removable from the rod 85 of the double acting piston. This has the advantage to make easy servicing or maintenance of the packing, or the foot valve.

The four long retractable guides 46 are of sufficient diameter to resist deflection under horizontal load due to slide-slipping action of the die that may occur under the terrific impact of the molten metal as it enters the die.

The strut spacers 73 and 74 allow for large adjustable clearance between the two platens with a good versatility of die height.

A modified form of the invention is illustrated in Figures 13, 14 and 15. The machine of this embodiment is substantially the same as that described above, including a frame 11a, a bottom slab 12a, side walls 13a and 14a, and a top slab 15a. Here, however, the entire construction is not monolithic, but on the contrary, the top slab 15a is a separate monolithic structural mass resting by gravity on the side walls 13a and 14a.

As illustrated in Figures 14 and 15, horizontal motion of the top slab 15a is resisted by a plurality of large diameter steel rods 300 set deeply into the side walls 13a and 14a. These steel rods extend upwardly into steel sleeves 301 anchored in the top slab 15a by means of anchor members 302 welded to the sleeves.

In this embodiment, the weight of the top slab is again at least 10% greater than the rated capacity of the machine. Thus, the machine is designed for safe loads of at least 110% of its rated capacity. Any loads greater than this will cause the top slab to be slightly lifted off the side walls, relieving the load. The steel rods and sleeves maintain proper alignment of the top slab in such event.

It will be understood there can be considerable choice in the design of the monolithic concrete frame to meet varying conditions, such as available space, multiplicity of machines in a single frame, etc. The top slab can be of pyramidal or other configuration to secure maximum structural strength of the reinforced monolithic slab to obtain the widest span for the required weight to resist the machine forces, taking into consideration allowable deflections of the slab under maximum load. In other words, the designer can utilize to the fullest extent the inherent strength of the materials composing the required weight of the monolithic slab to secure the least costly and most efficient results. The shape of the frame of the instant machine is a simple version. Many variations in the reinforcing of the monolithic structures may be used to suit the various frame designs.

It is of the essence of this invention to most efficiently use the contained strength and the force of gravity in a

weight member of monolithic reinforced concrete to overcome the upward vertical force of the machine and to produce a maximum of space around the machine.

The ability to incorporate a number of die casting machines in the same frame is also an important feature of this invention. This may be done in either of the embodiments of the invention heretofore described. The modified form of the invention shown in Figures 16-18 is especially adapted to the incorporation of a plurality of separate machines.

In this embodiment, the frame 400 is identical to the frames 11 and 11 described above, including side walls 401, except that here a plurality of top slabs 402 are provided, one for each separate die casting machine proper (not shown). The slabs may be of equal or different sizes. Each of the slabs rests on the side walls 401 by gravity, as in the first modified form of the invention, described above, and here also, rods 300a are set into the side walls and extend upwardly into sleeves 301a anchored in the top slabs for horizontal stability thereof. An elastic sealing membrane 404 is provided between the slabs and the side walls as shown in Figure 17.

As shown in the drawings, the slabs 402 are spaced apart, the spaces therebetween being made water-tight by means of copper or other sheet metal drains or membranes 405. As shown, these membranes are corrugated to compensate for any lateral shifting of the slabs due to expansion or contraction, or the like. The ends 406 of the membranes are embedded into the concrete mass of the slabs, holes 407 being punched in the sheet metal to facilitate the anchoring thereof. A copper or other sheet metal trough 410 communicates with the lower ends of each of the membranes 405, a down spout 411 being provided at the end of the trough to carry away the rain water collected thereby.

While each individual slab 402 may be provided with rods 300a and sleeves 301a for horizontal stability, in some cases it is preferred not to utilize these means on all slabs. In such event, it is preferred to utilize other means such as the rubbing pads 415. Each of the steel pads or plates is engaged in a threaded tube 417 embedded in the concrete of the top slab. The pads are provided with bores 418 for the reception of a tool for longitudinal adjustment and set screws 419 are provided to lock the pads in the desired position. The pads 415 seat against steel rubbing plates 420 suitably secured to the adjacent top slab.

Having fully described our invention, it is to be understood that we do not wish to be limited to the details set forth, but our invention is of the full scope of the appended claims.

We claim:

1. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component including a lower platen on said base; means on said lower platen for supporting a die; means for injecting molten metal into a die supported on said lower platen; means for relatively reciprocating said platens toward and away from each other; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means.

2. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component including a lower platen on said base; means

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on said lower platen for supporting a die; means for injecting molten metal into a die supported on said lower platen; means for relatively reciprocating said platens toward and away from each other; means for horizontally reciprocating said lower component on said base; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means.

3. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component on said base, said lower component including a lower platen, means on said lower platen for supporting a die, an electric induction furnace mounted in said lower platen, ram means for injecting molten metal from said furnace through said platen into a die adapted to be supported on said lower platen and interposed between said upper and lower platens; means for relatively reciprocating said platens toward and away from each other; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means.

4. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component on said base, said lower component including a lower platen, means on said lower platen for supporting a die, an electric induction furnace mounted in said lower platen, ram means for injecting molten metal from said furnace through said platen into a die adapted to be supported on said lower platen and interposed between said upper and lower platens; means for relatively reciprocating said platens toward and away from each other; means for horizontally reciprocating said lower component on said base; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means.

5. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass supported by gravity upon said side walls, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component including a lower platen on said base; means on said lower platen for supporting a die; means for injecting molten metal into a die supported on said lower platen; means for relatively reciprocating said platens toward and away from each other; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means; and means interconnecting said top slab and said side walls to prevent relative horizontal movement therebetween but permitting lifting of said slab from said side walls upon overloading of said machine.

6. In a die casting machine, a frame having a base,

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side walls and a top slab, said top slab being a substantially monolithic structural mass supported by gravity upon said side walls, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component including a lower platen on said base; means on said lower platen for supporting a die; means for injecting molten metal into a die supported on said lower platen; means for relatively reciprocating said platens toward and away from each other; means for horizontally reciprocating said lower component on said base; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means; and means interconnecting said top slab and said side walls to prevent relative horizontal movement therebetween but permitting lifting of said slab from said side walls upon overloading of said machine.

7. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass supported by gravity upon said side walls, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component on said base, said lower component including a lower platen, means on said lower platen for supporting a die; an electric induction furnace mounted in said lower platen, ram means for injecting molten metal from said furnace through said platen into a die adapted to be supported on said lower platen and interposed between said upper and lower platens; means for relatively reciprocating said platens toward and away from each other; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means; and means interconnecting said top slab and said side walls to prevent relative horizontal movement therebetween but permitting lifting of said slab from said side walls upon overloading of said machine.

8. In a die casting machine, a frame having a base, side walls and a top slab, said top slab being a substantially monolithic structural mass supported by gravity upon said side walls, said frame defining an opening; an upper machine component including an upper platen carried by said top slab; a lower machine component on said base, said lower component including a lower platen, means on said lower platen for supporting a die an electric induction furnace mounted in said lower platen, ram means for injecting molten metal from said furnace through said platen into a die adapted to be supported on said platen and interposed between said upper and lower platens; means for relatively reciprocating said platens toward and away from each other; means for horizontally reciprocating said lower component on said base; the size of said machine components being considerably less than the area of said base to thus establish a wide throat machine having a large clear area for workmen and equipment on all sides of said components within said frame, and the weight of said top slab and upper component exceeding the total force capabilities of said relative reciprocation means; and means interconnecting said top slab and said side walls to prevent relative horizontal movement therebetween but permitting lifting of said slab from said side walls upon overloading of said machine.

9. The machine defined in claim 3 wherein a die having a cavity is interposed between the lower platen and

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the upper platen, and wherein means are provided for establishing and maintaining a vacuum simultaneously in said furnace and in said die cavity.

10. The machine defined in claim 1 wherein the entire frame is a substantially monolithic structural mass.

11. The machine defined in claim 3 wherein a plurality of furnaces and ram means are provided.

12. The machine defined in claim 5 wherein a plurality of side-by-side top slabs are provided.

13. The machine defined in claim 5 wherein a plurality of spaced, side-by-side top slabs are provided, and wherein means for waterproofing the spaces between said slabs are provided.

14. The machine defined in claim 4, wherein a die having a cavity is interposed between the lower platen and the upper platen, and wherein means for feeding molten metal into said die are provided on said horizontally reciprocating lower component.

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