June 21, 1966 W. F. FISHER 3,256,572

DIE CASTING APPARATUS WITH POSITIVE SPRUE REMOVAL

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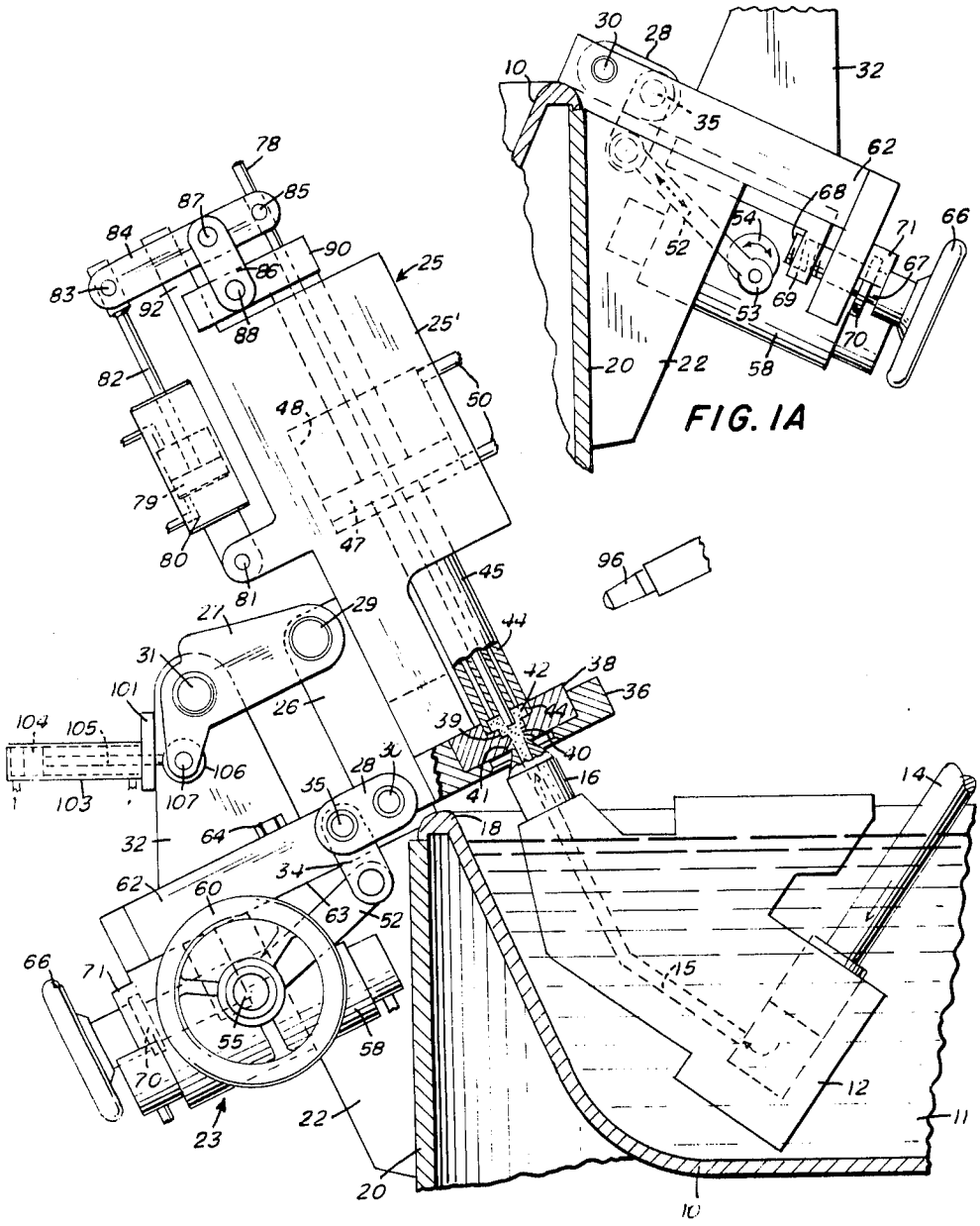


FIG. 1A

FIG. 1

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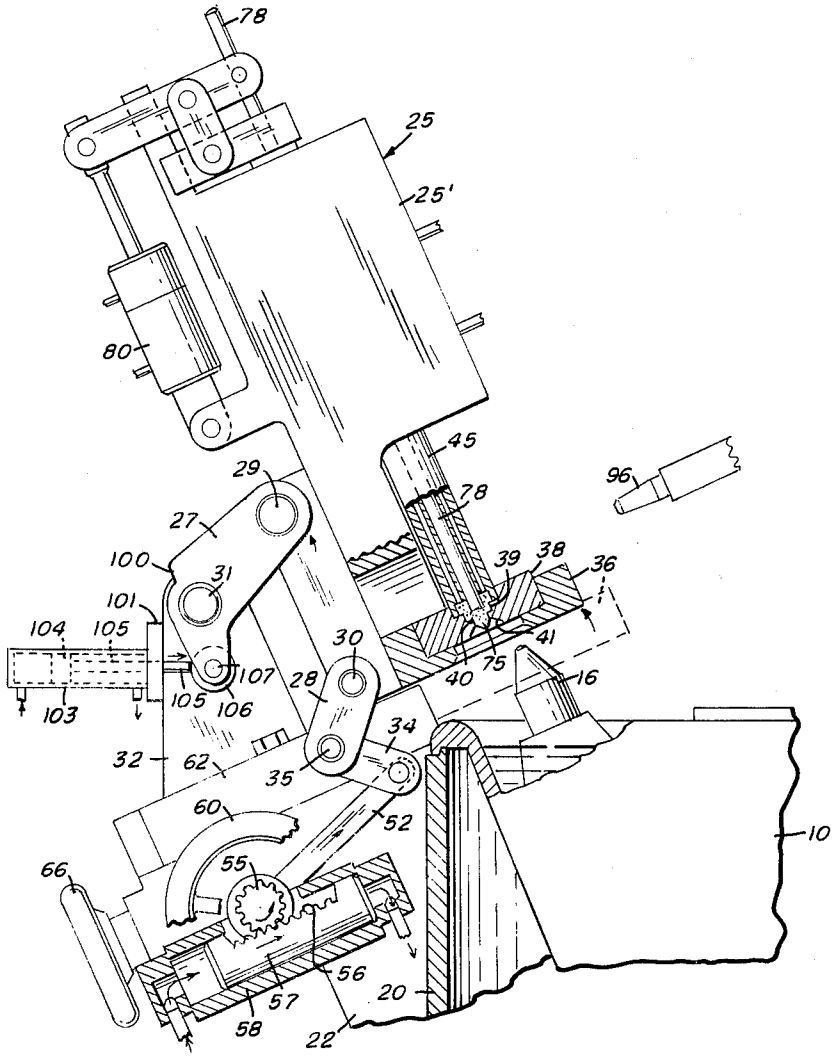


FIG. 2

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DIE CASTING APPARATUS WITH POSITIVE SPRUE REMOVAL

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FIG. 4

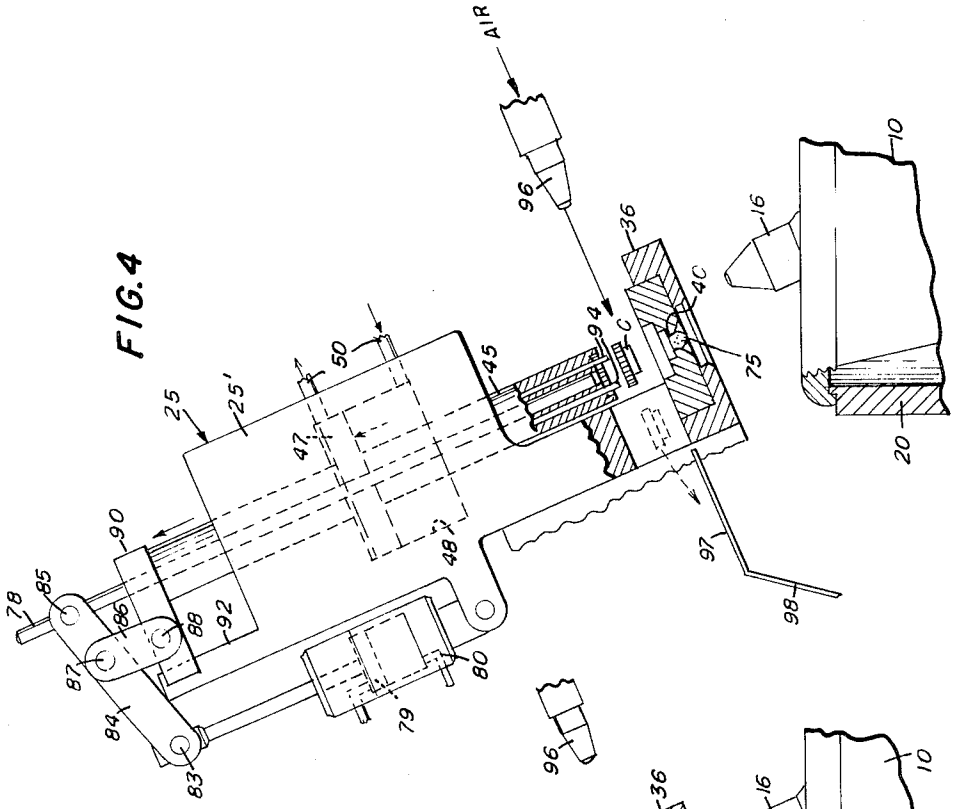
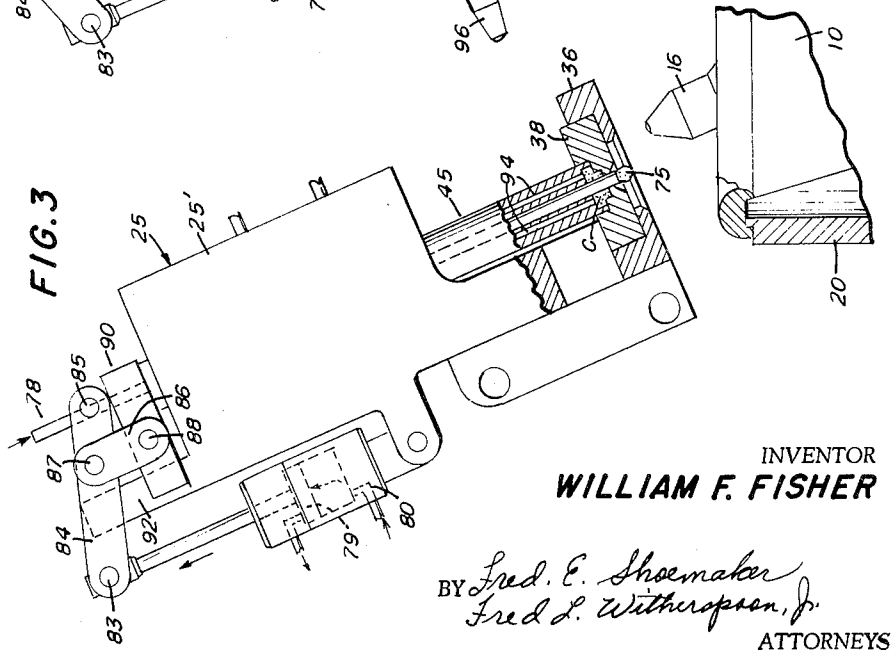


FIG. 3



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DIE CASTING APPARATUS WITH POSITIVE SPRUE REMOVAL

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FIG. 6

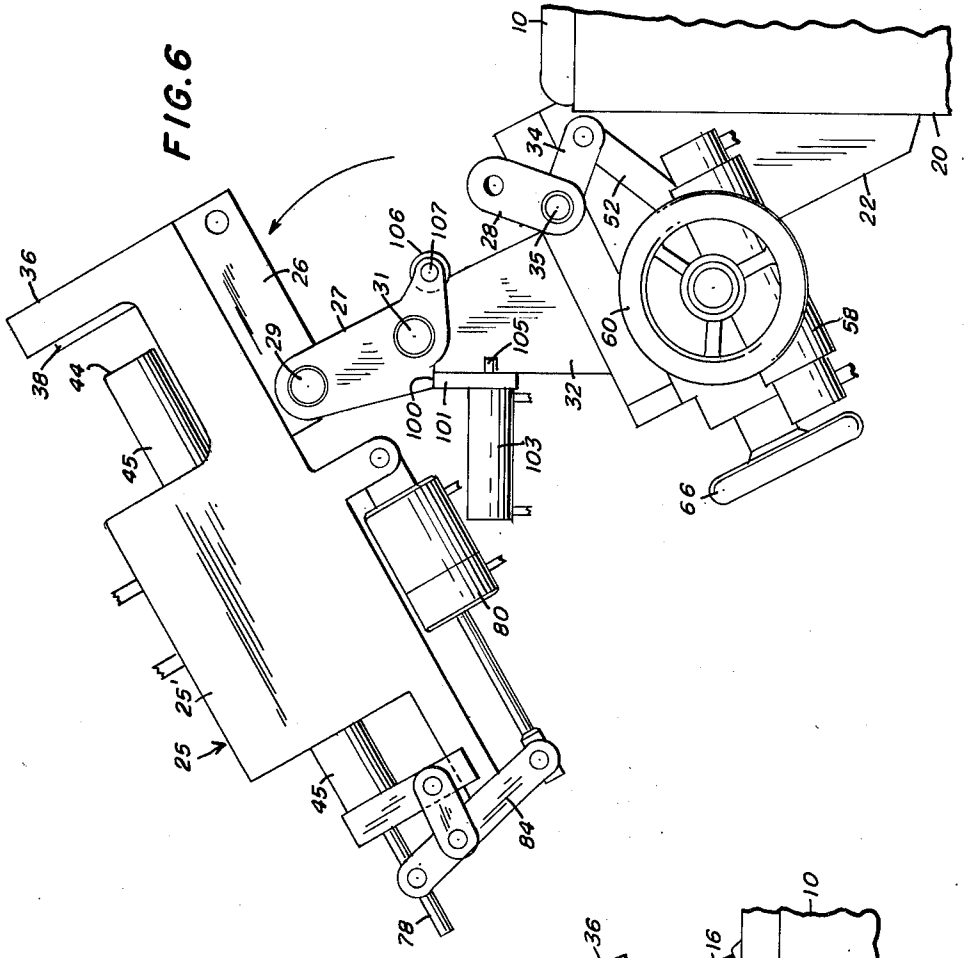
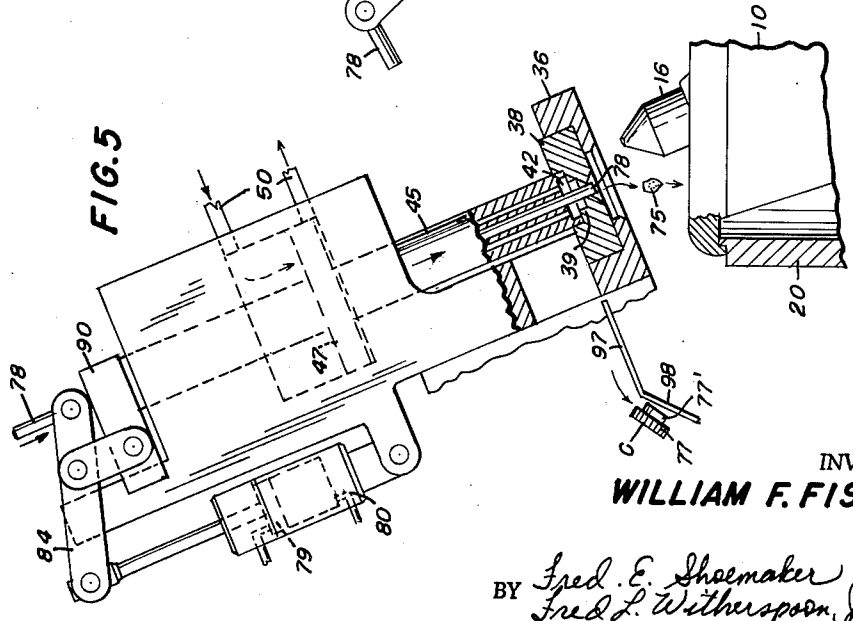


FIG. 5



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United States Patent Office 3,256,572 Patented June 21, 1966

3,256,572

DIE CASTING APPARATUS WITH POSITIVE SPRUE REMOVAL

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Filed June 13, 1963, Ser. No. 287,618
13 Claims. (Cl. 22—70)

This invention relates to automatic die casting apparatus and more particularly to such apparatus having unique die handling means together with positive sprue removal mechanism which insures against the spruce remaining in the die gate to thwart subsequent casting operations.

It is a general object of the present invention to provide a novel and improved automatic die casting machine in which mechanism is provided to insure removal of the sprue from the gate in the die and its return to the molten metal pot for remelting.

More particularly it is an object of the invention to provide a die catsing apparatus mechanism for manipulating a die assembly, having a cavity and gate, to advance it to engage the gate over a nozzle projecting upwardly from a melting pot for injection and to then withdraw the assembly to a position with the gate vertically disposed over the pot so that the sprue when discharged from the gate drops into the pot for remelting.

An important object of the invention resides in the provision of mechanism for expelling the sprue by the use of a punch that also acts, during the casting operation, as a core to form a hole in the casting.

Another important object of the invention consists of so arranging and operating the core-punch that it projects through the cast and into the gate to cut the sprue free of the cast and subsequently, following extraction of the cast, again extends through the gate to insure removal of the sprue therefrom and delivery into the pot.

A further important object of the invention consists in effecting the second core-punch projection after the die has closed following cast ejection, whereby on partial retraction of the punch the die is ready for a subsequent cast.

Among the unique features of the invention may be noted the following:

The use of a direct acting cylinder and piston for open ing and closing the casting die, the use of a cylinder and piston plus a fulcrumed lever for positioning the core-plunger for casting, advancing it for sprue cutting, retracting it for cast ejection, readvancing it for sprue ejection and retracting it to again position the core-plunger for casting.

Mounting the fulcrum for the core-plunger lever on an extension of the piston rod for the die closing cylinder to effect some of the core-plunger motions while its piston is stationary.

Providing a time delay between punching the sprue free from the cast and positively ejecting it from the die gate to permit the sprue to cool and shrink slightly.

Providing mechanism for moving the die assembly in respect to a stationary injector nozzle projecting through and above the surface of molten casting metal in a pot, so as to engage the die gate over the nozzle for a tight fit and yet traverse it laterally from the nozzle axis on withdrawal to permit the sprue to be discharged from the gate into the metal of the pot for remelting.

Other and further objects and features of the invention will be more apparent to those skilled in the art upon a consideration of the following specification and the accompanying drawings wherein is disclosed a single exemplary embodiment of the invention with the understanding that such changes and modifications may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

FIGURE 1 is an elevation, partly in central vertical section of the principal parts of die casting apparatus constructed in accordance with the present invention, and shown in the injection position;

FIGURE 1A is a fragmentary rear elevation of adjusting and moving mechanism for the die and its operating assembly;

FIGURE 2 is a view similar to FIGURE 1, but showing the still closed die asembly retracted from the injection nozzle, the core-punch unmoved from the casting position, and with the die assembly moving cylinder in longitudinal section;

FIGURE 3 is a fragmentary view, similar to FIGURE 2, but showing the core-punch projected to cut off the sprue;

FIGURE 4 is a view similar to FIGURE 3, but with the die opened to eject the cast with the resultant withdrawal of the core-punch;

FIGURE 5 is a view similar to FIGURE 3, but showing the second stroke of the core-punch for positively removing the sprue; and

FIGURE 6 is a view showing the die open, its operating link disconnected, and the die assembly thrown back for access for repairs or adjustment.

One of the problems associated with die casting deals with the removal and disposal of the sprue and if necessary the obliteration of the sprue mark from the finished product.

Also certain types of casts require such a uniform dispersal of the molten metal that a central gate is required or several gates are necessary. Such a cast may be represented by a pinion or gear having a central hub, a wheel disc and a toothed periphery. If the metal is not distributed rapidly and uniformly the teeth may not all be complete or uniform in shape and size, yet a central gate is difficult to achieve if it is also desired to cast a central bore to receive a mounting shaft.

Apparatus as described below solves all of the above problems, removes the sprue before ejecting the cast, leaves no sprue removal marks or unbalance areas, and returns the sprue to the melting pot for reuse.

Referring now to the drawings, and particularly to FIGURE 1, for a general layout of the essential parts of the apparatus for die casting with positive sprue removal, there is shown at **10** a pot for holding molten die casting metal which is preferably maintained at a relatively uniform level therein by being supplied, automatically in response to level detecting means, from a second or melting pot in a known manner. Submerged in the molten metal **11** is the injection pump **12**, actuated by means of a plunger driven by rod **14** under the control of automatic timing mechanism all as well known. Metal from the pump is delivered through bore **15** to the nozzle **16** which extends through and above the surface of the metal in the pot and is displaced laterally from the nearest edge **18** thereof as shown. As is more or less conventional, the pot, and other portions of the apparatus, is supported from suitable standards such as seen at **20** and housed in any desired manner.

A bracket **22** mounted on the support **20** carries operating mechanism **23** and adjusting devices for the die assembly **25** fitted with a side flange **26** to which are pivoted respectively arms **27** and **28** by pivots **29** and **30**. The opposite end of arm **27** is attached by pivot **31** to a bracket **32** extending upwardly from **22**, while link **28** has the integrated arm **34** forming a bell crank lever therewith and fulcrumed at **35**. Arms **27** and **28** may each be in pairs for lateral stability.

The assembly designated **25** is really a "die carrier" and its lower portion **36** is apertured and recessed and

removably mounts what may be termed the "stationary" die part 38, that is, stationary in respect to the carrier. Part 38 is provided with a suitable cavity 39, gate 40 and nozzle seat or recess 41 whereby as shown in FIGURE 1, it may be fitted fluid tightly over the tapered end of nozzle 16 whereby to receive a shot of die casting metal whenever the pump is actuated. The other portion 42 of the die cavity is formed in the lower end of movable die part 44 which forms the lower end of a plunger 45. Such plunger is guided in and extends entirely through and out the top of the carrier 25, having attached intermediate its ends a piston 47 operating in cylinder 48, formed intermediate the ends of carrier body 25'. The lower end 44 of the plunger 45, carrying the cavity 42, is shown as cylindrical in form and engages a recess in lower die member 38 to insure tightness and prevent any relative lateral movement when the die parts are locked closed under the action of piston 47 and appropriate fluid or air introduced above the piston through one of the nipples 50. The die is opened by admitting fluid beneath the piston and venting the upper side.

As seen in FIGURE 2 the whole carrier 25 with the die parts may be lifted off of the nozzle 16 and displaced laterally therefrom toward the edge of the tank 10 by counterclockwise movement of the arm 34 of the bell crank lever, which is achieved by means of a thrust on connecting rod 52 which, as seen in FIGURE 1A, is pivoted at 53 on a wrist pin on disc 54 partially rotatable by being attached to the same journalled shaft as pinion 55 whose teeth mesh with rack teeth 56 on piston 57 reciprocable in cylinder 58 under the action of air or hydraulic fluid introduced in one end or the other thereof. The piston 57 is elongated and stops against one or the other of the cylinder heads to limit its stroke.

The shaft carrying the disc and the pinion also carries the hand wheel 60, shown in FIGURES 1 and 2, to permit manipulation of the die carrier assembly for adjustment to insure that the recess 41 fits properly over the nozzle 16, and for this purpose the slide 62 carrying bracket 32 is adjustable along the top surface 63 of bracket 22 and may also be permitted to have certain limited lateral movements or adjustments, and one or more bolts, such as shown at 64, permits this adjustment which may be required at times when different dies are substituted or after a certain amount of wear.

There is likewise provided means for adjusting the tightness of engagement of the cavity in the bottom of the stationary die member over the mouth of the nozzle to compensate for initial adjustments and subsequent wear. This adjustment is achieved by means of hand wheel 66 mounted on shaft 67 threaded at its inner end 68 into a threaded aperture in arm 69 dependent from slide 62. Cylinder 58 and its attached parts is slidably mounted by gibs from slide 62 and, thus, as the wheel is rotated its shaft moves in or out and carries with it the cylinder 58 and by means of a disc 70 on shaft 67 which is engaged by the walls of a groove in block 71 attached to the cylinder. Thus rotation of wheel 66 adjusts the distance between the center line of the shaft 35, mounting disc 54 for driving the crank shaft, and the fulcrum 35 of the die lifting links to provide pressure adjustment on the nozzle.

FIGURE 1 illustrates the die engaged over the nozzle and metal injected to fill the cavity therein by a stroke of pump plunger 14. FIGURE 2 shows a whole die assembly lifted and moved latterally to the left by means of the links 27 and 28, the latter being actuated by its connecting rod 52 from piston 57 operating in cylinder 58. A small sprue is illustrated at 75 in the gate and projecting down into the recess 41 in the lower side of the stationary die member 38. In accordance with the present invention this gate is made of the same diameter and in axial alignment with the desired center aperture in the cast C, which is presumed in this instance to be a gear or pinion peripherally toothed as seen at 77 in FIGURE 5 and having a hub 77' on its lower face of somewhat less diameter. The central aperture for mounting the pinion on the shaft is achieved during the cast for most of the thickness of the gear disc and the hub by means of the core punch 78, which is slidably mounted co-axially in the movable die member 44, extends through and out beyond the upper end thereof and is adjustably positioned by the piston 79, reciprocable in cylinder 80, pivoted at 81 to an arm on the housing 25'. The piston actuates the rod 82 pivoted at 83 to link 84, pivoted at its opposite end at 85 to the upper end of the core punch 78. A slightly movable fulcrum for the lever 84 is achieved through link 86 pivoted to 84 intermediate its ends at 87 and at 88 to a lateral arm 90 secured to and movable with the upper end of the movable die member 45.

Fluid is introduced to either end of the cylinder in which the piston 79 operates through one of the nipples illustrated, and when the piston is in its maximum down position and the movable die member 45 seated in the stationary die member, the parts just described are sized and adjusted to position the lower end of the core punch, as illustrated in FIGURES 1 and 2, where it is shown projecting entirely through the disc of the gear and at least partially into the hub thereof, but not entirely through the latter. In this manner when, as in FIGURE 1, the metal is injected it first engages the lower end of the core punch and by the latter is distributed laterally in all directions uniformly thus filling all of the tooth indentations in the periphery of the disc portion simultaneously and uniformly. When, however, the cast is completed as seen in FIGURE 1 the central hole through the same is not extended through the lower end of the hub, and when the assembly plus the cast is lifted off the nozzle as in FIGURE 2, the metal in the gate and that taken out of the tip of the nozzle forms sprue 75. The metal quickly hardens and then as illustrated in FIGURE 3, the piston 79 in cylinder 80 is lifted to its maximum position by injecting fluid beneath it so that it tilts link 84 as seen and lowers the core punch 78 completing the central hole through the hub and pushing the sprue 75 out of the gate as clearly shown in FIGURE 3.

Should the sprue now drop loose from the gate it is seen to be vertically positioned above the metal in the pot 20, where it will be absorbed and remelted. However, reliance cannot be placed on the dropping of the sprue under these circumstances, since because of the need for rapid repetition casts, the sprue is still nearly molten where it touches the tip of the punch and may stick to the same and thus be drawn back into the gate when the punch is retracted, as seen in FIGURE 4, thus closing the gate in which the sprue sticks when the punch is lifted to the position there illustrated.

In FIGURE 4 the piston 79 in cylinder 80 is still shown at the top of its stroke, but since the movable die portion 45 has now been lifted from the closed position, illustrated in FIGURES 1, 2, and 3, to that illustrated in FIGURE 4 by the introduction of fluid beneath its piston 47, the movable die part 45 assumes the position illustrated in FIGURE 4 lifting with it the transverse arm 90 which has a forked end guided on the extension 92, from carrier 25', to prevent any die rotation and thus tilts lever 84 counterclockwise through the thrust of link 86, and thus raises the core-punch 78 entirely out of the cavity in the movable die part 45.

Simultaneously with the action of lifting the movable die part 45 to open the cavity the plurality of ejector pins 94, whose lower ends have previously been flush with the upper face of the cavity 42 in the movable die part, are projected downwardly by mechanism well known in the art to eject the cast C which is seen in FIGURE 4 in mid air between the two parts of the die which are now well spaced from each other, and as the cast C begins to fall a blast of air is released from nozzle 96 and blows the cast so that it drops on the ejection plate 97 and eventually slides down the chute 98 to be received on a conveyor belt or other means for removing it. In FIG-

URE 4 the sprue **75** is shown as held in gate **40** having been separated thereby from the core-punch when the latter was withdrawn.

Considering now FIGURE 5, the next step as illustrated there is to introduce fluid above piston **47**, thereby closing the die by lowering the movable portion **45** into close engagement with stationary die **38** in preparation for the next cast. This is done, however, without changing the position of piston **79**, which is generally in control of the core punch, but the latter is again projected through the gate by this movement of **45**, as clearly illustrated, effectively removing the sprue **75** which by this time has cooled sufficiently, along with the tip of the punch, so that it is pushed clear and does not stick to the punch so that it cannot be retracted and again plug up the gate.

Since the sprue is still vertically above the surface of the metal in the pot **10** it falls therein and is remelted. With the die closed there only remains to introduce fluid to the right end of cylinder **58** to retract connecting rod **52** and actuate bell crank lever **28** and link **27** to bring the gate recess **41** into engagement with the nozzle as seen in FIGURE 1, at the same time introducing fluid above piston **79** to retract the core punch to its proper injection position, as illustrated in FIGURES 1 and 2. The apparatus is now ready for a further shot of casting metal.

As illustrated in FIGURE 6 better access, for adjustment, replacement or repairs, may be had to the die parts and other components of the assembly by disconnecting link **28** from its attachment to the rib **26** which projects toward the left from the assembly **25'**, by withdrawing pin **30** therefrom, whereupon the assembly may be manually rocked back to the position, there illustrated, about its fulcrum pin **31** of link **27** until the shoulder **100** thereon engages the stop **101** secured to the left side of part **32** which projects up from the web **22** which extends laterally and upwardly from the support frame **20**. Since the assembly **25'** is only now attached to link **27** by pin **29** it also can be rocked back by a somewhat greater amount than permitted by the arcuate movement of link **27**, but its motion is eventually stopped by the engagement of cylinder **80** with cylinder **103** which projects horizontally to the left from stop member **101** which acts as a base for the same.

As seen in FIGURES 1 and 2 this cylinder **103** is fitted with a piston **104** having a rod **105** projecting through its right head and engageable with roller **106** carried by pin **107** held in a fork in the end of an angled extension of link **27**. An appropriate nipple supplies sufficient air pressure to the left end of the cylinder to more than support the entire weight of the die mechanism assembly whereby the connecting rod **52** only controls the rate of movement of the die assembly onto the nozzle **16** from the position of FIGURE 2 to that of FIGURE 1. All slack is thus taken up so that the toggle action of the crankpin will bring the die smoothly and gently into contact with the nozzle tip so that the latter is not unduly battered by the repeated engagements. The piston **104** is single acting and the opposite end of the cylinder is vented as shown.

The significance of using air rather than a spring for counterbalancing is that it permits control of the pressure, and more importantly, permits the pressure to be removed or at least relieved during the initial set-up and whenever aligning the die onto the nozzle, which is a somewhat delicate process, air pressure is delivered to the cylinder **103** through a pressure regulator which is self-releasing whenever adjusted to a different setting so that the operator merely backs off on the handwheel of the regulator when adjustment on the nozzle is required and the pressure drops to zero, or if desired can be set to a very low value to carry some of the weight of the die. This assembly of piston, cylinder and rod may be considered as a pneumatic die counterbalance control and is automatically supplied with compressed air by a control member on a sequence control panel which determines the delivery of pressure fluids to the various pistons and cylinders heretofore described, including the one for actuating the metal pump for injection. The sequencing can be done in any known manner such as by an electronic unit, timing cams or the like and appropriate adjusting means are provided wherein delays may be achieved during various portions of the piston strokes as required by the specific cast being made. Obviously large casts will require a longer time for injection and perhaps even for cooling before ejection. In any event, the whole series of operations may be timed and sequenced automatically to achieve maximum production in a given time.

I claim:

1. Die casting apparatus having in combination; a die carrier, fixed and movable die parts on said carrier, said fixed part having a cavity, a gate centrally and axially connecting said cavity to a lower surface of said fixed die part; a melting pot for casting metal, a pump immersed in said pot, a nozzle connected to said pump protruding above the level of metal in the pot and shaped to mate with said gate, means supporting said carrier for combined axial and lateral movement away from said nozzle to a terminal position with the gate vertically above the surface of metal in said pot, a core-punch axially movable in said movable die part and sized to closely engage the walls of said gate to eject the sprue therefrom formed on separation of the gate from said nozzle.

2. The die casting apparatus as claimed in claim **1** in which means is provided to open and close said die by axial movement of said movable part, means to advance or retract said core punch in respect to said movable part and said gate including power means fixed to said carrier, a transfer lever between the power means and core punch and a fulcrum for said lever movable with said die movable part.

3. The apparatus as defined in claim **2** in which the parts are so initially adjusted that said core-punch partially enters said cavity to act as a core when metal is injected into said cavity, means to actuate said power means on said carrier to extend said core-punch to sever said sprue to pass through said gate, means to actuate said means to open said die and thereby simultaneously move said fulcrum and withdraw said core-punch from the gate and from the die cavity, means to actuate said means to close the die and thereby move the fulcrum and again project the core-punch through the gate to insure sprue ejection and means to then actuate said power means to withdraw said core-punch to the initial position for subsequent metal injection.

4. In a die casting apparatus, in combination; an injection nozzle having a substantially vertical axis projecting above the level of molten metal in a pot, a die carrier, a fixed die part therein having an exposed lower face recess configured to mate with said nozzle, a die part movable in said carrier toward and away from the fixed part and with it providing a casting cavity, a gate connecting said recess and cavity, a core-punch reciprocable in said movable die and for extension through said gate to cut off and push the sprue therefrom after a cast and means to move the die carrier vertically and laterally away from said nozzle following a cast and prior to core-punch extension.

5. The die casting apparatus of claim **4** in which said core-punch and said movable die part are actuated respectively by separate power cylinders, a lever connecting the core-punch with its cylinder, and a fulcrum for said lever carried by and movable with said movable die part whereby after core-punch projection by its cylinder the lifting of the movable die part by its cylinder withdraws the core-punch to facilitate cast ejection.

6. The die casting apparatus of claim **5** wherein closure of the die parts preparatory to another cast automatically projects the core-punch through the gate with-

out motion of the core-punch power cylinder, and means to then actuate the last-mentioned cylinder to withdraw the core-punch to an injection position with its lower end just slightly above the gate.

7. Die casting apparatus having in combination; a stationary pump for molten casting metal, a tapered nozzle projecting above said pump in a generally vertical direction, a support fixed in relation to said nozzle and having a surface normal to the axis of said nozzle, a platform adjustably mounted for movement along said surface, a pair of links vertically spaced apart and pivoted one to said platform and one to a vertical extension thereof, a die carrier supported by said links and having a lower fixed die, a gate in said die adapted to mate with said nozzle when the links are substantially parallel to said surface, mechanism for lifting said carrier whereby the links guide the die gate upwardly and laterally beyond the nozzle so that a sprue ejected from the gate falls beside the nozzle.

8. The apparatus of claim 7 in which said adjustable mounting positions the gate to accurately engage over said nozzle one of said links having one end of a connecting rod articulated thereto, means including a crank pin for the other end of said link, an actuator for said crank pin, and means to adjust the crank pin and actuator toward or from the pivot for the said one link whereby to adjust the tightness of gate and nozzle engagement.

9. Die casting apparatus having in combination; a stationary die part having an open top cavity and a gate extending centrally and axially from said cavity through the bottom of said die, a movable die part axially engageable with the stationary part, a rod-like extension on said movable die having a piston intermediate its ends; a die carrier having a perforated platform mounting the stationary die part and a bore spaced above said platform guiding said rod-like extension and enlarged intermediate its ends to form a cylinder for said piston; a bore through the entire length of said extension aligned with said gate, a core-punch longitudinally movable in said last-mentioned bore, a second cylinder and piston supported by said carrier beside and substantially parallel to the first, a lever above said carrier articulated at one end to said core-punch, a rod extending upwardly from said second piston and articulated to the other end of said lever, an arm extending from said rod-like extension toward said piston rod, a fulcrum for said lever carried by said arm and means to supply fluid to either end of each of said cylinders to actuate the pistons therein to open or close said cavity and retract or extend said core-punch through said gate.

10. The die casting apparatus of claim 9 associated with a metal melting pot, a nozzle projecting upwardly through and above the surface of the metal in said pot, means to deliver molten metal through said nozzle, linkage supporting said die carrier adjacent said pot constructed to guide said gate for tight engagement over said nozzle, and means to actuate said linkage to lift the carrier vertically and laterally from the nozzle whereby extension of said core punch may discharge a sprue from said gate into the metal in said pot.

11. Die casting apparatus as defined in claim 7 in which said carrier lifting means includes an arm on the link which is pivoted to said platform forming therewith a bell-crank lever, power means to actuate said arm, and a removable pin connecting said platform pivoted link to said carrier whereby on removal the carrier and its die parts may be thrown back about the pivots of the other link for removal from above the pump and nozzle for service.

12. Die casting apparatus as defined in claim 11 in which said vertical extension of said platform supports a horizontally extending cylinder, piston and rod assembly for assisting in lifting the die carrier and cushioning its engagement with the nozzle, said cylinder being positioned to act as a stop for said carrier when it is thrown back for service.

13. Die casting apparatus as defined in claim 12 wherein the said other link has an angled arm, the free end of which is aligned with the said piston rod for lifting the link and carrier when the rod is projected.

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