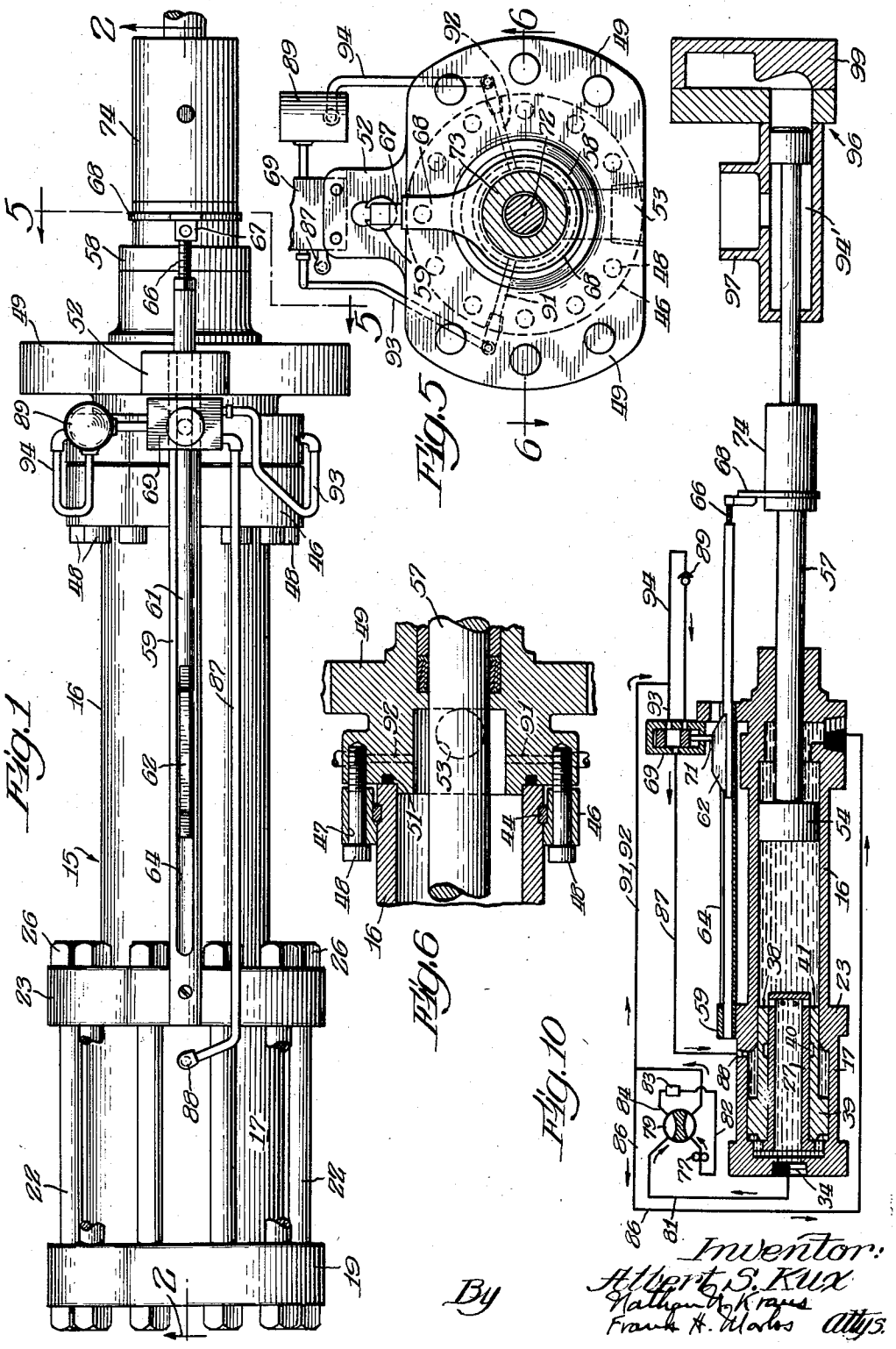
Jan. 6, 1959 A. S. KUX 2,867,088

PRESSURE MULTIPLIER

Filed April 22, 1955 4 Sheets-Sheet 1



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PRESSURE MULTIPLIER

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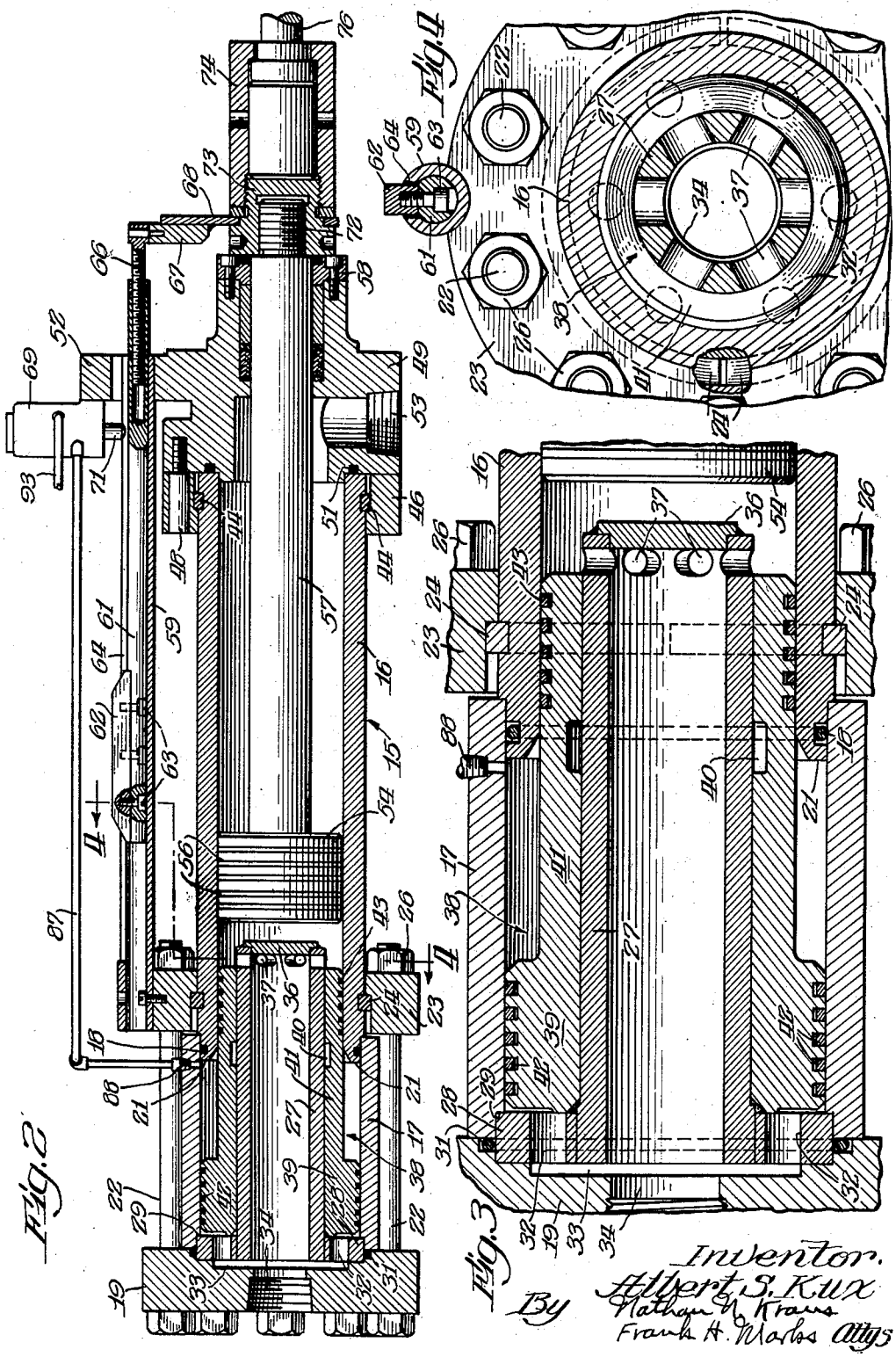


Fig. 2

Fig. 3

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PRESSURE MULTIPLIER

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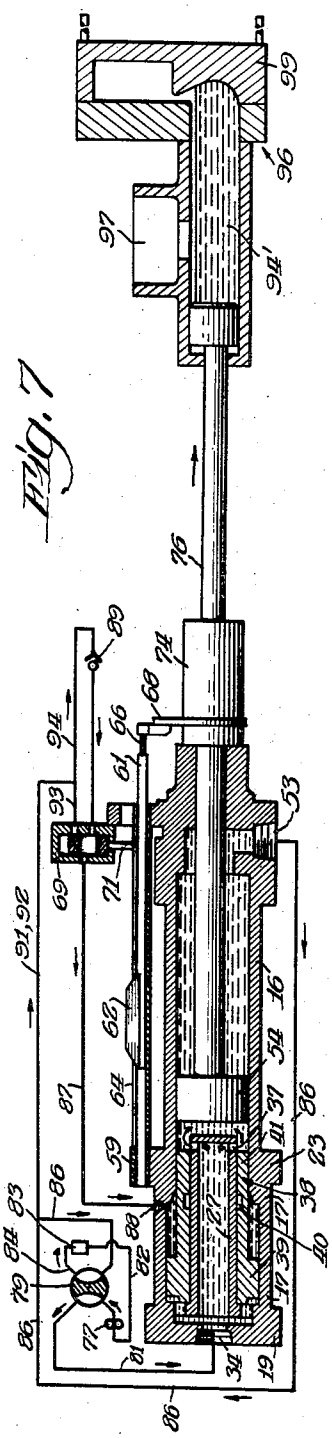


Fig. 7

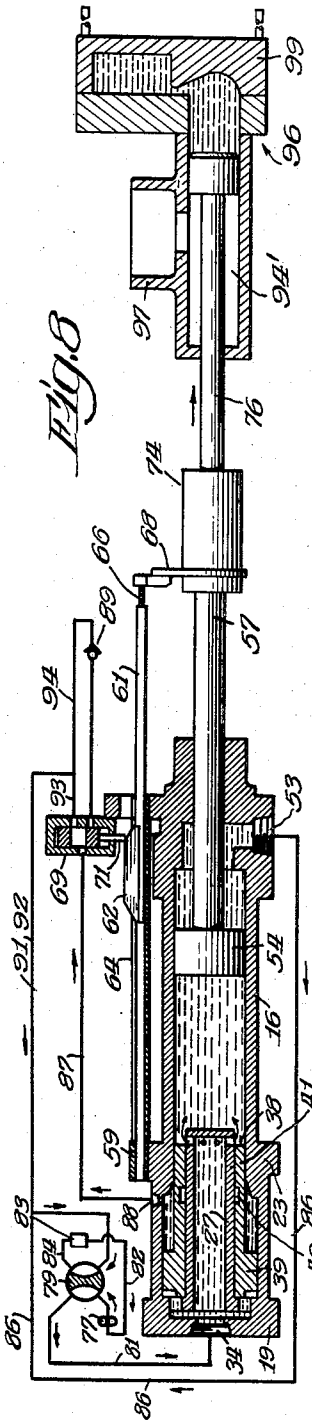


Fig. 8

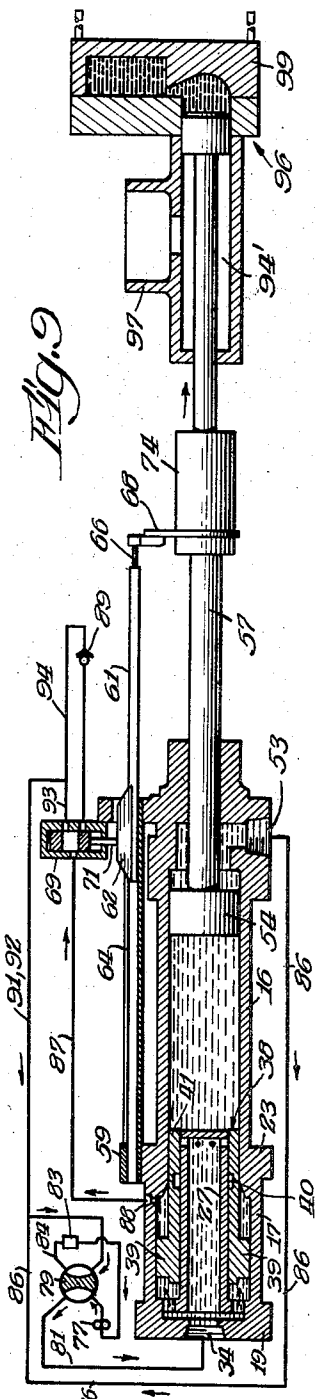


Fig. 9

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Fig. 11

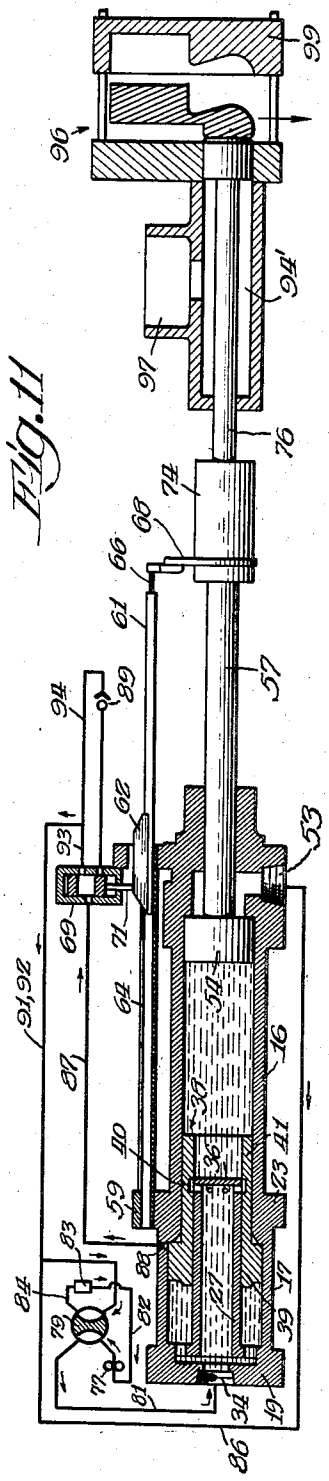
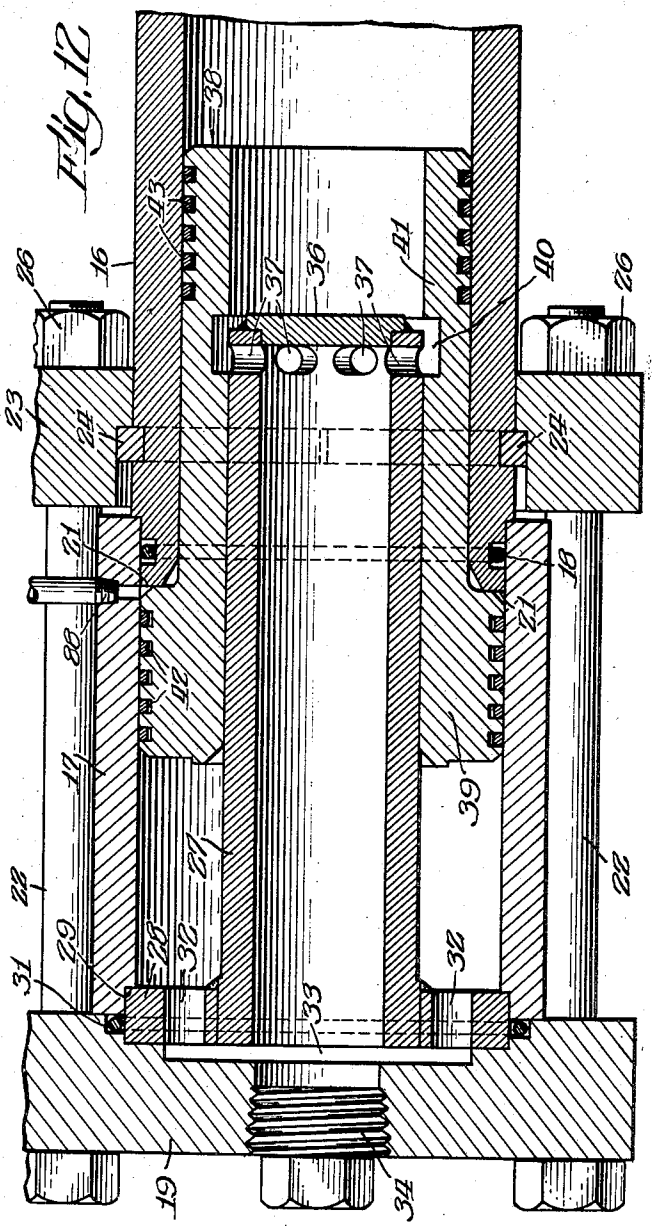


Fig. 12



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PRESSURE MULTIPLIER

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Application April 22, 1955, Serial No. 503,250

4 Claims. (Cl. 60—54.5)

My invention relates to hydraulic pressure multipliers or boosters.

It is a broad object of my invention to provide means capable of producing an additional force at the end of a forward stroke of a reciprocating mechanism.

It is a specific object of my invention to provide a device having a small working piston cooperating with a relatively movable piston of larger diameter, whereby the larger piston is caused to act at the end of the stroke of the smaller piston, to provide an increased force.

Such a device as is herein contemplated is particularly useful for operating die-casting machines where, in order to obtain castings of uniform density free from voids, it has been found necessary to apply pressure in two successive stages on the injection plunger in injecting the molten metal into a mold cavity, the secondary application of pressure following immediately after the first but being intensified or multiplied during a portion of the final travel of the plunger.

A further object of my invention is the provision of a device of the character set forth, which is fully automatic in its operation.

Other and further objects and advantages of my invention will become apparent from the following description, when considered in connection with the accompanying drawings, in which—

Fig. 1 is a top plan view of a device embodying my invention;

Fig. 2 is a longitudinal cross-sectional view taken substantially on line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view similar to that of Fig. 2, but on an enlarged scale;

Fig. 4 is a cross-sectional view taken substantially on line 4—4 of Fig. 2;

Fig. 5 is a cross-sectional view taken substantially on line 5—5 of Fig. 1;

Fig. 6 is a cross-sectional view taken substantially on line 6—6 of Fig. 5;

Figs. 7–11, inclusive, are more or less diagrammatic views showing different stages of operation; and

Fig. 12 is a fragmentary longitudinal cross-sectional view showing the parts in the relation illustrated in Fig. 10.

Referring to the drawings, wherein is shown a preferred embodiment of my invention, the numeral 15 indicates generally a cylinder structure comprising a relatively long section 16 of relatively smaller diameter and a relatively short section 17 of relatively larger diameter. One end portion of the section 16 is reduced in diameter and is received in the section 17, the end of the section 16 being provided with an annular recess in which is received a suitable sealing ring 18, to afford a fluid-tight engagement between the two sections. The end of section 16 provides an internal annular shoulder 21 at the circumferential meeting line with the section 17. The section 17 is provided with a cylinder head 19 having a series of circumferentially spaced apertures through which pass a series of studs or bolts 22, the opposite ends of said

studs passing through registering apertures in a flange 23 concentric with section 16, the said flange having an internal annular shoulder abutting a split ring 24 received in an annular recess in the surface of the tube. The bolts, of course, are provided with nuts 26 which afford means for maintaining the two sections in assembled coaxial relation.

A center tube 27 is located axially within the communicating bores of the sections 16 and 17, the said tube being provided at one end with a flange 28 which is welded thereto, the said flange being confined between the cylinder head 19 and an annular shoulder 29 provided in the end of the bore of section 17. The cylinder head 19 is provided with an annular recess to receive a suitable sealing ring 31 which affords a fluid-tight seal between the cylinder head 19, section 17 and flange 28. The flange 28 is provided with a series of annularly spaced apertures 32 in registration with a circular recess 33 in the cylinder head 19, the said recess being in communication with a port 34 in the cylinder head. The opposite end of the center tube 27 is sealed, as by a plate 36 which is welded thereto, the plate being smaller in diameter than the tube. Adjacent said plate there is provided in the wall of the tube a series of radial ports 37.

Supported on the tube 27 in concentric relation for reciprocation thereon is an intensifier piston indicated generally by numeral 38 and having an enlarged portion 39 which fits the bore of the section 17 and a reduced portion 41 which fits the bore of the section 16. Both portions of said piston are provided with suitable piston rings 42 and 43, respectively. The length of the piston 38 is less than the length of the center tube 27, such that in the relation illustrated in Figs. 2 and 4 the ports 37 are open. The bore of the reduced portion of the piston 38 is provided with an annular recess 40 spaced from the end and having a width substantially equal to the diameter of one of the ports 37 plus the thickness of plate 36 (Fig. 12). The opposite end of the section 16 is provided with an annular recess in which is received a split ring 44 which affords means for retaining a shouldered flange 46 in concentric relation with the section 16, the said flange being provided with a series of circumferentially spaced apertures 47 through which pass bolts 48 arranged to be received in registering threaded apertures provided in a cylinder base 49, the said base having an annular groove receiving a suitable sealing ring 51 to afford fluid-tight sealing engagement with the end of the section 16. The base is provided with an upward extension 52 for a purpose as will be hereinafter described. A threaded aperture 53 is provided in the bottom of the base to receive one end of a conduit, as will be hereinafter more fully explained. A working piston 54 is of such size as to fit within the bore of the section 16 and is provided with suitable piston rings 56. Connected to the piston 54 is a piston rod 57 which passes through a stuffing box 58 at the end of the cylinder base 49.

A tubular guide member 59 is supported on the flange 23 and in the upward extension 52 of the cylinder base 49, and extends in parallel relation to the axis of the section 16. Received within said guide member for reciprocation therein is a slide rod 61 on the top surface of which is mounted a cam element 62 secured as by screws 63. As seen clearly in Fig. 4, the guide member 59 is provided on its upper surface with a longitudinal slot 64 through which the cam element 62 projects, the said cam element being adapted to reciprocate longitudinally within the slot. The opposite end of the slide rod 61 is provided with internal threads for a portion of its length, to receive a cam bar adjusting screw 66, from the end of which depends a lug 67 welded to an upward extension of an annular member 68. Supported on the upper ex-

tension 52 of the cylinder base is a pilot valve 69 provided with a depending actuating stem 71, which is adapted to be engaged by the cam element 62 which effects operation of the valve in a manner as will be hereinafter described.

The free end of the piston rod 57 terminates in a threaded portion 72 on which is screwed an extension member 73, which is also threaded to cooperate with a plunger-retaining sleeve 74 which serves to secure a plunger 76 to the piston rod 57. The annular member 68 is carried on the extension member 73 and secured thereon by the sleeve 74. It will be apparent that, as the piston rod 57 is reciprocated, the cam rod 61 and cam element 62 supported thereon are caused to be correspondingly reciprocated.

In order to effect movement of the pistons 38 and 54, the admission and discharge of pressure fluid must be controlled in a predetermined order. Reference will now be had to the figures of the drawing for a better understanding of the fluid control means.

Referring to Figs. 7–11, inclusive, which illustrate diagrammatically the structure of my invention and the pressure fluid control means associated therewith, a hydraulic pump 77 is provided for delivering pressure fluid to the port 34 in the cylinder head 19. Said pump is connected by a conduit to a manually operated four-port valve 79, one port of which connects with the port 34 through conduit 81. The pump 77 has a suction port connected through conduit 82 with a fluid reservoir or tank 83, which is also connected to one of the ports of the valve 79 by a conduit 84. The remaining port of the valve 79 is connected by a conduit 86 to port 53. The pilot valve 69 has three ports, one of which connects through conduit 87 to port 88 in section 17. A second port in the valve 69 connects with check valve 89, while respective ports of both valves 69 and 89 are connected to passages 91 and 92, respectively, in the cylinder base 49 through conduits 93 and 94, respectively. The passages 91 and 92 afford communication with the bore of section 16. In the diagrammatic views Figs. 7–11, conduits 93 and 94 are illustrated as being connected to conduit 86 which affords communication with the bore of section 16.

Referring particularly to Fig. 7, which illustrates the arrangement of the parts at the beginning of a stroke, it will be seen that fluid is drawn from the reservoir 83 through conduit 82 by the pump 77 and is pumped through valve 79, conduit 81, port 34 through the center tube 27 and outwardly through the apertures 37 into the bore of section 16, to act on the piston 54 and effect movement of the same to the right, in the direction of the arrow. During such movement the fluid in the bore of section 16 between the base end of piston 54 and cylinder base 49 is discharged through port 53 and returns through conduit 86 and valve 79 to reservoir 83. It is assumed of course that, before admission of pressure fluid into the bore of section 16, the chamber 94' of the die-casting machine 96 will have been filled by metal poured into the well 97. The piston 54 continues to move to the right, as viewed in Fig. 8, moving the plunger 76 until the cavity of the die 99 is completely filled with metal. The cam element 62 of course moves simultaneously with the piston 54 and associated parts. At the point where the cavity is filled with metal the cam element 62 engages the member 71 of the pilot valve 69 to condition the said valve so that the fluid heretofore confined in the chamber between piston 38 and shoulder 21, which confined fluid serves to prevent movement of piston 38, is permitted to be discharged from said chamber, the fluid flowing through conduit 87, valve 69, conduit 93, passage 91, a portion of conduit 86, valve 79 and into reservoir 83. Pressure fluid now entering through port 34 is caused to pass through chamber 33 through the apertures 32 of the flange 28 into the chamber outside of the center tube 27, to act on the piston 38 which, as viewed in Fig. 9, is caused to move to the right, and in so doing the portion 41 effects closure of the radial ports 37 of the center tube, so that no pressure fluid may flow therethrough into the bore of the section 16. Pressure fluid, thus admitted, is caused to act entirely on the piston portion 39, which transmits its force through the fluid confined in the bore of section 16 to the head of piston 54. The unit pressure on the head of piston 54 is thereby multiplied by the ratio of the circular areas of the pistons 39 and 54. Thus there is achieved a primary application of a relatively low pressure during one portion of the travel of the piston rod and a secondary application of a higher pressure during a portion of the final travel thereof.

The piston 38 continues in its travel to the right until the leading face of piston portion 39 is caused to abut the shoulder 21 of section 16 and to be arrested thereby (Figs. 10 and 12). As seen in these figures, at this point the annular recess 40 is in registration with ports 37 with the recess overlapping the end of tube 27. Pressure fluid within the said tube is thus caused to pass through the ports 37, through the recess 40 and into the bore of section 16 to act on working piston 54, which is caused to continue its travel to the limit of its stroke (Fig. 10), effecting corresponding movement of the plunger 76 which effects ejection of the casting from the die 99. It is understood, of course, that at this stage the die plates have separated, as illustrated, to permit ejection of the casting.

In order to effect return movement of both pistons 38 and 54 to their non-operative positions, the valve 79 is manipulated to the position illustrated in Fig. 10, so that pressure fluid may be pumped from the reservoir 83 through valve 79, conduit 86, and through port 53 into the chamber of section 16 to act on the base end of piston 54 to effect movement of the same to the left, as viewed in Fig. 10. The valve 79, of course, is conditioned to permit discharge of fluid from the chamber at the head end of the piston 38, the fluid flowing through port 34, conduit 81, valve 79 and into reservoir 83. Correspondingly, some of the pressure fluid is caused to flow through passage 92, conduit 94, check valve 89, valve 69 and conduit 87 into port 88, to effect a reverse movement of piston 38. As soon as piston 38 has moved to the left a sufficient distance to uncover the ports 37, discharge of the fluid in the chamber of section 16 is effected through these ports, the fluid following the same course as that just described. Upon manipulation of the valve 79 to the position illustrated in Fig. 7, the apparatus is conditioned to repeat the cycle of operation hereinbefore described.

Various changes and modifications coming within the spirit of my invention will doubtless suggest themselves to those skilled in the art. Hence, I do not wish to be limited to the specific form shown or uses mentioned.

I claim:

1. A device of the type described comprising a cylinder structure including a first cylinder chamber of relatively larger diameter communicating with a second cylinder chamber of smaller diameter, a tube fixedly supported coaxially in said first cylinder chamber and extending into said second cylinder chamber, said tube being open at the head end but closed at the base end and having a port in the tube wall adjacent the closed end, an annular piston of relatively large diameter operating in said first chamber, said annular piston having a coaxial sleeve extension, said piston and sleeve extension being concentric with said tube and slidable thereon, said sleeve extension terminating short of said port in the initial position of said annular piston, a smaller piston operating in said second chamber independently of said annular piston, a piston rod connected to said smaller piston, pressure fluid-conducting and controlling means feeding pressure fluid through said tube and said port into said second chamber to effect forward movement of said smaller piston while preventing movement of said annular piston until said smaller piston has reached a predetermined point in its travel, said annular piston and sleeve extension being caused to slide

relative to said tube, whereby said sleeve extension is caused to effect closure of the port in said tube, the pressure fluid thereafter being directed only against said annular piston which is caused to transmit to said smaller piston through the medium of fluid confined in said second chamber between the sleeve and the tube ends and said smaller piston a force of increased intensity during the next portion of travel of said annular piston.

2. A device of the type described comprising a cylinder structure including a first cylinder chamber of relatively larger diameter communicating with a second cylinder chamber of smaller diameter, a sleeve valve within said cylinder structure and including a stationary tubular element having a port and a movable tubular element concentric therewith and arranged to effect opening and closing of said port, a piston of relatively large diameter coaxial with said stationary element and operating in said first chamber, said piston being operatively associated with said movable element, a smaller piston operating in said second chamber independently of said first mentioned piston, a piston rod connected to said smaller piston, pressure fluid-conducting and controlling means feeding pressure fluid through said sleeve valve into said smaller chamber to effect forward movement of said smaller piston, pressure fluid acting on the base end of said larger piston restraining movement thereof during a predetermined movement of said smaller piston, said means being actuated by the movement of said piston rod to permit discharge of said pressure fluid, whereby pressure fluid is cause to act on said larger piston to move said piston and associated movable valve element in a forward direction, said movable valve element in such movement effecting closure of said port, whereby pressure fluid is caused to be directed only against the larger piston which through the medium of fluid confined in said second chamber between the sleeve and tube ends and the smaller piston is caused to transmit to said smaller piston a force of increased intensity during the next portion of travel of said larger piston.

3. A device of the type described comprising a cylinder structure including a cylinder chamber of relatively larger diameter communicating with a cylinder chamber of smaller diameter and forming an internal annular shoulder at the circumferential meeting line therewith, a piston of relatively large diameter operating in said first chamber, a smaller piston operating in said smaller chamber independently of said first mentioned piston, a piston rod connected with said smaller piston, a tube fixedly supported coaxially in said larger chamber and extending into said smaller chamber, said tube being open at the head end but closed at the base end and having a port in the tube wall adjacent the closed end, said larger piston being concentric with said tube and being reciprocable thereon, a sleeve concentric with said tube and connected to said larger piston and adapted to effect opening and closing of said port, means controlling the flow of pressure fluid through said tube and port to move said smaller piston, said larger piston and annular shoulder defining a pressure chamber containing fluid restraining movement of said larger piston up to a predetermined point of

movement of said smaller piston, means thereafter operable to permit discharge of fluid from said last-mentioned chamber, whereby pressure fluid admitted into said larger cylinder chamber is caused to act on said larger piston to move the same together with said sleeve, said sleeve effecting closure of said port, whereby the pressure fluid is thereafter caused to be directed only against said larger piston which through the medium of fluid confined between the tube and sleeve ends and the smaller piston is caused to transmit to said smaller piston a force of increased intensity during the final portion of travel of said smaller piston.

4. A device of the type described comprising a cylinder structure including a first cylinder chamber of relatively larger diameter communicating with a second cylinder chamber of smaller diameter, a tube fixedly supported coaxially in said first cylinder chamber and extending into said second cylinder chamber, said tube being open at the head end but closed at the base end and having a port in the tube wall adjacent the closed end, an annular piston of relatively large diameter operating in said first chamber, said annular piston having a coaxial sleeve extension, said extension having an intermediate annular recess in the bore thereof, the recess having a width greater than the port in the tube wall, said piston and sleeve extension being concentric with said tube and slidable thereon, said sleeve extension terminating short of said port in the initial position of said annular piston, a smaller piston operating in said second chamber independently of said first mentioned piston, a piston rod connected to said smaller piston, pressure fluid-conducting and controlling means feeding pressure fluid through said tube and said port into said second chamber to effect forward movement of said smaller piston while preventing movement of said annular piston until said smaller piston has reached a predetermined point in its travel, said annular piston and sleeve extension being caused to slide relative to said tube, whereby said sleeve extension is caused to effect closure of the port in said tube, the pressure fluid thereafter being directed only against said annular piston which is caused to transmit to said smaller piston through the medium of fluid confined in said second chamber between the sleeve and the tube ends and said smaller piston a force of increased intensity during the next portion of travel of said annular piston, said annular recess at the end of the travel of said annular piston being disposed in registration with the tube port, whereby pressure fluid in said tube may pass through said tube port and annular recess into said second cylinder chamber to act on said smaller piston and move the same for an additional length of travel.

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