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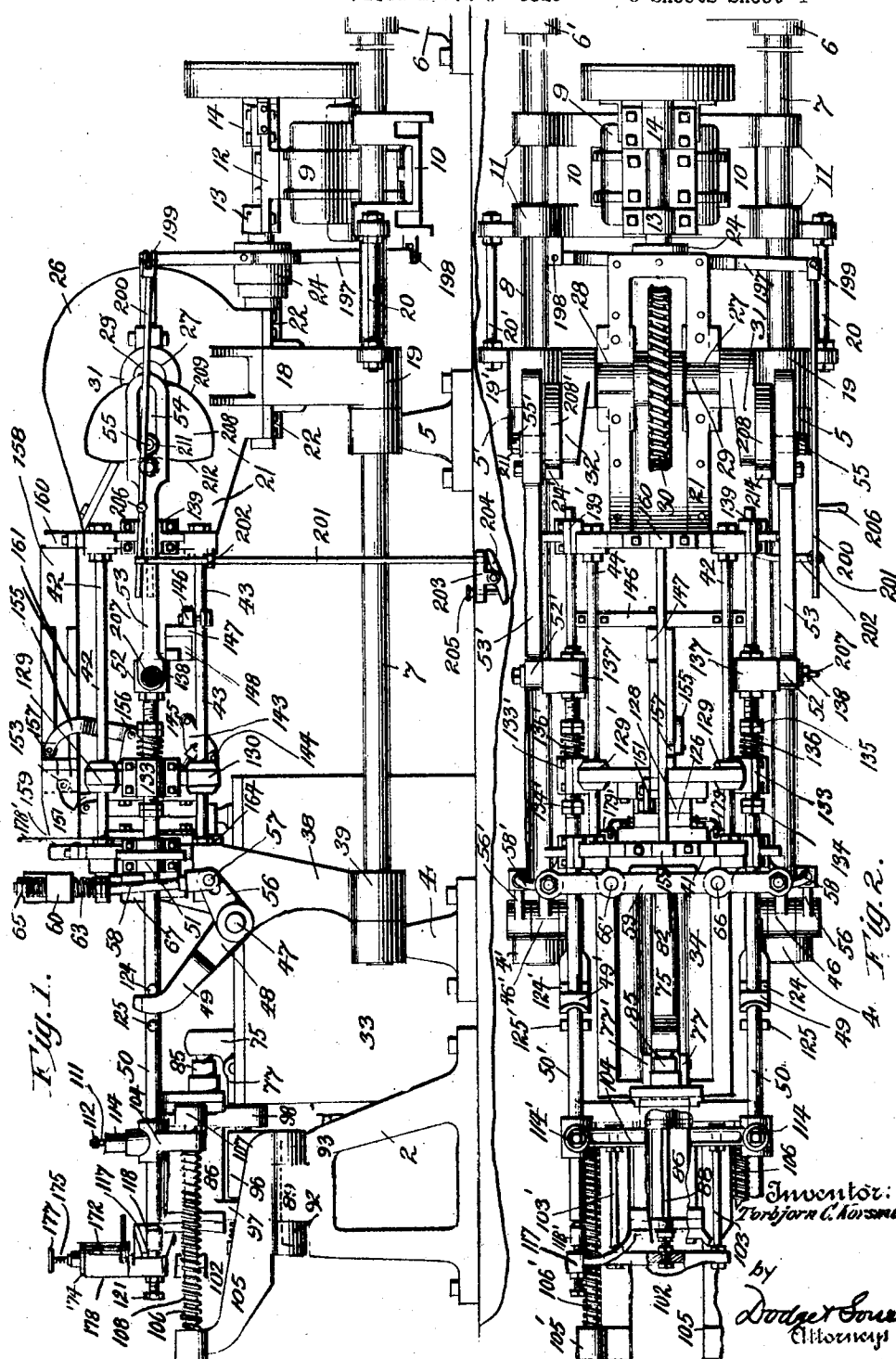
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T. C. KORSMO

DIE CASTING MACHINE

Filed March 6 1925

5 Sheets-Sheet 1



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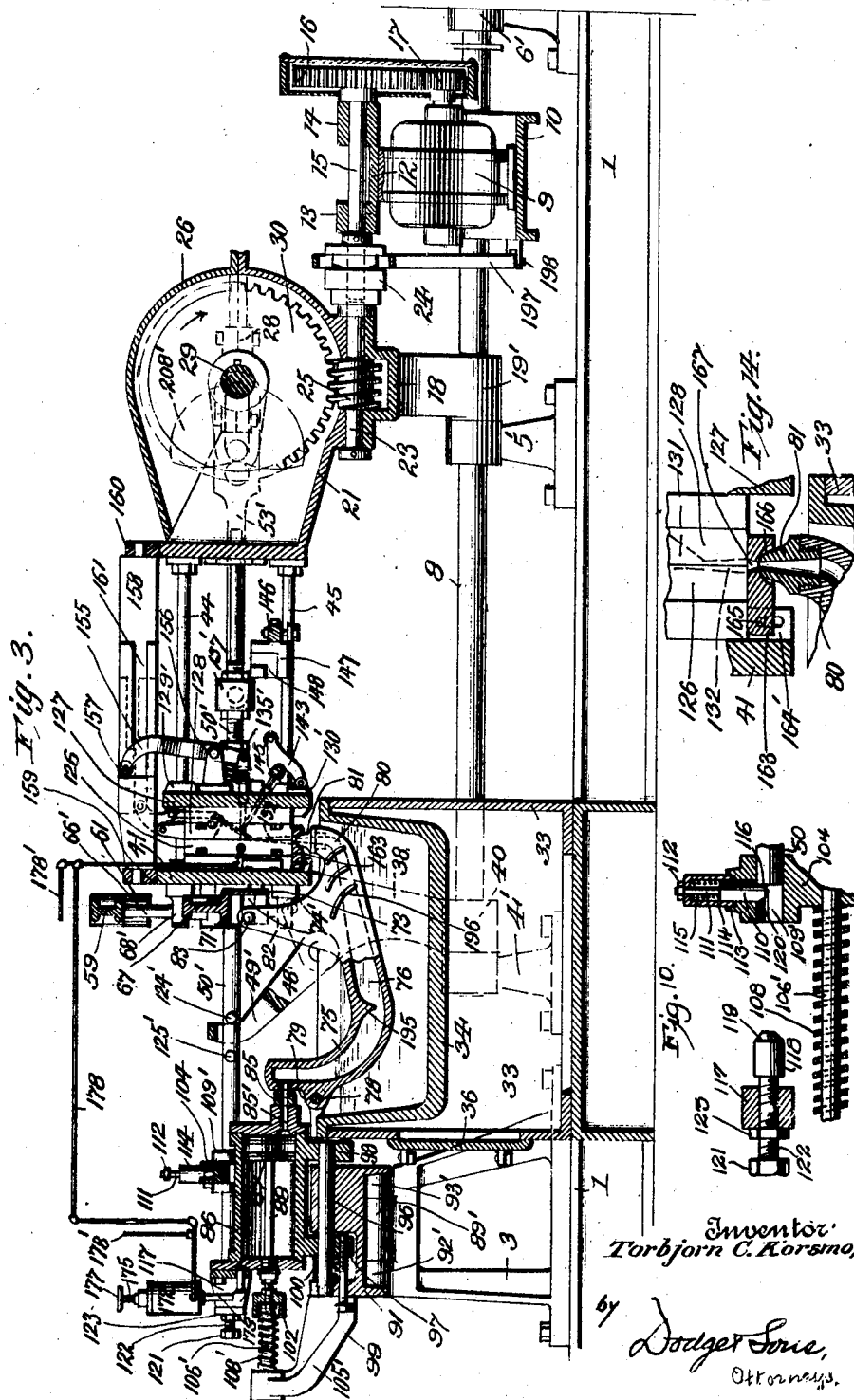
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DIE CASTING MACHINE

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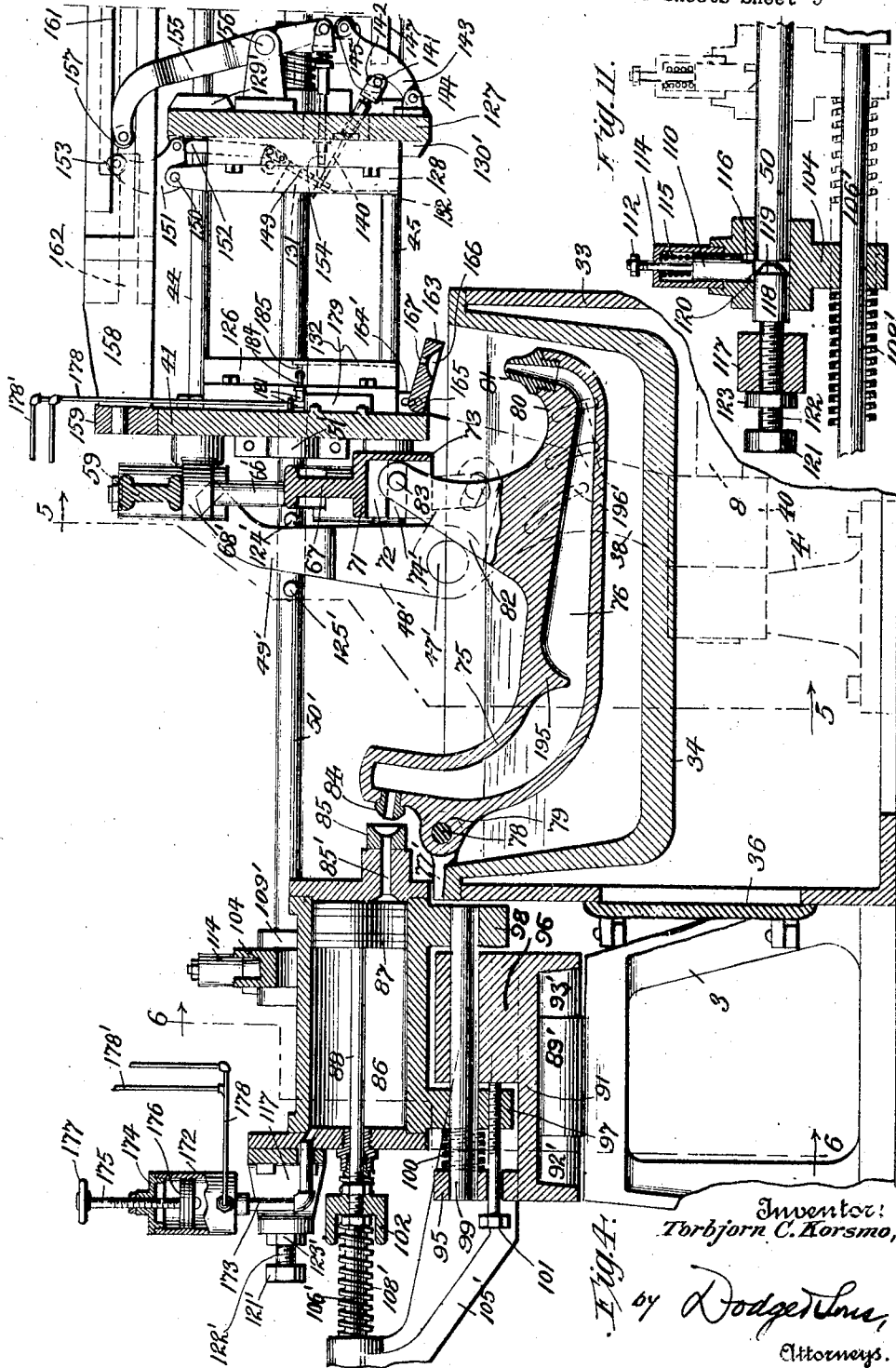
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DIE CASTING MACHINE

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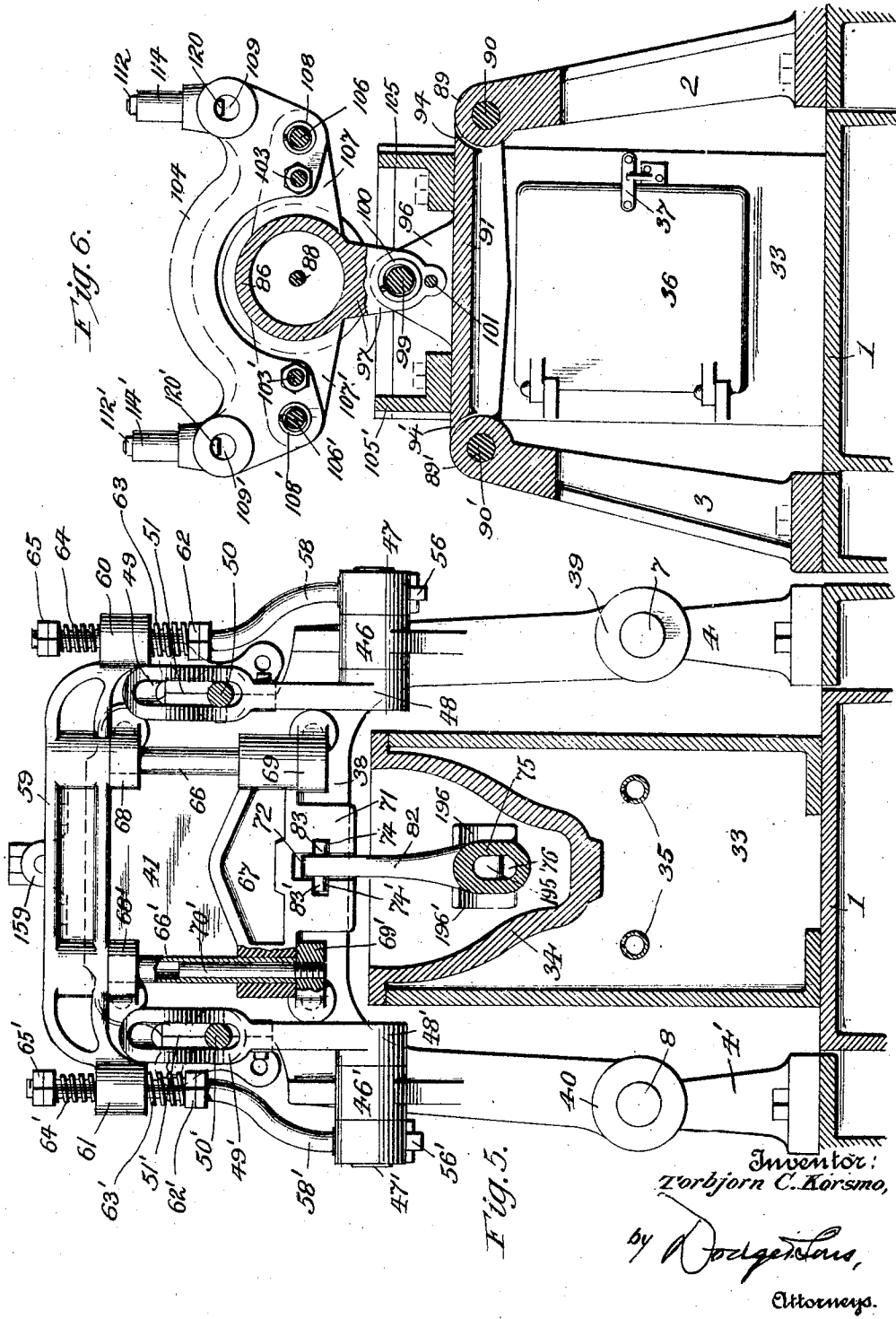
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DIE CASTING MACHINE

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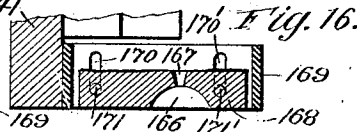
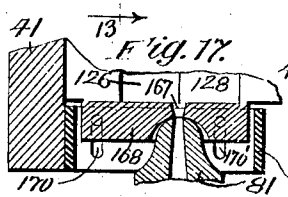
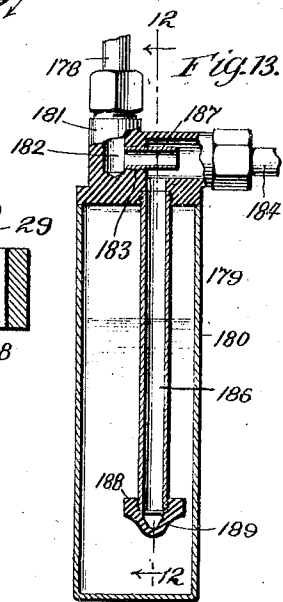
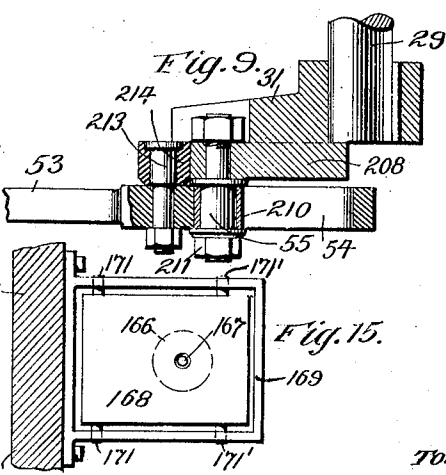
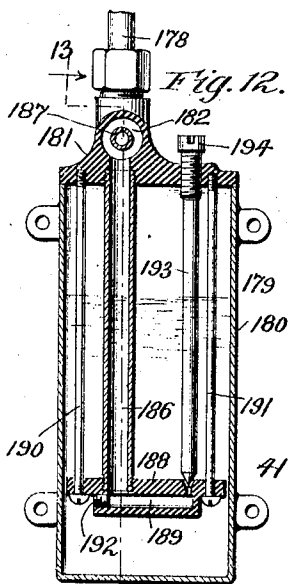
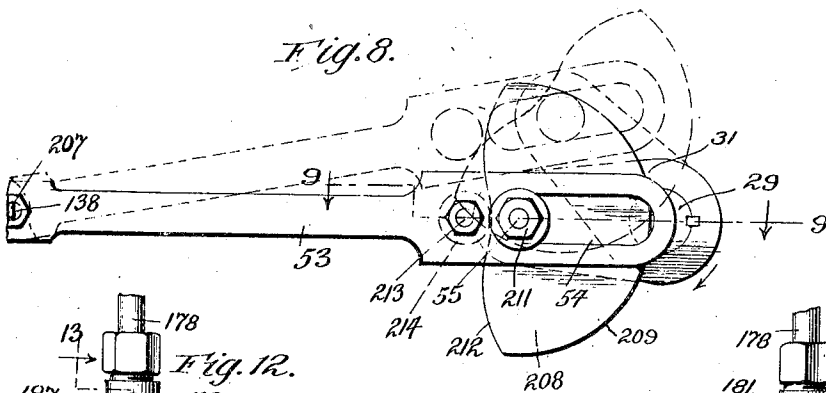
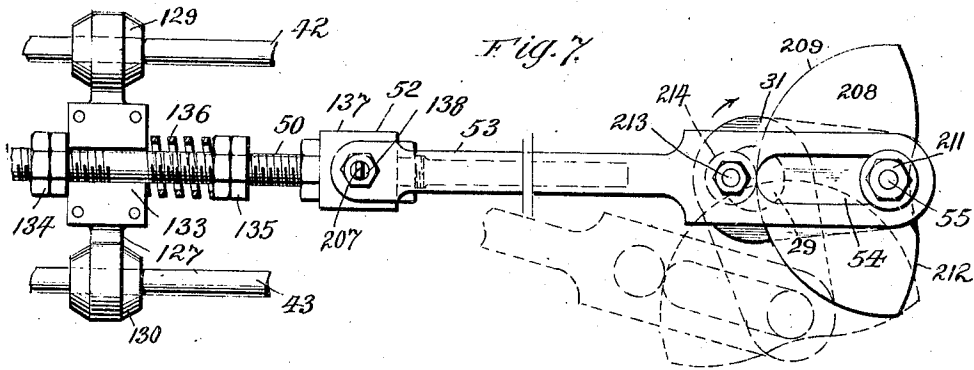
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DIE CASTING MACHINE

Filed March 6 1925

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UNITED STATES PATENT OFFICE.

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DIE-CASTING MACHINE.

Application filed March 6, 1925. Serial No. 13,543.

This invention relates to the art of casting and particularly to die-casting machines. The main purpose of the invention is to provide an automatic machine capable of repeating its cycle indefinitely to produce a series of satisfactory castings in an efficient and safe manner.

In general the machine includes a movable pressure chamber having a duct ending in a nozzle which in one position is submerged in the molten metal in the melting pot to allow the metal to flow into the pressure chamber and in another position is elevated so as to raise the nozzle out of the metal and bring it into engagement with the die in position to eject metal thereinto. When the pressure chamber is in the last-named position, pressure fluid is automatically admitted to the pressure chamber to eject the metal charge from said chamber through the nozzle into the die.

Important features of the invention, in addition to the automatic feature, are the provision of readily interchangeable melting pots, dies and pressure chambers. Other important features are the incorporation in the machine of means for supplying the pressure fluid without having recourse to an external compressor; means for using waste heat from the melting pot to pre-heat the pressure fluid, and many details relating to the venting of the die, lubrication of the mold cavity, lubrication of other parts of the machine, and accessory mechanisms for operating cores, slides, ejectors and the like in proper time relation with each other.

The accompanying drawings show an embodiment of the invention so far found best adapted to attain the objects hereinbefore mentioned and by means of which still other objects may be attained as will appear hereinafter.

In these drawings,

Fig. 1 represents a front elevation of the machine, the parts being shown in the positions which they assume when a casting is being "shot";

Fig. 2, a plan view of the machine with the parts in the same positions, certain of them, however, being omitted or broken away for the sake of clearness;

Fig. 3, a vertical, longitudinal section with the parts in the same positions;

Fig. 4, an enlarged fragmentary, sectional view, similar to a portion of Fig. 3, with the parts in the positions which they assume after a casting has been "shot" and the die has opened to eject it;

Fig. 5, a vertical, transverse section on line 5—5 of Fig. 4, looking in the direction of the arrows;

Fig. 6, a similar view on line 6—6 of Fig. 4;

Fig. 7, an enlarged front elevation of one of the sets of driving mechanisms, the parts being shown in full lines in the positions which they occupy when the die is open and, in dotted lines, in the positions assumed by them as the die starts to close;

Fig. 8, a similar view showing the positions of these parts at two stages of the operation of the machine during the interval the die is held closed;

Fig. 9, a section taken on line 9—9 of Fig. 8 (full line position);

Fig. 10, an enlarged, vertical section of the means for actuating the fluid-pressure mechanism, the parts being shown in the positions which they occupy when the movable die part is fully retracted to eject the casting, as in Fig. 4;

Fig. 11, a similar view showing, in full lines, the same actuating means about to be released to set the fluid-pressure mechanism into operation, and in dotted lines, a position assumed after its release;

Fig. 12, an enlarged, transverse section on line 12—12 of Fig. 13, showing one of the lubricators;

Fig. 13, an enlarged, longitudinal section of the lubricator on line 13—13 of Fig. 12;

Fig. 14, an enlarged, vertical longitudinal section showing in detail the manner in which the nipple plate coacts with the die and the pressure chamber or goose-neck;

Fig. 15, a plan view of a modified form of nipple plate;

Fig. 16, a longitudinal, vertical section of the same, the nipple plate being in its operative position; and

Fig. 17, a similar view with the nipple plate in its operative position against the bottom of the die.

The main framework of the machine consists of the base 1, which extends beneath the entire machine, the front and rear stand-

ards 2, 3 for supporting the pressure-fluid mechanism, and the three pairs of guide supports 4, 4', 5, 5', and 6, 6' which are fixed on base 1 and support a pair of parallel horizontal guide rods 7 and 8. Rods 7 and 8 support the driving mechanism for the machine, the die and parts associated therewith, and the means for actuating both the fluid-compressor mechanism and the goose-neck member by which the metal is fed into the die. The purpose of mounting the above enumerated parts slidably on guides is to permit the dies and the various actuating members to be shifted on occasion away from the melting pot to permit inspection and adjustments or the substitution of dies. The parts do not shift on the guides 7 and 8 during the normal operation of the machine.

Driving mechanism.—At the right end of the machine there is an electric motor 9. Motor 9 is supported on a cradle 10 which is slidably supported at 11 on the guides 7 and 8. Carried by motor 9 is a support 12 having an inner bearing 13 and an outer bearing 14 in which is journaled a driving-shaft 15. Shaft 15 is held against longitudinal movement and has a large spur gear 16 mounted on its outer end with which engages a smaller gear 17, on the end of the shaft of motor 9.

To the left of motor 9 (Figs. 1, 2 and 3), is a carriage 18 mounted for sliding movement on guides 7, 8 by means of lugs 19, 19', which embrace the guides 7 and 8. Spacer bolts 20, 20' rigidly connect together cradle 10 and carriage 18. Carriage 18 supports a housing 21, the carriage and housing being bolted rigidly together at 22 (Fig. 1) and having their abutting surfaces formed to provide suitable split-bearings for a shaft 23. Shaft 23 is provided with thrust collars, and at its right-hand end projects beyond the bearings, where a clutch 24 is interposed between it and the aligned drive-shaft 15. Housing 21 and carriage 18 are formed to receive and enclose a worm 25 fixed on shaft 23. A worm wheel 30 which meshes with the worm 25, is keyed on a cross shaft 29. This shaft 29 is mounted to rotate in bearings 27 and 28 which are carried by the housing 21. A removable cover 26 for enclosing the worm wheel is bolted to the housing 21. The shaft 29 projects at its ends beyond the bearings 27, 28, and fixed to each end is a corresponding one of two parallel and equal cranks 31 and 32.

When motor 9 is in operation and clutch 24 engaged (as shown in the drawings), the motor will drive worm-wheel 30, its shaft 29 and cranks 31, 32 through the other parts referred to. The direction of rotation of the shaft 29 is shown by an arrow in Fig. 3.

The furnace shown at 33 is mounted on base 1 adjacent the standards 2 and 3, and

between these and the motor 9. A melting pot 34 is removably mounted in the top of the furnace. Any suitable heating means may be used, and one such means is conventionally shown at 35 in Fig. 5. Access to the heating means is afforded by a door 36 having a latch 37.

A carriage 38 of inverted U-shape is supported by bearings 39 and 40 on guides 7 and 8. In the normal position (see Fig. 1) the carriage 38 straddles furnace 33. Carriage 38 carries above the furnace 33 a vertical die head or hot-plate 41. Four parallel horizontal guide rods 42, 43, 44, and 45 extend between the hot plate 41 and the end of housing 21, to each of which each rod is rigidly connected. These rods guide the die carriage in its movements.

Since the parts now to be described are duplicated at the front and rear of the machine, only the front set will be described, the corresponding parts of the rear set being indicated by the same numbers primed. Carriage 38 has a bearing 46 in which a short cross-shaft 47 is mounted. On shaft 47 there is secured an upwardly extending crank 48, the upper end of which is in the form of an elongated loop 49. Through this loop extends a horizontal rod 50 which latter is supported intermediate its ends for reciprocating movement in a split-bearing 51 on the hot-plate 41. The rod 50 is pivotally connected at 52 to one end of a connecting-rod 53. The opposite end of connecting-rod 53 has a slot 54 therein through which projects a stud 55 fixed on crank 31. (Rod 53' is connected to parallel crank 32.)

Fixed on cross shaft 47 is a crank 56 shorter than the crank 48, and projecting in an approximately horizontal direction. The crank 47 is connected to an upright rod 58 by means of a pin and slot connection 57. Above the cranks 56, 56' and extending transversely of the machine, there is a horizontal yoke 59 having at its ends extensions 60 and 61, formed with guideways through which the rods 58 and 58' respectively pass. The upper portion of each rod 58, and 58' is threaded and receives, in the order stated, nut 62, spring 63, extension 60 (extension 61 in the case of the rod 58'), spring 64 and nut 65.

The springs permit the use of different sized connected parts without the need of adjustment, since they will yield to accommodate differences of dimension.

As more clearly shown in Fig. 5, yoke 59 is provided with a pair of depending, tubular extensions 66, 66', one on either side of the longitudinal center of the machine. Fixedly mounted on the lower end of these extensions is a goose-neck actuating-yoke 67. Hot-plate 41 is provided with a front pair of lugs 68, 69 and a rear pair, 68', 69'. Lugs 68, 68' have vertical guide-ways

through which extensions 66, 66' of yoke 59 extend and are thus guided in part. The lower lugs 69, 69' are each furnished with an upright guide-post (the rear post only being shown, at 70', Fig. 5), rigidly mounted at its lower end in the lug. These guide-posts project into the corresponding tubular extension, 66 or 66', of member 59.

By the above means the yoke 59 is guided and its reciprocatory motion is limited.

At its middle the yoke 67 has a depending portion 71 provided with a cruciform recess consisting of a vertically disposed channel 72 which extends to the bottom of the yoke 67 and horizontal extensions 74, 74'. The cruciform recess above described extends only part way through the yoke and is closed at its back by a wall 73. This recess engages an actuating arm on a goose-neck later to be described. Movable mounted in the melting pot is a goose-neck 75 having a substantially U-shaped duct 76 extending completely therethrough.

The goose-neck is hinged to the melting pot 34 by means of a pair of apertured hinge lugs 77, 77' upon the melting pot 34, an apertured hinge lug 79 on the goose-neck 75, and a removable hinge pin 78 inserted through the apertures in the lugs. The goose-neck swings in a vertical plane. At the discharge end 80 of goose-neck 75 there is provided a removable nipple 81 through which the molten metal first flows into duct 76 of the goose-neck, after which the metal is ejected through nipple 81 into the die.

A rigid arm 82 projecting upward from the goose-neck is the means by which the goose-neck swings in a vertical plane, its nozzle end 80 in the molten metal to receive a charge and then to elevate it above the level of the metal for the purpose of connecting with the die. The upper end of arm 82 projects freely into channel 72 in the yoke 67 and a pair of lugs 83, 83' on the arm 82 engages in grooves 74, 74', respectively, thus establishing a driving connection between the yoke and goose-neck. The end of goose-neck 75 which is pivoted on melting-pot 34 projects at all times above the top of the melting pot 34. Duct 76 at this end of the pressure-chamber is in communication with a nipple 84 mounted in an opening in the left-hand end of the goose-neck near the top thereof (see Fig. 4). The outer end of nipple 84, which is of a hemispherical shape, is adapted, when the goose-neck 75 is raised to its upper position to engage and effect a tight seal with the co-acting seat formed in the socket member 85 on an air-compressor cylinder 86.

Air-pressure mechanism.—A passageway 85' connects the socket member 85 with one working space of an air cylinder 86. Within cylinder 86 is a piston 87 mounted

on a piston rod 88, by means of which it is actuated. This rod extends through a stuffing box in the head of the cylinder remote from the socket member 85.

The cylinder 86 is supported on the standards 2 and 3 in such a manner that it may be swung to either side of the machine to permit the interchange of melting pots and for other purposes. The standards 2 and 3 are provided at their tops with cylindrical apertured hinge lugs 89, 89' respectively. A table member 91 having two pairs of hinged lugs 92, 93 and 92', 93' is hingedly connected to each of the standards 2 and 3 by hinge pins 90, 90', which pass respectively through the lugs 92, 89, 93, and 92', 89' and 93'. Thus the table is rigidly supported when both pins 90, 90' are inserted and may be swung about either pin upon the removal of the other.

Table member 91 is provided at its left margin with an upstanding portion 95 and to the right of this with an upstanding portion 96.

The air cylinder 86 overlies the upstanding portion 96 and has a pair of downwardly extending lugs 97, 98 which straddle the portion 96, the parts being so dimensioned that clearance is afforded for movement of the cylinder in the direction of its axis. The lugs 97 and 98 are slidably mounted on a guide bar 99 which is fixed in the upward extending portions 95 and 96 of the table 91. To maintain cylinder 86 yieldingly in its right hand position, and thus offer sealing pressure between nipple 84 and socket member 85, a coil spring 100 is mounted on guide bar 99 under compressive stress between the portion 95 and the lug 97. An adjustable screw stop 101 threaded in the lug 97 and seating against the portion 96 serves to limit adjustably the movement of the cylinder 86 to the right.

On the outer end of piston-rod 88 there is rigidly mounted a transverse, horizontal member 102 which at each end extends somewhat beyond the side of cylinder 86. Member 102 at its ends is rigidly connected in turn by a pair of rods 103, 103' to another horizontal, transverse member 104 which straddles air cylinder 86 but is free to reciprocate horizontally without interference therewith. Thus, when member 104 is reciprocated, it, and the member 102, rods 103, 103', piston-rod 88 and piston 87, reciprocate as a unit.

Bolted to the upper side of table member 91, one on either side of upstanding portion 95, are supporting arms 105, 105'. These arms project out well beyond the end of the machine and each carries one end of a corresponding rod 106, 106'. At their other ends these rods are secured in corresponding ears 107, 107 formed on the air-cylinder 86. The transverse member 104 is slidably mounted

ed on the rods 106, 106' and is urged to the right by a pair of compression coil springs 108, 108' which surround respective rods 106, 106'. The rods 50, 50' extend through bearings 109, 109' in the member 104, and means are provided to latch the rods and the member 104 together, so that in the closing movement of the dies the rods 50, 50' shift the member 104 to the left against the resistance of the springs 108, 108'. At the limit of motion the latch connection is released and the springs operate to shift the parts, and particularly the piston 87, to the right. The pressure generated in front of the piston 87 is used to eject the metal from the goose-neck into the die.

The restoration of the rods 50, 50' is accomplished by their connection with connecting-rods 53, 53', which are operated by the driving means for the machine. The parts of the machine are so arranged and proportioned that, when rods 50, 50' are in their extreme right-hand position, springs 108, 108' have expanded to move yoke member 104 to its extreme right-hand position against ears 107, 107', as shown in Figs. 1 and 2. At the same time, the left-hand extremities of rods 50, 50' are located within bearings 109, 109'. There is one latch mechanism for each rod 50, 50'. These are duplicates. That for rod 50 will be described. That for rod 50' bears similar reference numerals primed. A vertical opening is provided in yoke 104 leading from bearing 109 (see Fig. 10), and in this opening a plunger 110 is mounted for reciprocation. The upper end 111 of the plunger is of reduced diameter and threaded to receive a nut 112. On the upper side of bearing 109 there is formed an annular flange 113 surrounding but spaced from plunger 110 and in which is seated the lower open end of a casing 114. The upper end 111 of plunger 110 projects freely through an opening in the upper wall of casing 114. Thus casing 114 and nut 112 coact to limit the downward motion of plunger 110. A coil spring 115 on the upper end of plunger 110 serves constantly to urge the plunger towards its lowermost position, that shown in Fig. 10. The lower end of plunger 110 is notched at 116 to engage the end of rod 50. Thus when the rod 50 starts to the left from its right hand limit of motion it shifts yoke 104 to the left.

The bracket member 117 is secured to one end of cylinder 86 and has arms extending in each direction laterally relatively to the cylinder. Adjustable trips 118, 118' are mounted in the ends thereof aligned with the axes of the rods 50, 50'. Each of the trips 118 is provided with a cylindrical body so dimensioned as to be capable of entering the bearing 109, 109' of the yoke 104, and the end of each trip is tapered as shown at

119. As the rods 50, 50' approach the limit of their left hand movement, the tapered portions 119, 119' of the trips 118 will engage the inclined surfaces 120, 120' formed on the lower end of the latch plungers 110, 110', forcing the plungers upward and disengaging the latches. When this occurs the springs 108, 108' act through the yoke 104 to return the piston 86 to its right hand limit of motion. Trips 118, 118' are carried by shanks 122 threaded in the bracket member 117. These are formed with heads 121 by means of which they may be turned to effect any necessary adjustments, and the adjustment when made is maintained by lock nuts 123.

In order to operate pressure-chamber 75 to raise and lower it towards and from the die, rods 50, 50' have pins 124, 124', respectively, mounted therein and projecting at both sides of the rods to engage the loops 49, 49' on the upper ends of cranks 48, 48'. In Fig. 4, wherein goose-neck 75 is in its charge-receiving or lowermost position, it will be seen that nipple 84 and socket 85 at the left end of the goose-neck are separated, to permit venting of the parts at this point, and nipple 81 is below the metal level in melting-pot 34 to permit the metal to flow into the goose-neck. As soon as rods 50, 50' start moving to the left, pins 124, 124' act on loops 49, 49' and, through the mechanism already described, swing the nozzle end 80 of goose-neck 75 up out of the metal about pin 78 as a center and into operative relation to the die. At the same time, nipple 84, and socket 85 are brought into sealing engagement with each other preparatory to the passage of the compressed air therethrough from cylinder 86 into goose-neck 75 to act on the charge of molten metal therein. After the casting has been "shot" and rods 50, 50' again return to the right after actuating the air-pressure mechanism, goose-neck 75 and its movable supporting and actuating parts gravitate back to the charge-receiving position of Fig. 4. If, however, the metal of which the castings are being made is too heavy for goose-neck 75 to settle therein, a second pair of pins 125, 125' is mounted in rods 50, 50' for engagement with the opposite edges of loops 49, 49' to positively return the parts to the condition shown in Fig. 4. Ordinarily, however, this second pair of pins may be omitted.

It will be noted that when piston 87 is being retracted by the rods 50, 50' the goose-neck 75 starts from its lowermost position and rises. Thus throughout practically the entire reaction of piston 87 the duct 85 is open to the atmosphere, and the air drawn into the cylinder 86 is heated air from directly above the melting pot. Consequently, when the trips act and the springs

108 return the piston 87, this charge of heated air is injected into the goose-neck through the nipple 84. This use of heated air to eject the metal from the goose-neck into the die is important, as it reduces the tendency to cool the metal.

Die.—The stationary part 126 of the die is detachably mounted on the hot-plate 41. The movable part 128 of the die is detachably mounted on a carriage 127 which by means of guideways 129, 130, 129', 130', is slidably mounted on the guides 42, 43, 44 and 45. The parts are so proportioned that the two portions of the die are presented in proper contact and registry with each other, with the sprue hole approximately aligned with the upper positions of the nipple 81 of goose-neck 75. The range of motion of the carriage 127 is such as to permit removal of the finished casting when the die parts are separated.

From the above it will be seen that the usual two-part or split die is used, having the cavity 131 into which the metal is forced through port 132 (Fig. 14).

Operating means for movable die part.—Die carriage 127 is provided with split bearings 133, 133' through which extend rods 50, 50', respectively. Each of these rods is threaded at this point for a portion of its length on each side of its bearing in die carriage 127. As shown in Fig. 7, a pair of nuts 134 is mounted on this portion of rod 50 to the left of carriage 127 and a second pair of nuts 135 to the right of the carriage, between which and the pair of nuts 135 is a coil spring 136 under compression. The same arrangement is used at the rear of the machine on rod 50'. Springs 136, 136' serve to hold die carriage 127 normally against nuts 134, 134'. This construction permits the movable die part 128 to be brought into closed position against stationary die part 126 and then be held closed by yielding pressure, while rods 50, 50' travel further to the left. At the limit of movement there is a dwell, as hereinafter explained, to permit the casting to be "shot" and "freeze." After this the parts move in the reverse direction opening the die so that the casting may be removed. This overtravel of rods 50, 50' to the left after the die is closed permits die parts of different thicknesses to be used and simplifies adjustment. By suitably adjusting nuts 135 proper pressure between the die parts is secured.

As is best shown in Fig. 2, the pivotal connection at 52 between connecting rod 53 and rod 50 includes a block 137 removably held on the rod by suitable nuts and having a pivot pin 138 formed thereon on which is pivoted the inner end of connecting-rod 53. Rod 50 to the right of block 137 is of reduced diameter and is guided in split-bearing 139 carried by housing 21.

Die-core, slide and ejecting pin operating mechanism.—In many cases it is necessary to use core pieces and slides projecting into the casting cavity in the die and it is particularly desirable that means be provided to advance and withdraw these members automatically at the proper times in the operation of the machine; also that there be automatic means to eject the casting from the die cavity when the die is opened. Such means are a feature of the present machine. There may be any number of sets of means of this character in the machine.

At 140 there is shown an ejecting pin the outer, lower end of which has a pin 141 with which a notch 142 in a lever 143 engages. Lever 143 is pivoted at 144 to carriage 127 and at its upper end carries a roller 145. Mounted for horizontal adjustment on guide rods 42, 45 to the right of lever 143 is a transverse member 146 on the front of which is attached a guide block 147 having an open-ended, right-angle groove 148 in the front face thereof. When the die is closed, element 143 rests in its lowermost position, as shown in Fig. 3, so that roller 145 is in horizontal alinement with the horizontal portion of groove 148 in block 147 and ejector pin 140 is withdrawn from the die cavity. However, when the die opens after a casting has been formed, roller 145 enters the horizontal portion of groove 148 and, as the movement to the right continues, the roller is forced into the vertical portion of the groove. This results in the upper end of lever 143 being swung upwardly towards carriage 127 advancing ejector pin 140 through the movable die part 128 to eject the casting. The relative positions of the parts at this point are shown in Fig. 4. The reverse movement of the parts begins before roller 145 reaches the upper end of groove 148 and the parts are returned to their original positions of Fig. 3, as will be apparent.

In Fig. 4 there is also shown a movable core 149 (in dotted lines) within the cavity of movable die part 128. Pivoted at 150 on the upper part of die part 128 is a bell-crank 151 one end of which is pivotally connected to a link 152. Link 152 at its lower end is operatively connected by any suitable means to slide 149 so that upward and downward movement of link 152 will serve to withdraw the slide or advance it into the die cavity. At the upper end of bell crank 151 there is mounted a roller 153.

A movable core 154 is provided for the die in movable die member 128 (Fig. 4). At its outer end core 154 has a pivotal connection with the lower end of an upright lever 155 which latter is pivotally mounted intermediate its ends at 156 on the die carriage 127. At the upper end of lever 155, there is mounted a roller 157.

In order that slide 149 and core 154 may be operated by rollers 153, 157, respectively, there is located at the top of the machine a longitudinally-disposed bar 158 the ends of which are removably mounted in brackets 159, 160 attached to the top of hot plate 41 and the left-hand wall of housing 21 respectively. A right-angle groove 161 is formed in the front face of bar 158 in which roller 157 operates. There is a groove 162 in the rear face of bar 158 in which roller 153 operates and this includes, as shown in Figs. 3 and 4, a left-hand horizontal portion and a right-hand horizontal portion, the latter at a somewhat higher level and connected with the former by a vertical portion located to the right of the vertical portion of groove 161 on the front of the bar. The purpose of this is to insure the withdrawal of core 154, which projects through slide 149 within the die, before the withdrawal of the slide begins. In other words, assuming the die is closed, the parts will be in the positions shown in Fig. 3. with roller 153 in the inner horizontal end of its groove and roller 157 in the vertical portion of its groove. As the die opens and die part 128 moves to the right, roller 157 is drawn into the horizontal portion of its groove, thereby depressing the upper end of lever 155 to withdraw its core 154 immediately. Shortly thereafter, roller 153 moves into the vertical portion of its groove, thereby elevating the upper end of bell-crank 151 and thus moving slide 149 upward in die part 128 to permit ejector pin 140 to advance and eject the casting. Upon reverse movement of movable die part 128 to the left, the parts just described will return to their original positions in the reverse order.

Obviously the details of the ejector will vary with the form of the die, and the mechanisms just discussed are merely illustrative and subject to the widest variation.

Nipple plate.—Mounted on hot-plate 41 is the nipple plate 163. Referring to the preferred form shown in Figs. 4 and 14, this plate is pivotally supported by a pair of vertically slotted lugs 164, 164' so that it is mounted for vertical swinging and sliding movement on its pivot pin 165. The under side of nipple plate 163 has a concavity 166 formed therein which connects centrally with an upwardly flaring port 167 which leads to the upper face thereof. The position of nipple plate 163, when the die is open, is shown in Fig. 4. In this position the nipple plate has dropped out of contact with the die, so that it will not in any wise interfere with the closing of the die parts. The main purpose of nipple plate 163 is to prevent nipple 81 of goose-neck 75 from engaging the die directly at the time a charge of metal is being forced into the die. This avoids any wedging action of the nip-

ple 81 such as would tend to produce partial separation of the die parts.

When the nozzle end of goose-neck 75 is elevated from the charge-receiving position of Fig. 4, its nipple 81 engages the concavity in the nipple plate in which it centers itself as the goose-neck continues upward and moves the nipple plate to its operative position shown in Fig. 14. In this same figure it will be noted that the concavity 166 is somewhat larger than the upper end of nipple 81 so as to take care of any possible misalignment of the parts; also that the curvature of the concavity is such that any metal which might escape between it and nipple 81 would be directed back into the melting-pot 34, thereby protecting the operator. The nipple plate 163, of course, is located so that in its operative position, opening 167 therein aligns with the port 132 of the die.

The parts of the machine are so arranged and their operations so timed that nipple plate 163 is not raised into operative position against the bottom of the die until the die is closed. In fact, the nipple plate is moved into this position just after the die is closed and while rods 50, 50' are over-traveling to the left to compress springs 136, 136'. Hence, when the nipple is raised it is brought against the flat bottom of the momentarily stationary die parts and can therefore readily accommodate itself to these parts and seat closely against the bottom of the die.

A modified form of the nipple plate is shown in Figs. 15, 16 and 17. The modified nipple plate 168, it will be noted, is mounted only for bodily vertical movement between its inoperative position of Fig. 16 and its operative position of Fig. 17. In such modified construction, the hot plate 41 has attached to its right-hand face a rectangular bracket 169 having in the sides thereof two pairs of vertical slots 170, 170'. Into these slots project the outer ends of a pair of transverse pins 171, 171' mounted in the ends of the nipple plate. With this construction, nipple plate 168 has no swinging movement when operated by nipple 81 of the goose-neck 75, but simply moves vertically into position against the bottom of the die above the plane of the top of its supporting bracket 169. (See Fig. 17.) When goose-neck 75 is lowered, nipple plate gravitates to its inoperative position of Fig. 16.

Lubricating and die-venting means.—In Fig. 4 there is shown an upright cylinder 172 mounted on the upper end of a pipe 173 which connects the interior of the lower portion of the cylinder with the interior of air-cylinder 86 to the left of its piston 87. The upper end of cylinder 172 has a removable head 174 in which is threaded a rod 175. This rod is connected to a movable piston head 176 fitting snugly within the

cylinder. On rod 175 is a hand-wheel 177 by rotation of which piston head 176 may be raised or lowered to vary the volume between it and the lower end of the cylinder 172. Communicating with this space at the front and rear sides of the cylinder 172 are pipes 178, 178', portions of which are shown broken away for the sake of clearness, they being again shown in the vicinity of the die with the cavity 131 of which they are in communication through certain lubricating means now to be described.

Any desired number or suitable type of lubricating devices 179 may be employed, two having been found entirely practicable, one attached to the right face of hot-plate 41 in front of stationary die-member 126 and the other in a corresponding position at the rear thereof.

Figs. 12 and 13 serve to show clearly the interior construction of the particular type of lubricator disclosed in the drawings. It comprises a casing 180, which forms a storage tank for the oil. On the top of casing 180 there is mounted a cover 181 having a right-angle passage-way 182 formed therein and provided with a constriction 183. To the upper end of passage-way 182 pipe 178 is connected and at its other end a pipe 184 connects it to the die cavity through a passage-way 185 formed in stationary die-part 126 (see Fig. 4). The other lubricator 179' and its pipe 178' are connected to the opposite side of the die cavity in the same manner.

Located within casing 180 of lubricator 179 is a depending pipe 186 the upper end of which is secured in cover 181 and communicates with passage-way 182 thereof. Secured at one end in constricted portion 183 of passage-way 182 so as to project over the upper open end of pipe 186 is a short tubular nozzle 187. The lower end of pipe 186 is attached to a member 188, suspended within casing 180, and communicates with a passage-way 189 formed therein. A pair of bolts 190, 191 serves to support member 188 in position within the lubricator. A screw-plug 192 is provided in one end of passage-way 189 for cleaning purposes. The opposite end of passage-way 189 is open at the top of member 188 in the form of a tapered seat with which coacts the lower tapered end of a pin 193 to form a needle valve for controlling the passage of the oil from casing or tank 180 into passage-way 189. The upper end of pin 193 projects through cover 181 and has a slotted head 194 whereby it may be adjusted in its threaded mounting in the cover to regulate the entering flow of the oil.

In operation, the above described parts lubricate the interior of the die cavity 131 and the interior of cylinder 86 and also drawn from the die cavity air and gases

therein at the time the molten metal is being forced from the goose-neck 75 into the die. When piston 87 moves to the right to force the metal into the die, a suction is created to the left of the piston in the cylinder. This suction is transmitted through the connections described to the die cavity. Thus, the die cavity is vented and at the same time, the flow of air towards air cylinder 86 in pipes 178, 178' causes a mist of lubricant from lubricators 179, 179' to be drawn into these pipes and back through the various connections into the left end of cylinder 86.

The cylinder 172 and piston 176 merely provide a variable clearance volume connected to the cylinder space at the left of piston 87 which volume is adjusted to compensate for variations in the volume of the mold cavity. Thus the piston 176 is adjusted according to the volume of the cavity in the mold being used, and when properly adjusted insures proper venting and sound castings, by setting the rate of outflow of air to agree with the rate of in-flow of metal. In this way splashing of the metal charge within the die cavity is avoided. Splashing of the metal within the die causes the formation of defective castings either because of resultant uneven cooling or because of the closure of the air vents, and the consequent formation of air holes in the casting.

If a die having a relatively large cavity is used, the piston 176, is moved downward in its cylinder 172 so as to decrease the clearance volume. In this manner, the suction from cylinder 86 acts more effectively within the die and the air will therefore be drawn from the die cavity at a greater rate.

Upon the return movement of piston 87 in air cylinder 86, a pressure flow will take place in the vent connections toward the die. This occurs during and after the closing movement of the die parts but before the charge of molten metal is "shot". The flow just mentioned causes an aspirating effect at nozzle 187 which draws oil from the lubricator and sprays it into the mold cavity. Thus, during the operation of the machine, there is always a lubricant mist which is carried back and forth through the air connections described to lubricate the interior of air pressure cylinder 86 and the die cavity surfaces, the supply of lubricant mist being automatically replenished during each cycle of operations of the machine by the aspirating effect.

It is not essential that the lubricators be located as shown in the drawings, but they may be placed in communication at any desired point with the connections between air cylinder 86 and the die. Also, instead of using oil as a lubricant, the form of the lubricators may be changed so as to adapt them for feeding to the air line a special powder that is sometimes used for the same

purpose; or if it is desired to provide a different lubricant for air cylinder 86 from that used for lubricating the die cavity surfaces, any suitable type of lubricator 5 may be connected into the air lines, one, located between cylinder 86 and cylinder 172, to feed the desired lubricant to air cylinder 86 and the other, located between cylinder 172 and the die, to feed a different lubricant 10 to the die cavity. It is also possible, instead of using a number of lubricators, to connect a suitable lubricant feeding device to the interior of cylinder 172 below piston 176 which will function to furnish lubricant for 15 the parts above mentioned.

Pressure-chamber or goose-neck.—Pressure chamber 75 is formed with an internal transverse depending partition 195 which forms a contraction in the passage-way 76. 20 The purpose of this is to trap the compressed air fed into the left-hand end of the goose-neck when the metal is being forced from the goose-neck into the die, and prevent air from flowing to the die. If it were not 25 for partition or deflector 195 it would be possible for the air to displace the metal partly and then escape along the top of the metal and reach the die before it is full of metal. With the goose-neck 75 in the position shown in Fig. 3, because of the shape 30 of the pressure chamber and location of the deflector 195, a much greater volume of metal will be forced out of the pressure chamber before compressed air can escape along the top of the metal and into the die. 35 This not only permits a greater proportion of the metal to be forced out of the goose-neck into the die, but it also lessens oxidation of the metal, since the air contact is with a much smaller area of metal than would 40 otherwise be the case. The shape of the passage-way 76 is such that when the goose-neck 75 is in the charge-receiving position of Fig. 4, the base of the passage-way is 45 approximately horizontal. However, when goose-neck 75 is elevated to the position of Fig. 3, to "shoot" a casting, the legs thereof are substantially vertical and the base of the passage-way 76 is inclined upwardly toward 50 the right. This arrangement aids in an increased amount of metal being discharged by the compressed air from goose-neck 75 into the die. There are formed on the front and rear sides of the nozzle end of goose-neck 75 opposed series of wings 196, 196'. 55 The purpose of these wings is to keep the metal in melting pot 34 well stirred and also to keep the surface of the metal clean where the goose-neck nozzle 81 dips into the melting pot 34 to receive its charge of metal. 60 When the goose-neck 75 is lowered into the melting pot 34, the wings serve to throw the molten metal back in the pot away from the nipple 81 thus removing the dross or scum

from the top of the metal and permitting only clean metal to enter the goose-neck 75.

Control and tripping mechanism for clutch.—Referring to Figs. 1, 2 and 3, it will be noted that clutch 24 is provided with an inclined shipper lever 197 which is provided with a loose pivotal connection at 198 with the saddle 10. At its upper end shipper lever 197 has a loose pivotal connection 199, with one end of a clutch operating rod 200. The opposite end of rod 200 rests freely in the upper forked end of an upright rod 201. The rod 201 is guided for vertical movement by a bracket 202, mounted on housing 21.

On the base 1 of the machine (see Fig. 1) there is secured a guide bracket 203, which not only guides the rod 201 but which also supports a pivoted lever 204. This lever is in engagement at one end with the rod 201, and at its other end with a vertically movable pedal 205, also guided in the bracket 203. When the operator depresses the pedal member 205, he elevates the rod 201 and carries the left hand end of rod 200 from its lower dotted line position in Fig. 1 to its upper full line position in Fig. 1.

In the lower position just named the end of the rod 200 will be struck by the extension 207 on the block 137, when this moves to its extreme right hand position at the end of a casting cycle. In its elevated position the extension 207 clears the rod 200. A handle 206 is mounted on the rod 200. To start the machine into operation the operator grasps the handle 206 and draws the rod 200 to the left, engaging the clutch 24. Unless he immediately depresses pedal 205 the machine will come to rest at the end of the first casting cycle, but so long as he maintains the pedal member 205 depressed the machine will continue in operation, performing successive cycles without interruption. Other trip mechanisms for performing the same or similar clutch controlling functions may be substituted.

Cam movement for driving mechanism.—The mechanism whereby connecting-rods 53, 53' and cross-shaft 29 are operatively connected to drive the machine will now be described. This mechanism is duplicated at the front and back of the machine and therefore only that in front will be described. It has already been stated that parallel cranks 31, 32 and the right ends of connecting-rods 53, 53' are joined by pin-and-slot connections, 54, 55, 54', 55'.

Referring more particularly to Figs. 7, 8 and 9, it will be seen that on the outer face of each crank 31 and 32 there is mounted a corresponding cam-disk 208 208'. Cam 208 is so formed that the continuously convex portion 209 of its periphery constitutes an arc of a circle in the center of which is located the stud 55. A roller 210 is journaled

on stud 55 to reduce the friction between these parts when stud 55 is moved back and forth in slot 54 in the operation of the machine. A flanged nut 211 on the outer end of stud 55 serves to hold the parts in place.

Cam 208 is located on crank 31 with its convex peripheral portion 209 nearest shaft 29 and disposed symmetrically with reference to the center line of the crank. Convex peripheral portion 209 of the cam constitutes the active surface thereof, while the remainder of the periphery constitutes the dwell 212 of the cam. Suitably attached to connecting-rod 53 just to the left of slot 54 and projecting from the inner face of the rod is the follower stud 213 on which is rotatably mounted the follower roller 214 which engages cam 208. Roller 214 and stud 213 are so located on the connecting-rod that, as long as stud 55 and its roller 210 are located in the outer end of slot 54 (Fig. 7), the convex peripheral portion 209 of cam 208 and stud roller 214 are in contact with each other.

The size of cam 208 and the exact shape of its periphery, of course, depend upon the movement which it is desired to impart to rod 50 through connecting-rod 53. In full lines in Fig. 7, the parts are in the positions assumed by them when the movable die part 128 has been fully retracted to the right for the removal of the casting. In dotted lines, the parts are shown as shaft 29 continues to rotate clockwise to again close the die preliminary to forming the next casting. Stud 55 is still in the outer end of slot 54. It remains in this position until roller 214, upon the continued rotation of shaft 29, passes from the camming surface 209 of the cam 208 onto its dwell 212. As long as stud 55 is in the outer end of slot 54, there exists in effect nothing more than an ordinary crank and connecting-rod connection between shaft 29 and rod 50. Hence, as the parts leave the full-line position of Fig. 7, at which time the movement of rod 50 to the left is comparatively slow, the speed at which rod 50 is moved gradually increases until roller 214 passes onto the dwell 212 of cam 208, when horizontal movement of rod 50 ceases altogether. This is caused by the fact that dwell 212 is shaped so as to merely have rolling contact with roller 214, but impart no motion thereto.

The purpose of the dwell 212 on cam 208 is to permit the driving mechanism to operate continuously and yet provide a suitable period during which the die parts are held tightly closed for the purpose of "shooting" the casting and allowing it to "freeze".

In Fig. 8, full lines, the above-described mechanism is shown at the middle of its dwell period, crank 31 and connecting-rod

53 having straightened out and stud 55 moved to the inner end of its slot 54 in the rod. As the clockwise rotation of crank 31 continues, the crank and connecting-rod 53 "break", as shown in dotted lines, and stud 55 gradually moves to the right in its slot 54 until it reaches the outer end thereof. At the same instant, roller 214 leaves dwell 212 of cam 208, thus again forming the crank and connecting-rod connection. Up to this time the dwell period has continued and rod 50 has not started on its return movement to the right to open the die, but does so immediately and with a sudden jerk upon the engagement of roller 210 with the outer end of its slot 54. Because of this connection of the parts, the return movement of rod 50 to the right is begun quite rapidly and gradually decreases in speed as the parts approach the full position of Fig. 7. The comparatively slow movement imparted to rod 50 and 50' by the driving mechanism towards the end of the opening movement of the movable die part and at the beginning of its closing movement allows the necessary time for complete removal of the casting from the movable die part in which it remains when the die parts are separated.

The arrangement and construction of the parts is such that the die parts are securely locked together during the entire "dwell" period of the cams 208, 208'. Any force tending to move rods 50, 50' to the right during this period, such for instance as might result from pressure within the die cavity 131, would be effectually resisted by stud rollers 210, 210', 214, 214'.

General operation.—It will be assumed that the die has opened, as shown in Fig. 4, at which time the slide 149 and core pin 154 have been withdrawn through movable die part 128 and ejector pin 140 advanced to eject the casting. At this time, the ladle type pressure chamber 75 has swung downwardly about its pivot pin 78, breaking its connection with cylinder 86 and the die and permitting the pressure-chamber to vent at both ends, so that the molten metal in melting pot 34 flows into the nozzle end of the pressure chamber which is at that time submerged in the metal.

To set the machine into operation, motor 9 is started after which the operator depresses pedal member 205 and then moves handle 206 to the left to engage clutch 24, which had been automatically disengaged when the machine stopped. This results, as explained, in movement of rods 50, 50' to the left to close the die, advance slide 149 and core pin 154 and withdraw ejector pin 140. At the same time the movement of rods 50, 50' serves to compress the springs of the air compressor and to move piston 87 to the left, this movement, as heretofore explained, being utilized to feed lubricant into

the die cavity. During these operations, the nozzle end of goose-neck 75 is raised out of the molten metal in melting pot 34 into contact with nipple plate 163. Nipple plate 163 however is not moved into contact with the die until after the die has closed. This is accomplished by the over-travel of rods 50, 50', as a result of which tight joints are formed between goose-neck nipple 81, nipple plate 163 and the bottom of the closed die. At the same time nipples 84 and 85 at the air pressure end of goose-neck 75 engage to form a tight joint for the pressure fluid from cylinder 86. The coil spring 100 yields to assure resilient seating.

After nipple plate 163 has been clamped tightly against the bottom of the die, rods 50, 50' at the end of their movement to the left effect the release of the now fully compressed springs of the air pressure mechanism, the springs acting suddenly with considerable force to move piston 87 to the right. This results in a quantity of heated, compressed air being conducted into passage-way 76 of goose-neck 75 to act upon the charge of molten metal therein and eject it under pressure into the die cavity 131 to form the casting. As the metal is forced into cavity 131, the cavity is vented automatically, by the movement of piston 87 to the right, as already explained.

When rods 50, 50' reach their extreme left-hand position, they remain stationary for a short time to permit the casting to "freeze" and they then start their return movement to the right. The nozzle end of goose-neck 75 and nipple 163 thereupon swing downward away from the bottom of the closed die, pulling out any "frozen" metal formed in the upper end of nozzle 81 and the port 167 in nipple plate 163. When the rods have returned a distance equal to their over-travel, the die begins to open and, as the movable die part 128 continues its opening movement carrying the casting with it, the core pin and slide are withdrawn and the ejector is actuated. In the meantime, goose-neck 75 and the other parts return to the positions of Fig. 4.

The above described cycle of operations may be repeated as long as melting pot 34 contains sufficient molten metal to supply goose-neck 75. However, should the operator release pedal 205, extension 207 on pivot block 137 would act upon rod 200 towards the end of the opening movement of the die part 128, to disengage clutch 24 and stop the machine.

If the die is to be changed, this may be done away from the heat of the melting-pot 34 by temporarily shifting the die parts, the driving mechanism and the pressure-chamber actuating mechanism to the right on rods 7, 8, this being accomplished without removal of any of the parts. Since pres-

sure-chamber 75 is connected to the stationary melting-pot 34, this same shifting of the parts results in lugs or pins 83, 83' being moved out of their slots 74, 74' in actuating-yoke 67, thereby automatically disconnecting the pressure-chamber from its actuating mechanism. Pressure-chamber 75, if desired, may then be replaced by another pressure-chamber by simply removing pin 78. At the same time the fluid-pressure mechanism may be swung out of the way, after either pin 90 or 90' has been removed, to permit the removal of melting pot 34.

It is contemplated that bar 158 and block 147 or similar members may be used also for operating suitable sprue cutting and casting trimming mechanisms.

What is claimed is:—

1. The combination in a die casting machine of a die; a pressure-chamber for conducting molten metal to the die; and means for furnishing to said pressure-chamber a pressure fluid, of a temperature approaching that of the molten metal, to act directly upon the molten metal and force it into the die.

2. The combination in a die casting machine of a die; a pressure-chamber for conducting molten metal to the die; and means for furnishing to said pressure-chamber dry compressed air, of a temperature approaching that of the molten metal, to act directly upon the molten metal and force it into the die.

3. The combination in a die casting machine of a die; a container for molten metal; a pressure-chamber adapted to receive molten metal from said container and conduct it to the die; and means for compressing air and discharging it into said pressure-chamber to displace metal therefrom into the die, said means drawing its supply of air from a point near the molten metal in said container.

4. The combination with an automatic die casting machine of the type adapted to carry out automatically a complete casting cycle, of a die having a cavity; suction venting means connected with said cavity, and arranged to operate periodically in time with each casting operation performed by said machine; and adjustable means for varying the action of said suction venting means.

5. In a die casting machine the combination of a die formed of separable sections; a pressure chamber for conducting molten metal to the die cavity when the die is closed; a compressor having a compression working space and a suction working space; means for establishing a connection from the pressure working space to said pressure chamber; a connection from the die cavity to the suction working space; and means for imparting a single working stroke to said compressor when the die is closed.

6. The combination in a die casting machine of a die having a cavity; a pressure-chamber for conducting molten metal to the die cavity; a compressor for supplying fluid-under-pressure to said pressure-chamber to force molten metal therefrom into the die; a connection arranged to subject the air cavity simultaneously to suction induced by said compressor; and means for supplying a lubricant to said connection.

7. The combination in a die casting machine of a die having a cavity; a pressure-chamber for conducting molten metal to the die cavity; a compressor, including a cylinder and a piston adapted to reciprocate therein, for supplying fluid-under-pressure from one side of its piston to said pressure-chamber to force molten metal therefrom into the die; means connecting the interior of the compressor cylinder on the other side of its piston to the die cavity so as to vent the die through said connecting means during the fluid-compressing stroke of the piston and cause a pressure-flow in the connecting means towards the die upon the return movement of the piston; and means for supplying a lubricant to said connecting means.

8. The combination in a die casting machine of a multi-part die having a cavity, one of said die parts being adapted to be moved relatively to the other to open and close the die; driving means for said movable die part; and means adapted to be actuated by said driving means to lubricate the surfaces of the die cavity when the die is closed.

9. The combination in a die casting machine of a multi-part die having a cavity, certain of said die parts being adapted to be moved to close and open the die; means for conducting molten metal into the die when it is closed; a compressor for supplying fluid-under-pressure to force molten metal from said conducting means into the die when the die is closed; driving means for said movable die part; and means adapted to be actuated by said driving means to lubricate said compressor and said die cavity.

10. The combination in a die casting machine of a die adapted to be closed and opened; a pressure-chamber having a fluid-pressure end and a die-charging end, the chamber being adapted to conduct molten metal to said die when the die is closed; a compressor for supplying fluid-under-pressure to said chamber when the die is closed to force molten metal from the chamber into the die; driving means for closing and opening the die; and means, controlled by said driving means, for effecting the venting of the pressure-chamber at both of its ends after the molten metal has been forced into the die.

11. In a die casting machine, the com-

bination of a container for molten metal; a die having a sprue hole; a substantially stationary connection for supplying fluid under pressure; a pressure-chamber having an inlet port for pressure fluid and a discharge port for molten metal; and means for shifting said pressure-chamber between two positions, in one of which said discharge port is submerged in the molten metal, and in the other of which said inlet port is in connection with the pressure-fluid supply and said discharge port in connection with the sprue hole in said die.

12. The combination in a die casting machine of a multi-part die having a sprue hole in the plane of separation, the parts of said die being relatively movable to open and close the die; driving means for causing such movement of the die parts; and a pressure-chamber adapted to be moved in a direction transverse to the motion of the die parts into position to charge said die through said sprue hole, said pressure-chamber being operatively connected with said driving means so as to assume its die charging position after the die is closed.

13. The combination in a die casting machine of a multi-part die having a sprue hole formed in the plane of separation, one of said parts being movable to open and close the die; means for driving said movable die part; and a pressure-chamber adapted to be moved in a direction transverse to the motion of the movable die parts into position to charge said die through said sprue hole, said pressure-chamber being operatively connected with said driving means so as to assume its die-charging position after the die is closed and leave its die-charging position before the die is opened.

14. The combination in a die casting machine of a multi-part removable die, certain of said parts being movable to open and close the die; and automatically-compensating driving means for the movable die part for permitting the ready substitution of different sized dies.

15. In a die casting machine, the combination of a die composed of separable sections having a sprue hole in a plane of separation; a ported plate movably mounted adjacent said die so as to be capable of moving into sealing face contact with the face of the die, with the port in the plate substantially registering with the sprue hole; and a nozzle movably mounted so as to be capable of movement into engagement with the aperture in said plate; and means for forcing said nozzle into such engagement and thereby forcing said plate into sealing engagement with said die.

16. In a die casting machine the combination of a die composed of separable sections having a sprue hole in the plane of separation, said sections being guided for

relative movement to open and close the die; a ported plate movably mounted adjacent said die so as to be capable of moving into sealing face contact with the die when closed, with the port in the plate substantially registering with said sprue hole; a nozzle movably mounted so as to be capable of movement into engagement with the port in said plate; driving means; and driving connections from said means to the movable die parts and to said nozzle respectively, arranged to operate the parts in the following sequence: close the die, move the nozzle into contact with the plate and force the plate into contact with the die, retract the nozzle, open the die.

17. The combination in a die casting machine of a melting pot for metal; a ladle-type pressure-chamber mounted so that it may be raised and lowered in the melting pot; means for operating said pressure chamber; and metal stirring means located on the pressure chamber.

18. The combination in a die casting machine of a melting pot for metal; a ladle-type pressure-chamber having a nozzle, said chamber being pivotally mounted on said melting-pot so that its nozzle may be submerged in the molten metal in the melting pot and raised out of such metal; operating means for the pressure-chamber; and external inclined wings formed on the pressure chamber for stirring the metal.

19. The combination in a die casting machine of a multi-part die, certain of said parts being adapted to be moved to open and close the die; means for conducting molten metal into the die in the intervals it is closed; means for supplying pressure-fluid to force molten metal from said conducting means into the die when the die is closed; a reciprocating carriage; and connecting means for operating by the movement of the carriage said die, said conducting means, and said fluid supply means.

20. The combination in a die casting machine of a die adapted to be opened and closed; a melting pot adapted to contain molten metal; movable means for collecting a charge of molten metal from the melting pot; means for admitting pressure-fluid to force a charge of molten metal from said collecting means into the die; a reciprocating carriage; and connections between said reciprocating carriage, the die, the charge collecting means, and the pressure fluid admitting means arranged to operate the same in timed relation.

21. In a die casting machine the combination of a multi-part die having parts movable relatively to each other to open and close the die; a plunger movably mounted in one part of said die; means operable in the closed position of the die for conducting metal thereinto; means for supplying pres-

sure fluid to force molten metal from said conducting means into the die; a reciprocating carriage; individual connections from said carriage for producing relative movement of the die parts, for actuating said metal conducting means, and for actuating said fluid supplying means in timed relation by power derived from the reciprocating movements of the carriage; and means operable by the movements of the carriage for actuating said movable plunger.

22. The combination with a die casting machine of a die adapted to be opened and closed; a melting pot; a movable goose neck arranged in one position to collect molten metal from the melting pot and in another position to connect with said die; a shiftable abutment connected to discharge air into said goose neck when the latter is connected with the die; actuating means for shifting said die and goose neck in timed relation to close the die and connect the goose neck therewith; power storing means connected with said abutment; a releasable connection between said actuating means and said abutment arranged to retract said abutment and store power in said power storing means as the die is moved toward closed position; and means for releasing said connection upon the complete closing of said die, to permit said abutment to be actuated by said power storing means.

23. The combination in a die casting machine of a die adapted to be opened and closed; means for conducting molten metal into said die when it is closed; means for generating pressure-fluid and supplying it to said conducting means when the die is closed to force molten metal into the die; and common operating means for said die, said conducting means and said pressure-fluid generating and supplying means.

24. The combination in a die casting machine of a die; a removable melting-pot; means for conducting molten metal to the die; a compressor for supplying pressure-fluid to said conducting means to force molten metal therefrom into the die, said compressor projecting over said melting-pot; and a support upon which said compressor is shiftable mounted.

25. In a die casting machine the combination of a die; a removable melting pot; a movable goose neck having an air inlet and a nozzle, the nozzle being carried from beneath the molten metal in said pot to connecting relation with said die by the movements of the goose neck; and a pressure fluid supplying means having a discharge connection overhanging said melting pot in a position to be engaged by the inlet connection of said goose neck when the latter is in its raised die engaging position.

26. In a die casting machine the combination of a die; a removable melting pot; a

movable goose neck having an air inlet and a nozzle, the nozzle being carried from beneath the molten metal in said pot to connecting relation with said die by the movements of the goose neck; and a pressure fluid supply means having a yielding discharge connection projecting over said melting pot and adapted to enter into sealing engagement with the inlet of said goose neck when the latter is in its raised die engaging position.

27. In a die casting machine, the combination of a die; means for conducting molten metal into the die; and spring-actuated means for supplying pressure-fluid to said conducting means to force molten metal therefrom into the die.

28. In a die casting machine, the combination of a multi-part die, one of said parts being movable to open and close the die; driving means for said movable die part, said movable die part having a cavity; a movable member mounted in said movable die part for co-operation with the cavity to form a casting; and means in the path of said member and adjustable to different positions in said path for advancing said movable member within the die cavity as the die closes and for withdrawing said member as the die opens.

29. In a die casting machine, the combination of a multi-part die, one of said parts being movable to open and close the die; driving means for said movable die part, said movable die part having a cavity; movable casting forming members mounted in said movable die part; and means on the machine for first advancing one of said casting-forming members and then another into the die cavity as the die closes and for withdrawing said members in the reverse order as the die opens.

30. In a die casting machine, the combination of a multi-part die having a sprue hole formed by the closed die parts; a movable member for bridging said closed die parts, said member having a passage-way there-through; die-charging means, including a nozzle adapted to be actuated to move said member against the closed die with said nozzle and the passage-way in said member registering with the sprue hole.

31. In a die casting machine, the combination of a die composed of separable sections having a sprue hole in a plane of separation; a pressure-chamber having a nozzle adapted to be tightly connected to the sprue hole to charge the die; means for moving the nozzle into charging position; and shiftable means free of connection with the nozzle, interposed between the nozzle and the die, when the nozzle is in charging position, to prevent the nozzle from prying the die sections apart.

32. The combination in a die casting machine of a frame-work; a die mounted there-

on; a pressure-chamber; operating means for moving said pressure-chamber into charging relation to said die; and automatic compensating means associated with said operating means for permitting the ready substitution of a different sized pressure-chamber.

33. The combination in a die casting machine of a frame-work; a die mounted thereon; a pressure chamber having a die-charging nozzle and fluid-pressure end; means for supplying pressure-fluid; and operating means for moving said pressure chamber to connect its nozzle with the die and its fluid-pressure end with the pressure-fluid supply means, said supply means being resiliently mounted so as to insure a tight connection between said means and the fluid-pressure end of the pressure-chamber.

34. In a die casting machine, the combination of a multi-part die, one of said die parts being movable to open and close the die; driving means for said movable die part, said movable die part having a cavity; a member mounted in said movable die part for co-operation with the cavity to form a casting; and means on the machine for causing the advance of said member within the die cavity as the die closes and for causing the withdrawal of said member as the die opens, said last-mentioned means being adjustably mounted for varying the times at which said member is advanced and withdrawn.

35. The combination in a die casting machine of a frame-work; a multi-part die mounted thereon, one of said die parts being adapted to be moved to open and close the die; driving means for said movable die part; a pressure-chamber adapted to be moved into die charging position when the die is closed to conduct molten metal into the die; fluid-compressor mechanism adapted to supply pressure-fluid to the pressure-chamber when the pressure chamber is in die-charging position, said compressor mechanism including resilient means adapted to be compressed and then released to supply a quantity of pressure-fluid to the pressure-chamber; operative connections between said die-part driving means, the pressure-chamber and the compressor mechanism for moving the pressure-chamber into die-charging position after the die has been closed and for compressing said resilient means during the closing movement of the die; automatic means for maintaining said resilient means in their compressed condition; and automatic means for releasing said maintaining means, while the die is closed and the pressure-chamber is in die-charging position, to cause a supply of pressure-fluid to be furnished to the pressure-chamber.

36. In a die casting machine, the combination of a container for molten metal; a die having an inlet for molten metal; a connec-

tion for supplying fluid under pressure; a pressure chamber having an inlet adapted to seal against said pressure connection, and a discharge nozzle for molten metal adapted to seal simultaneously against said die inlet; means for shifting said pressure chamber alternately to submerge said nozzle in the metal in said container and to establish through the movement of said chamber connection with said supply connection and said die.

37. In a die casting machine the combination of a container for molten metal; a die having an inlet opening for molten metal; a connection for supplying pressure fluid; a pressure chamber having an inlet adapted to seal against said pressure connection, and a discharge nozzle for molten metal adapted to seal simultaneously against said die inlet; and means for shifting said pressure chamber alternately to submerge said nozzle in the metal in said container while maintaining said inlet open to the atmosphere, and to establish through the movement of said chamber connection with said supply and said die inlet.

38. In a die casting machine, the combination of a container for molten metal; a die composed of separable parts having a sprue hole in a plane of separation; a ported plate movably mounted adjacent said die so as to be capable of moving into sealing face contact with the face of the die with the port in the plate substantially registering with the sprue hole; a connection for supplying pressure-fluid; a pressure-chamber provided with an inlet port for pressure-fluid and having a nozzle provided with a discharge port for molten metal, said pressure-chamber being mounted so as to be capable of movement into engagement with the aperture in said plate; and means for shifting said pressure-chamber between two positions, in one of which said discharge port is submerged in the molten metal, and in the other of which said inlet port is connected with the pressure-fluid supply and said nozzle is in engagement with the aperture in said plate to clamp the plate in sealing engagement with the die.

39. In a die casting machine, the combination of a container for molten metal; a die composed of separable parts having a sprue hole in a plane of separation; driving means for opening and closing the die; a ported plate movably mounted adjacent said die so as to be capable of moving into sealing face contact with the die with the port in the plate substantially registering with the sprue hole; a connection for supplying pressure-fluid; and a pressure-chamber provided with an inlet port for pressure-fluid and having a nozzle provided with a discharge port for molten metal, said pressure-

chamber being operatively connected to said driving means for shifting said pressure-chamber between two positions, in one of which said discharge port is submerged in the molten metal, and in the other of which said inlet port is connected with the pressure-fluid supply and said nozzle is in engagement with the aperture in said plate to clamp the plate in sealing engagement with the closed die.

40. In a die casting machine, the combination of a container for molten metal; a multi-part die having a sprue hole, one of said parts being movable to open and close the die; operating means for said movable die part; a connection for supplying pressure-fluid; a pressure-chamber having an inlet port for pressure-fluid and a discharge port for molten metal, said pressure-chamber being operatively connected to the die operating means for shifting said pressure-chamber between two positions, in one of which said discharge port is submerged in the molten metal, and in the other of which said inlet port is in connection with the pressure-fluid supply and said discharge port in connection with the sprue hole in the closed die, said pressure-fluid supply also being operatively connected to the die operating means so as automatically to supply pressure-fluid to the pressure chamber when the pressure-chamber is in its last-mentioned position.

41. In a die casting machine, the combination of a container for molten metal; a die having a sprue hole; means for generating and supplying pressure-fluid, said means including a cylinder, a piston adapted to reciprocate therein and resilient means; a pressure-chamber having an inlet port for pressure-fluid and a discharge port for molten metal; means for shifting said pressure-chamber between two positions, in one of which said discharge port is submerged in the molten metal, and in the other of which said inlet port is in connection with the pressure-fluid supply and said discharge port in connection with the sprue hole in said die; means for placing said resilient means under tension; and means for releasing said resilient means to move said piston through its range of movement in one direction to generate pressure-fluid.

42. In a die casting machine, the combination of supporting means; a pressure-chamber mounted for movement thereon; actuating means for said pressure-chamber arranged to be shifted between a normal operative position and an inoperative position; and a releasable connection between said pressure-chamber and said actuating means adapted to be automatically released by movement of said actuating means to inoperative position.

43. In a die casting machine, the combination of supporting means; a pressure-chamber mounted for movement thereon and provided with a pair of lugs; and actuating means for said pressure-chamber arranged to be shifted between a normal operative position and an inoperative position and provided with a pair of recesses in which said pair of lugs on the pressure-chamber is normally disposed, said pair of lugs being adapted to be moved out of said pair of recesses to automatically disconnect the pressure-chamber and its actuating means by movement of said actuating means to inoperative position.

44. In a die casting machine the combination of a die; power actuating means; a driving connection between the actuating means and the die; power storing means; a molten metal injector operable by power from said storing means; a mechanism operated by the closing movements of the die and serving to store power in said power storing means while preventing the action of said injecting means; and a device actuated by the die closing means upon the closing of the die to permit said injecting means to function through energy derived from said power storing means.

45. In a die casting machine, the combination of a die having a cavity; means for conducting metal to the die cavity; a cylinder; a piston adapted to reciprocate therein; means for operating said piston; a vent connection between the die cavity and the working space in said cylinder on one side of the piston; and means connecting the working space in said cylinder on the opposite side of the piston with said metal conducting means for forcing metal into said cavity when the die is closed.

46. In a die casting machine, the combination of a die; means for opening and closing the die; a cylinder; a piston mounted for reciprocation therein; said piston being connected to the die opening and closing means for operation by the latter in one direction; means for conducting metal to the die; means connecting the interior of said cylinder with the metal conducting means; and spring means adapted to be stressed by the movement of the piston and

then released to force the metal from the conducting means into the die.

47. In a die casting machine the combination of a base including a substantially horizontal guide structure; a melting pot mounted in said base; a goose neck movable relatively to said melting pot to accumulate a charge from said pot, and alternately therewith to assume a die charging position; means for discharging pressure fluid into said goose neck in its die charging position; a carriage mounted on said guide structure and having a normal position toward said melting pot, and an abnormal position away from said melting pot; a separable die so mounted on said carriage as normally to be positioned above said melting pot when the die is closed; actuating mechanism mounted on said carriage and connected with said die to close and open the same; and releasable connections from said actuating mechanism to said goose neck and to said pressure fluid discharging means for actuating the same in timed relation with the die.

48. In a die casting machine the combination of a base including a substantially horizontal guide structure; a melting pot mounted in said base; a goose neck mounted in said melting pot and movable therein from a lower charge receiving position to a higher die charging position; a pressure impulse generating device mounted on said base and arranged to enter into cooperative relation with said goose neck when the latter is in its die charging position; a carriage mounted on said guide-structure; secondary guides on said carriage; a separable die including a fixed part fixedly mounted on said carriage, and a relatively movable part mounted on said secondary guides; an actuating member, including a reciprocating member mounted on said carriage and operatively connected with said movable die part to close and open the die; a releasable driving connection between said reciprocating member and said goose neck; and a releasable actuating connection between said reciprocating member and said pressure impulse generating means.

In testimony whereof I have signed my name to this specification.

TORBJORN C. KORSMO.