

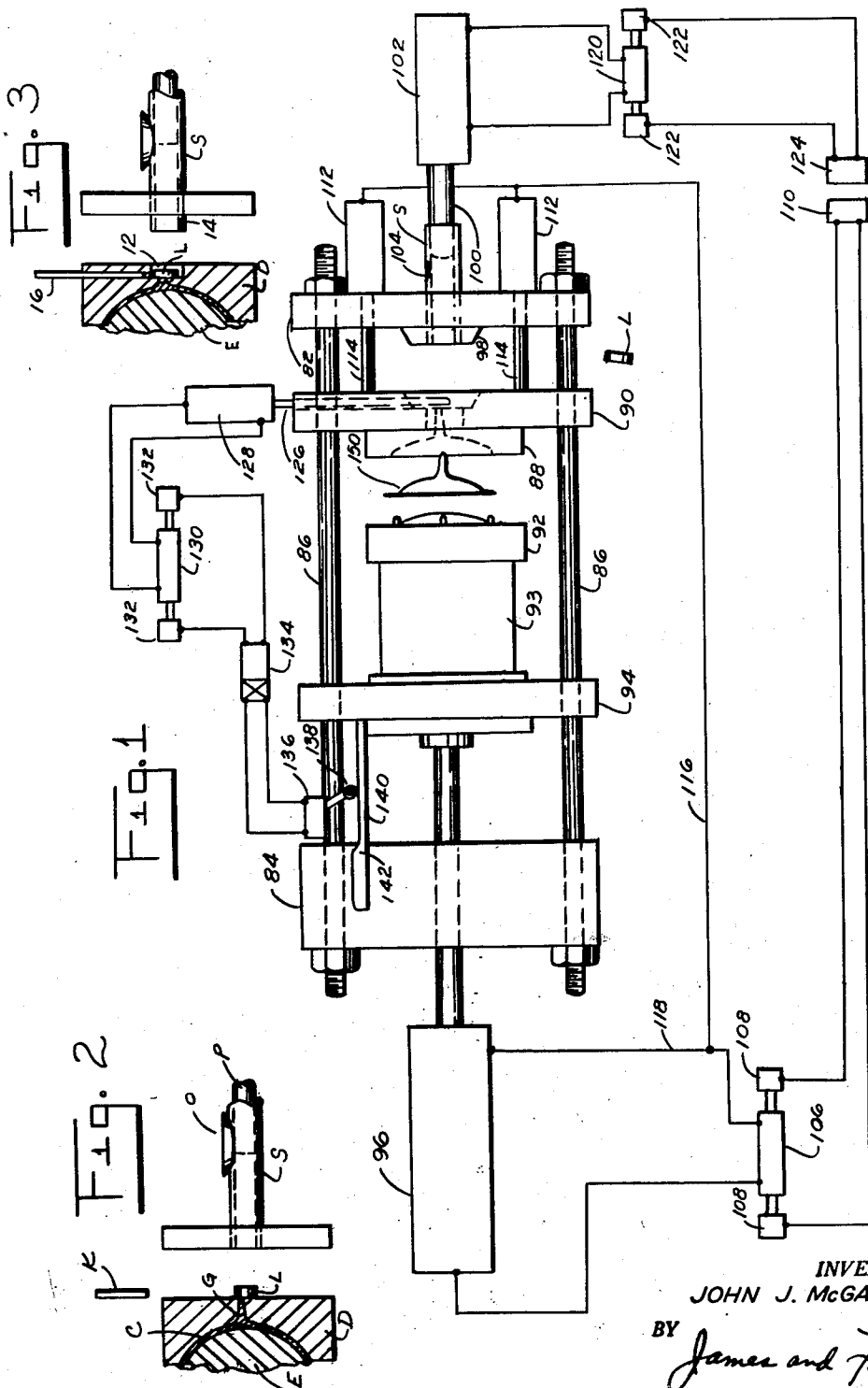
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J. J. McGARIGAL
DIE CASTING APPARATUS

2,612,666

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2 SHEETS—SHEET 1



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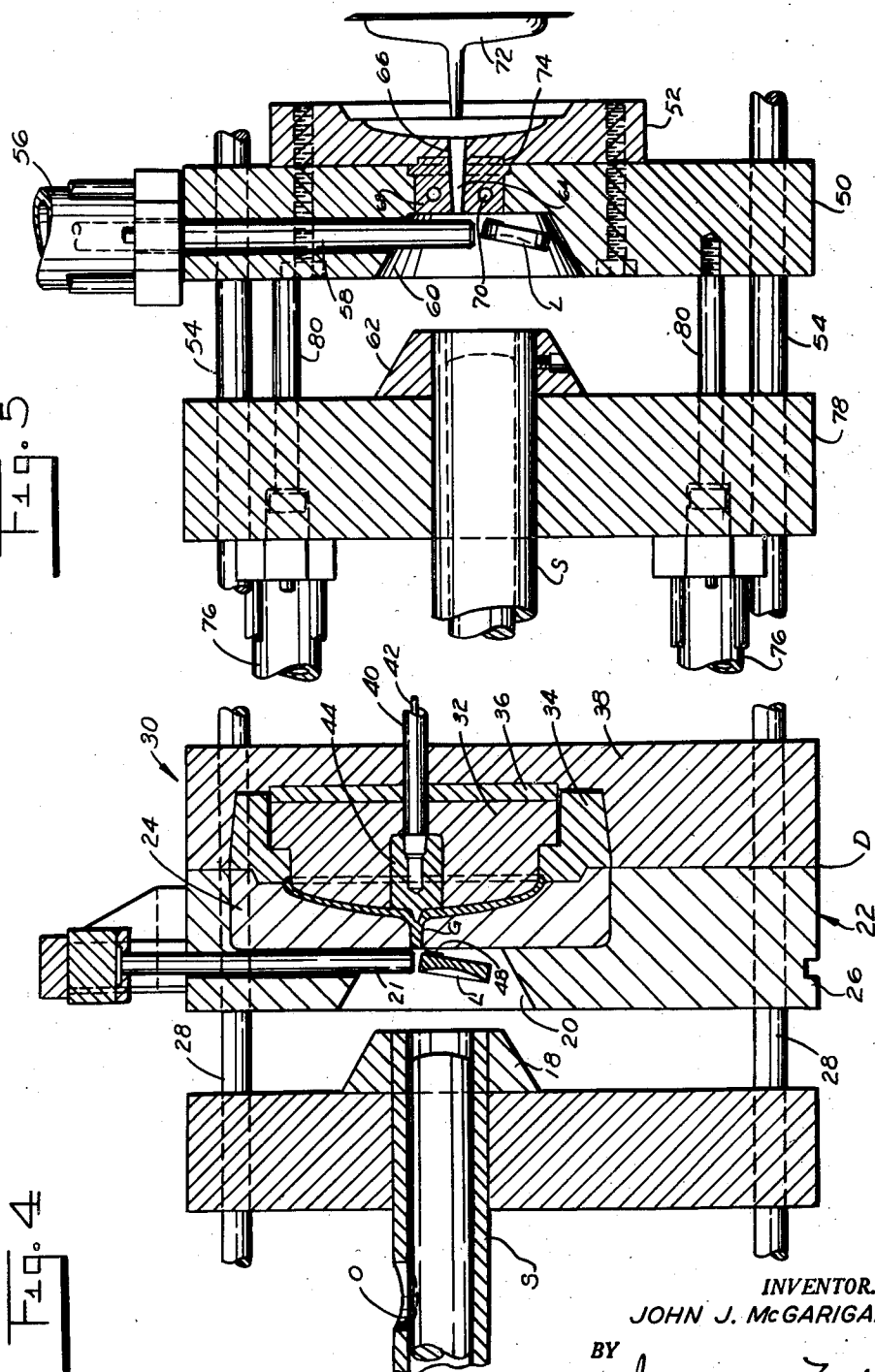
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2 SHEETS—SHEET 2

Fig. 5

Fig. 4



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DIE CASTING APPARATUS

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This invention relates to molding apparatus, and more particularly to die-casting apparatus for so-called "cold-chamber" molding.

In order to help produce dense, homogeneous castings, high molding pressures are desirable, and have been obtained by cold-chamber casting. An equally important advantage of cold-chamber casting is that there is far less contamination of the molten metal by iron, because of the lower temperature of the metal. In cold-chamber casting, a single charge of molten metal is preliminarily poured in a shot sleeve communicating with the die cavity, whereupon a plunger is forced through the sleeve.

The primary object of the present invention is to generally improve molding apparatus, particularly cold-chamber casting apparatus.

Much die-casting apparatus is constructed with horizontally opening dies, that is, with the parting face of the die vertical. This facilitates ejection of the finished piece. Such machines, however, require the use of a sideward or substantially horizontal shot sleeve. It is desirable to prevent the molten metal from flowing into the die cavity before the plunger is operated, for such metal will solidify prematurely, and cause internal flaws and surface discolorations.

Heretofore such preliminary flow of molten metal has been avoided by locating the shot sleeve lower than the die cavity, the shot sleeve passing through the cover die and being connected to the lower edge of the cavity by a gate extending vertically on the parting face. This was done even when molding a thin circular article such as a saucepan cover or a fry pan, which should more preferably be gated at the center for equal-distance flow of metal. Many pieces were defective, and I believe that the rejects were caused largely by the edge gating.

One object of the present invention is to make it possible to gate wherever desired in the casting itself, even when using a horizontal shot sleeve. With a circular casting, the most desirable gate location is usually at the center of the casting.

Still further objects are to eliminate the need for an oversized die extending substantially below the die cavity in order to provide room for the shot sleeve, and also to avoid the machine-work needed to cut through such a die.

In accordance with the present invention, the shot sleeve is raised nearly to the level of the center of the die cavity, and a substantially horizontal, tapered gate much smaller in diameter than the shot sleeve passes through the die to the mold cavity. The cover die and shot sleeve are made relatively movable, and when separated,

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a slug of solidified metal formed within the end of the sleeve remains with the gate and cover die. Appropriate knock-off means is provided to break this slug away from the gate, after the die has been bodily separated from the shot sleeve, but before the die has been opened.

Another object of the invention is to minimize the necessary length of shot sleeve, while preventing premature flow of metal therefrom. For this purpose, the gate is located eccentrically of the sleeve, being raised substantially above the center line of the sleeve.

Still further objects are to prevent leakage of metal around the end of the sleeve during the casting operation, and to facilitate discharge of the slug after it is knocked off the gate. For this purpose, the end of the sleeve is preferably enlarged and tapered, and the cover die is recessed with a mating seat.

Other objects are to avoid the need for machining away a large volume of metal from the back of the cover die; to facilitate changing from one die to another; and to conveniently mount the knock-off means for movement with the die. With these objects in view, I provide an adapter plate on which the cover die is detachably mounted. The enlarged, tapered recess which receives the end of the sleeve is formed in the adapter plate and the knock-off means are permanently mounted on the adapter plate. A tapered gate passes through the adapter plate and registers with a continuation gate passing through the cover die to the middle of the cavity. Thus the operation is exactly the same as though the cover die were recessed and carried the knock-off means, yet the adapter plate remains a part of the molding machine when the cover die is removed or changed.

To accomplish the foregoing objects, and other more specific objects which will hereinafter appear, my invention resides in the molding machine elements and their relation one to another, as are hereinafter more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawings in which:

Fig. 1 is a schematic view in side elevation of apparatus embodying features of my invention;

Fig. 2 is a fragmentary view showing the invention in most elementary form;

Fig. 3 is a similar view showing a modification;

Fig. 4 is a vertical section through a part of a machine having more of the features of my invention; and

Fig. 5 is a somewhat similar view through a

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modification embodying additional features of the invention.

Referring to the drawings, in all forms of the invention shown, the molding apparatus comprises a horizontal shot sleeve S having an opening O to receive molding material, and a plunger P movable past the opening. There is also a die D having a mold cavity C and a tapered gate G. The die and sleeve are relatively movable, the sleeve being connected to the gate G when injecting material into the mold cavity, and then being separated from the die, as shown in the drawing, in order to make it possible to knock the slug L from the gate by means of suitable knock-off means K. The slug L is, of course, formed by a residue of metal in the end of the sleeve S during the molding operation. In Fig. 2 only a fragment of the ejector die E is shown. The knock-off means K functions before the die itself is opened, and after the slug has been knocked from the gate, the ejector die E is separated from the cover die, taking the molded piece and gate with it. Conventional ejector pins, not shown, then strip the molded piece from the ejector die.

Fig. 3 shows a modification of the invention in which the die D is recessed at 12 to receive the end 14 of the sleeve S. This helps prevent leakage of metal, and also makes it possible to mount the knock-off rod 16 in the die, so that it need be moved vertically only a small amount, instead of being retracted to a position wholly above the die as shown in Fig. 2.

Reference is now made to Fig. 4. This differs from Fig. 3 primarily in that the end of the sleeve is enlarged and tapered. This is preferably done by the addition of a tapered ring 18 which is fitted tightly around the end of the sleeve. The recess 20 in the cover die 22 is enlarged and tapered to mate accurately with the ring 18. This has the advantages of providing more room to knock the slug L from the gate G; of facilitating sliding of the slug out of the recess; of providing automatic alignment of the parts; and of preventing leakage around the end of the sleeve.

In the arrangement shown in Fig. 4, the cover die 22 is made up of a cavity portion 24 permanently fitted into an outer portion 26, the latter being slidably mounted on the tie bars 28 of the machine. It may be removably mounted on the tie bars by releasable support means, but here the drawing has been simplified as though the tie bars pass through the die. The knock-off rod 21 is mechanically operated as the die moves away from the sleeve.

Only the top portion of the ejector die 30 is shown, this being built up of parts 32, 34 and 36 set into an outer portion 38. Concentric pipes 40 and 42 lead to a water-cooled core 44. The core is provided to help pull the casting with the ejector die from the cover die. It helps form a hole needed in the saucepan cover to later receive a handle. The core is made separate so that it can be replaced when eroded, it being at the hottest point in the die.

Fig. 4, being to larger scale, more clearly shows the preferred location of the gate G relative to the sleeve S. The gate is preferably elevated substantially above the center line of the sleeve. This is further indicated by the break-off point 48 on the slug L. In this way a greater volume of metal may be poured into the sleeve without danger of premature flow into the mold cavity. With small castings this would not be impor-

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tant, but with larger castings, the sleeve and the plunger travel would have to be lengthened if the gate were kept at the center line of the sleeve.

Fig. 5 illustrates a preferred form of the invention, in which an adapter plate 50 is provided, on which the cover die 52 is removably bolted. The adapter plate is slidable on the tie rods 54 of the machine, and carries a double-acting hydraulic cylinder 56 for the knock-off rod 58. The tapered recess 60 for the enlarged end 62 of shot sleeve S is formed in the adapter plate 50, rather than in the mold itself. A tapered gate opening 64 passes through the adapter plate and registers with an extension 66 cut through the die. In preferred form, a special gate bushing 68 is fitted into the adapter plate. This bushing may, if desired, be provided with water passages 70 for cooling. Registration of the gates 64 and 66 is important, in order not to oppose withdrawal of the casting 72 from the cover die. The bushing 68 may accordingly be provided with a shallow projection 74 which is matingly received in a shallow recess in the cover die.

When the ejector die is retracted, single-acting hydraulic cylinders 76 move the adapter plate 50 away from the stationary head 78 for a limited distance, by means of rods 80. The casting 72 has already been withdrawn from the cover die. The ejector die is not shown.

The arrangement of Fig. 5 using an adapter plate as described, has the advantage that the same adapter plate may be used with a series of different dies. It avoids the need for a thick, bulky cover die, and the further need for extensive machining of the cover die to cut in the tapered recess and to receive the knock-off rod. It has the additional convenience of remaining on the tie rods 54, and remaining with the operating mechanism 56 for the knock-off rod, and remaining connected to the single-acting cylinders 76 which keep the die closed during its initial movement.

Referring now to Fig. 1, the apparatus comprises stationary front and back plates 82 and 84 connected by tie rods 86. The cover die 88 is mounted on an adapter plate 90 slidable on tie rods 86. The ejector die 92, including die base 93, is mounted on a movable plate 94 slidable on rods 86. The die base 93 has the usual ejector mechanism, not shown, for operating the ejector rods. The ejector die is moved by a double-acting hydraulic cylinder 96. A toggle mechanism may be used between the cylinder and the movable plate 94, but has been omitted here in order to simplify the drawing.

The shot sleeve S is secured to front plate 82 and is provided with an enlarged tapered end 98. The plunger 100 is moved by a double-acting hydraulic cylinder 102. It will be understood that the plunger, when in retracted position, is to the right of the opening 104, so that molten metal may be poured through the opening into the sleeve.

The hydraulic cylinder 96 is controlled by a valve 106 which is operated by air cylinders 108 controlled by manual means 110. The cover die 88 and adapter plate 90 are initially moved to the left with the ejector die 92, by means of single-acting cylinders 112 and rods 114. The cylinders 112 are connected by piping schematically shown at 116, to the pipe 118 leading to the return side of cylinder 96. In this way, pressure is applied to the cylinders 112 at the end of the casting operation when the die is being opened, and is relieved when the die is closed.

The cylinder 102 is controlled by a valve 120 operated by air cylinders 122 controlled by a manually operable means 124, preferably located near the control 110 and the pour hole 104, for the convenience of the operator. These are the only manual controls on the machine.

The knock-off rod 126 is operated by a double-acting hydraulic cylinder 128 controlled by a valve 130. This is operated by air cylinders 132 controlled by a solenoid-operated valve 134 which in turn is connected to a switch 136 having a cam roller 138 cooperating with a cam strip 140 secured to and movable with the plate 94. The drop 142 on cam 140 is so located that the knock-off means is operated after the adapter plate 90 is moved away from the stationary head 82, but before the ejector die 92 is moved away from the cover die 88 to eject the casting. In the drawing, the broken-off slug is shown at L, and the casting is indicated at 150.

It is believed that the construction and operation, as well as the advantages, of my improved apparatus for cold-chamber casting, will be apparent from the foregoing detailed description. The die is closed, a ladle of metal poured, and the shot plunger operated by means of valve 124. After a short wait the die is retracted by means of valve 110. As the die retracts, the knock-off rod operates to break off the slug. The cover die stops but the ejector die keeps moving. As the die opens, the molded piece is ejected. The die is again closed by valve 110, and the cycle repeated.

The advantages of low iron contamination and very high operating pressures are retained, but it is possible to gate the casting wherever desired in the casting itself, and most conveniently, at the center of the casting. There is accordingly less distance for the metal to travel in the die, and the distance traveled to different parts of the casting is more nearly equal. A better and more homogeneous casting results, with a better surface finish. In fact, in some cases the surface may be buffed and polished directly from the die after a trimming operation, and without intermediate grinding operations. Despite the time needed to knock off the slug before opening the die, the over-all production speed is increased because of the reduction in the number of rejected castings, that is, there are more good castings per hour. There is no need for the die to be extensive below the die cavity to provide room for the sleeve. In preferred form, there is no need for the cover die to be machined to receive the sleeve and knock-off rod. In making new dies, there is a great saving in die steel. Shapes difficult for edge gating, such as saucepan covers and fry-pans, which have heretofore proved troublesome to mold successfully by the cold-chamber method, are readily made with the improved apparatus. Dies previously used on gooseneck type machines may readily be converted for use on the present apparatus.

It will be understood that the hydraulic cylinders 112 may be connected constantly to a pressure source, thus acting as hydraulic springs, instead of intermittently as shown. Moreover, it is not essential to use hydraulic actuating means for the machine, for mechanical drives are also available.

It will therefore be apparent that while I have shown and described my invention in several preferred forms, many changes and modifications may be made in the structures disclosed, without departing from the spirit of the invention

as sought to be defined in the following claims. In the die casting industry the terms "edge gating" and "center gating" are used, but "edge gating" means a gate along the parting face of the die, whether or not at the edge of the casting, and "center gating" means a gate running through the solid metal of the die transversely of the parting face, whether or not at the center of the casting. Because of this ambiguity, and to avoid confusion, the claims employ the term "enclosed gate" in lieu of the term "center gate." In the claims reference to the sleeve or gate being "horizontal" is intended to mean that it is sidewardly directed rather than upright or vertically directed, and is not intended to limit the claims to strict or perfect horizontality. The expression "in the direction of the axis of the sleeve" is intended to mean end to end, or substantially in the same direction, rather than perfectly so.

I claim:

1. Casting apparatus comprising a horizontal shot sleeve having an open end, said sleeve having an opening to receive poured molding material in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, the end of said sleeve being enlarged and tapered, a permanent die having separable parts, said die having a mold cavity and an enclosed horizontal gate through one of the die parts leading to the cavity, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of liquid molding material from flowing into the gate and cavity before the plunger is operated, said die having a recessed tapered seat to mate with the enlarged tapered end of the sleeve, means to relatively bodily move the die and the sleeve toward one another in the direction of the axis of the sleeve in order to connect the sleeve to the gate when ejecting liquid from the sleeve through the gate into the mold cavity, and away from one another in order to separate the die and sleeve with a solidified slug of excess material from the end of the sleeve usually left with the gate, and knock-off means movable transversely of the axis of the sleeve into the recessed seat in order to break the slug from the gate after the die has been separated from the sleeve, and thereby permitting said slug to slide gravitationally out of the recessed seat.

2. A casting machine for rapidly repeated casting cycles, said machine comprising a horizontal stationary shot sleeve having an open end, said sleeve having an opening to receive poured molding material in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate, and having an ejector die portion, said die having a mold cavity and an enclosed horizontal gate through the cover die portion, said adapter plate having a gate passage forming a continuation of the gate in the cover die, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of liquid molding material from flowing into the gate and cavity before the plunger is operated, and knock-off means mounted on the adapter plate for movement therewith, said knock-off means being movable transversely of the axis

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of the sleeve to break from the gate a solidified slug of excess molding material formed by the end of the sleeve.

3. Casting apparatus comprising a stationary shot sleeve having an open end, a plunger passing into said sleeve through the other end, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, the end of said sleeve being enlarged and tapered, the adapter plate having a tapered recessed seat mating with the enlarged tapered end of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate, and having an ejector die portion, said die having a mold cavity and an enclosed gate through the cover die, said adapter plate having a gate passage forming a continuation of the gate in the cover die, and knock-off means mounted on the adapter plate for movement therewith, said knock-off means being slidable transversely of the axis of the sleeve into or out of said recessed seat.

4. Casting apparatus comprising a horizontal stationary shot sleeve having an open end, said sleeve having an opening to receive poured molding material in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, the end of said sleeve being enlarged and tapered, the adapter plate having a tapered recessed seat mating with the enlarged tapered end of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate, and having an ejector die portion, said die having a mold cavity and an enclosed horizontal gate through the cover die portion, said adapter plate having a gate passage forming a continuation of the gate in the cover die, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of liquid molding material from flowing into the gate and cavity before the plunger is operated, and knock-off means movable transversely of the axis of the sleeve into or out of said recessed seat, said seat serving to facilitate discharge of a solidified slug of excess molding material as well as alignment and fit of the mating parts.

5. A casting machine for rapidly repeated casting cycles, said machine comprising a horizontal stationary shot sleeve having an open end, said sleeve having an opening to receive poured molding material in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate, and having an ejector die portion, said die having a mold cavity and an enclosed horizontal gate through the cover die portion, said adapter plate having a gate forming a continuation of the gate in the cover die, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of liquid molding material from flowing into the gate and cavity before the plunger is operated, and knock-off means mounted on the adapter

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plate for movement therewith, said knock-off means being movable transversely of the axis of the sleeve to break from the gate a solidified slug of excess molding material formed by the end of the sleeve, a double-acting hydraulic cylinder to move the ejector die, a valve controlling said cylinder, one or more single-acting hydraulic cylinders for moving the adapter plate away from the shot sleeve, and means connecting said single-acting cylinders to the return side of the double-acting cylinder.

6. A die casting machine for rapidly repeated casting of metal, said machine comprising a horizontal stationary shot sleeve having an open end, said sleeve having an opening at the top to receive poured metal in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, the end of said sleeve being enlarged and tapered, the adapter plate having a tapered recessed seat mating with the enlarged tapered end of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate and having an ejector die portion, said die having a mold cavity and an enclosed horizontal gate through the cover die portion, said adapter plate having a gate passage forming a continuation of the gate in the cover die, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of molten metal from flowing into the gate and cavity before the plunger is operated, and knock-off means mounted on the adapter plate for movement therewith, said knock-off means being movable transversely of the axis of the sleeve into the aforesaid tapered recessed seat in order to break from the gate a solidified slug of excess metal formed by the end of the sleeve.

7. A die casting machine for rapidly repeated casting of metal, said machine comprising a horizontal stationary shot sleeve having an open end, said sleeve having an opening at the top to receive poured metal in liquid state, a plunger movable in said sleeve past said opening, said sleeve having a diameter at least as great as that of the plunger all the way to the open end of the sleeve, an adapter plate movable toward or away from the end of the sleeve in the direction of the axis of the sleeve, the end of said sleeve being enlarged and tapered, the adapter plate having a tapered recessed seat mating with the enlarged tapered end of the sleeve, a die having a cover die portion carried on the opposite side of the adapter plate and having an ejector die portion, said die having a mold cavity and an enclosed horizontal gate through the cover die portion, said adapter plate having a gate forming a continuation of the gate in the cover die, said gate being located above the bottom of the sleeve a distance sufficient to prevent any of the desired charge of molten metal from flowing into the gate and cavity before the plunger is operated, and knock-off means mounted on the adapter plate for movement therewith, said knock-off means being movable transversely of the axis of the sleeve into the aforesaid tapered recessed seat in order to break from the gate a solidified slug of excess metal formed by the end of the sleeve, a double-acting hydraulic cylinder to move the ejector die, a valve controlling said cylinder, one or more single-acting hydraulic cylinders for

moving the adapter plate away from the shot sleeve, and means connecting said single-acting cylinders to the return side of the double-acting cylinder.

JOHN J. McGARIGAL. 5

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