United States Patent

Hehl

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[45] **May 16, 1972**

[54] HYDRAULIC ARRANGEMENT FOR INJECTION-MOLDING APPARATUS

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[21] Appl. No.: **820,250**

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Aug. 28, 1968 Germany ..... P 17 79 567.4

[52] **U.S. Cl.** **425/154,** 425/242
[51] **Int. Cl.** **B29f 1/06**
[58] **Field of Search** ..... 18/30 LA, 30 LB, 30 LE, 30 LF, 18/30 LM, 30 NV, 30 CR, 16 C, 16 R, DIG. 26, 30 LD; 100/269 B

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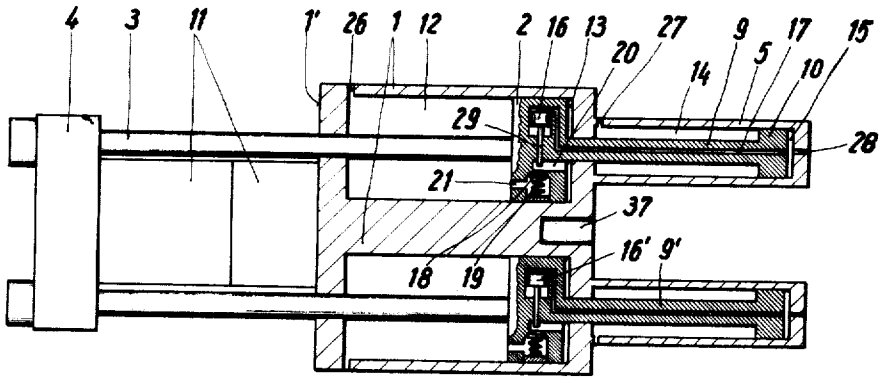
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Primary Examiner—J. Spencer Overholser
Assistant Examiner—David S. Safran
Attorney—Spencer & Kaye

[57] **ABSTRACT**

Injection-molding apparatus in which a mold means of two parts is moved between open and closed positions. The molding means is moved by a first hydraulic means. A second hydraulic means is also operatively associated with the mold means and together with the first hydraulic means forms a single operating unit; such second hydraulic means being for applying a greater force to the mold means to hold it in its closed position than is capable of being applied by the first hydraulic means. Means are also provided for rendering the second hydraulic means inoperative during operation of the first hydraulic means.

33 Claims, 22 Drawing Figures



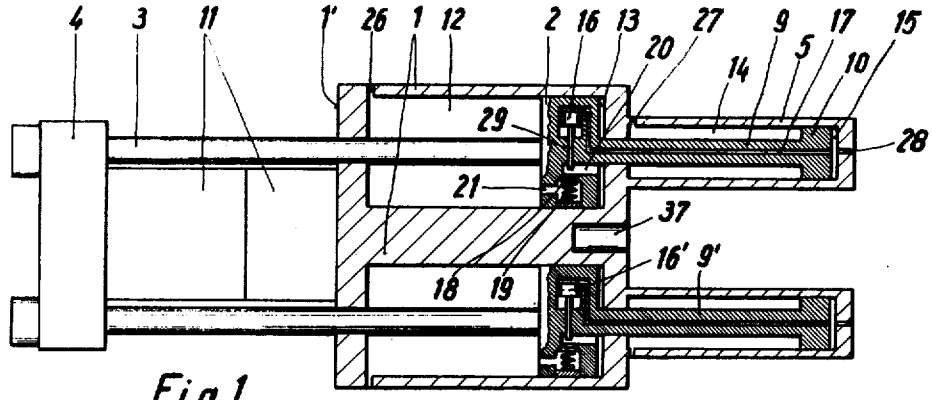


Fig.1

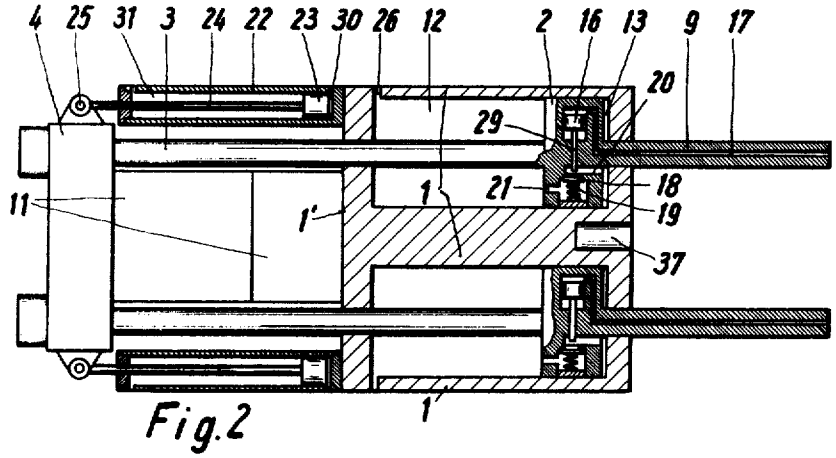


Fig.2

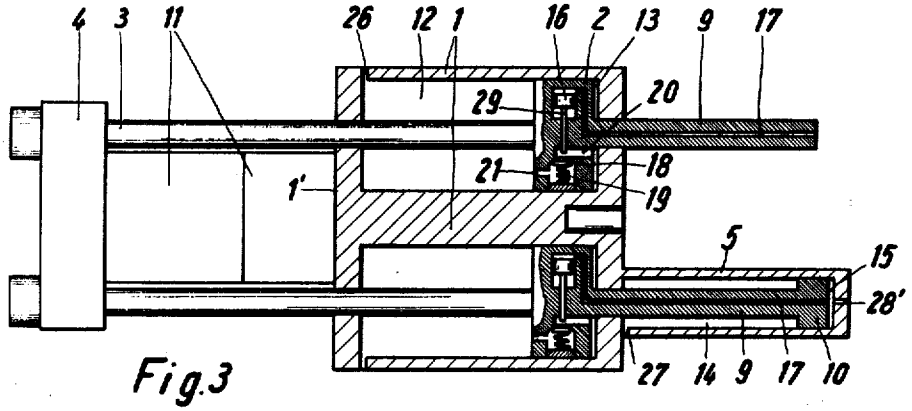


Fig.3

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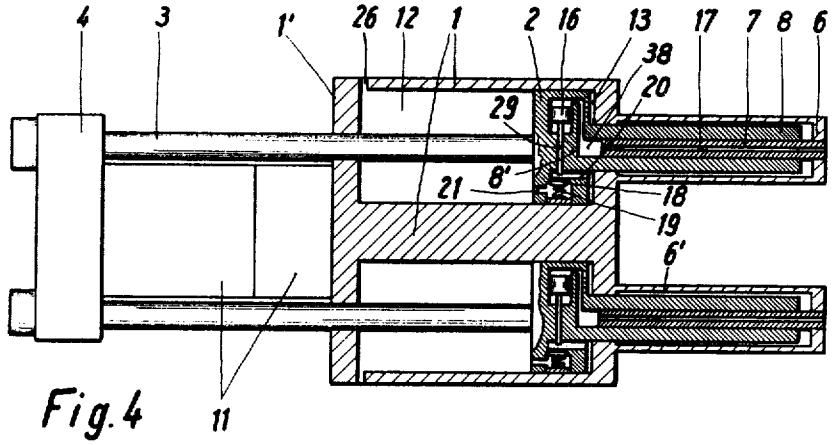


Fig. 4

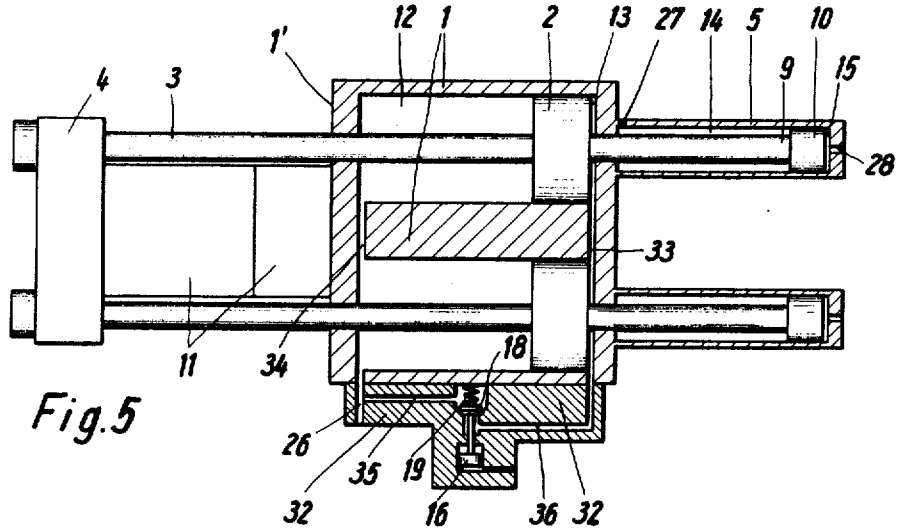


Fig. 5

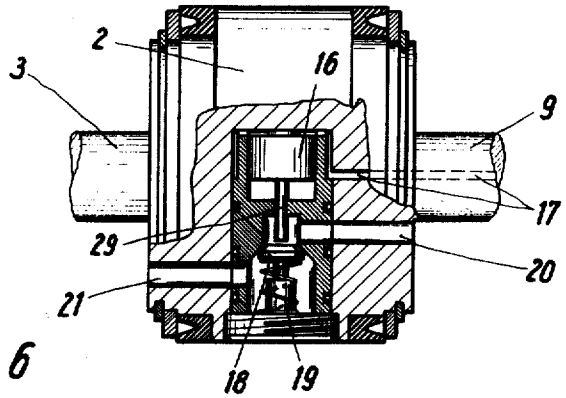


Fig. 6

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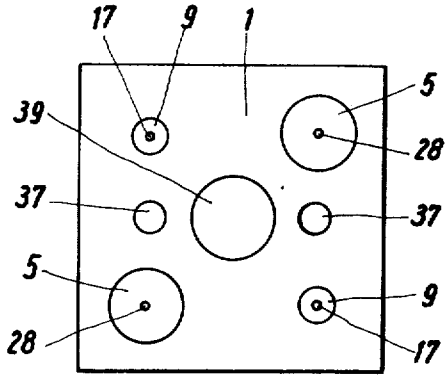


Fig. 7

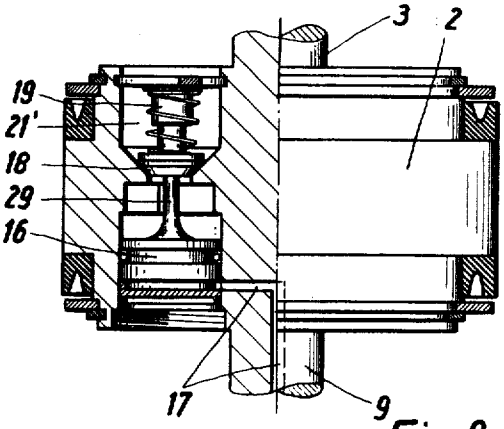


Fig. 8

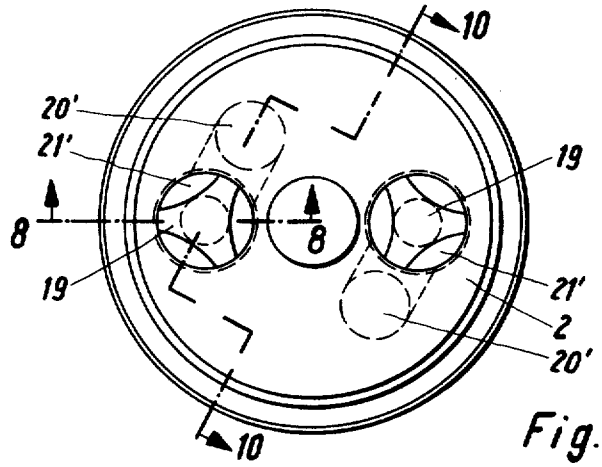


Fig. 9

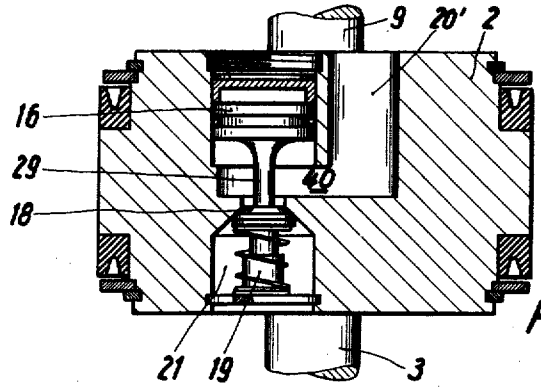


Fig. 10

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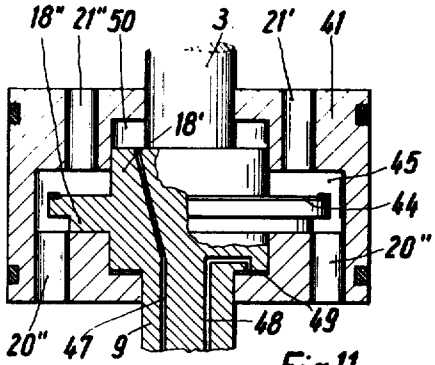


Fig.11

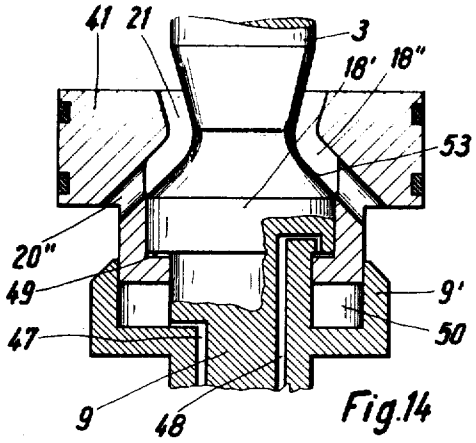


Fig.14

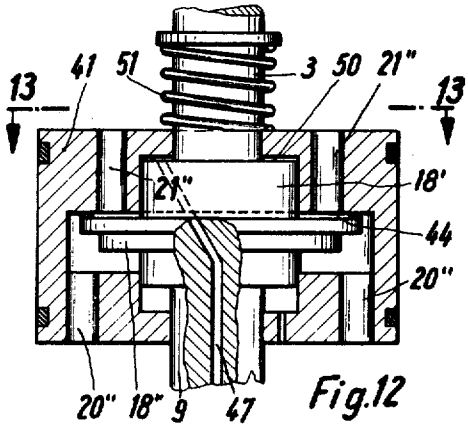


Fig.12

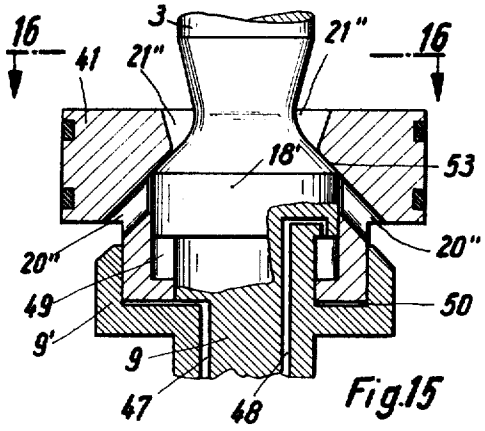


Fig.15

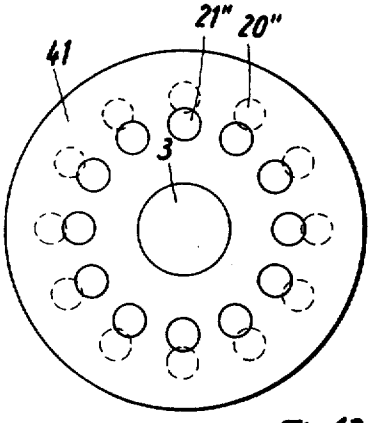


Fig.13

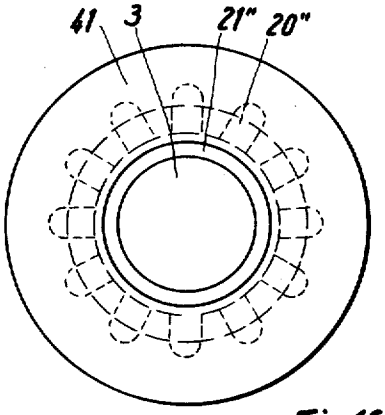


Fig.16

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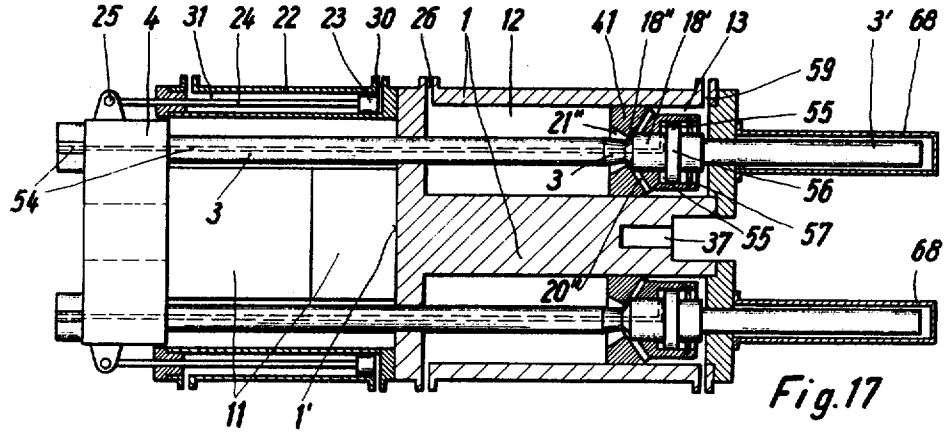


Fig.17

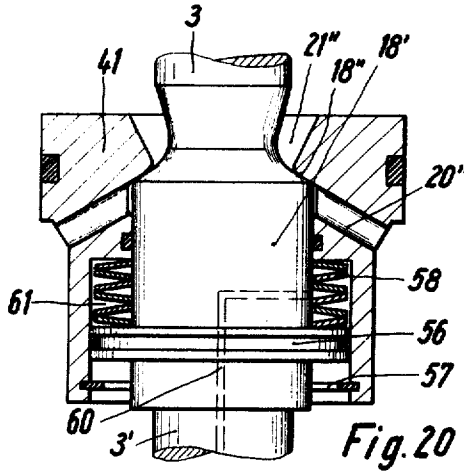


Fig.20

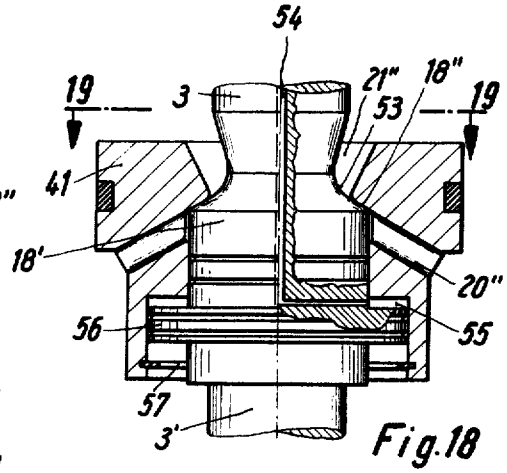


Fig.18

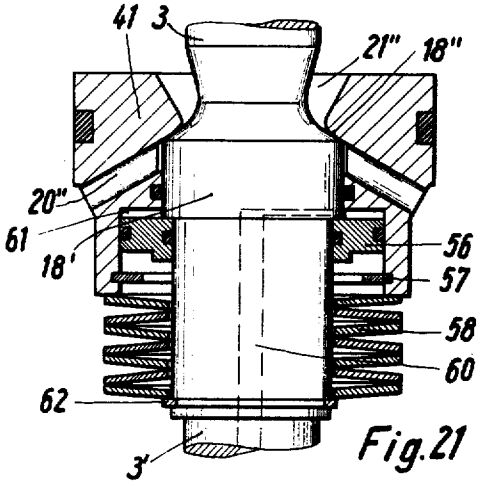


Fig.21

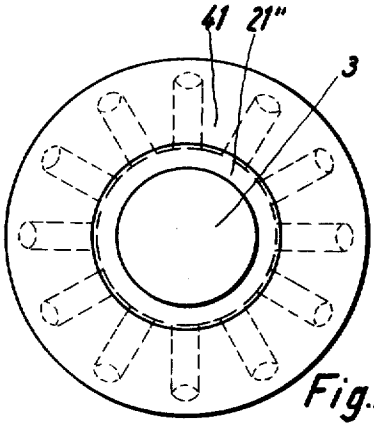


Fig.19

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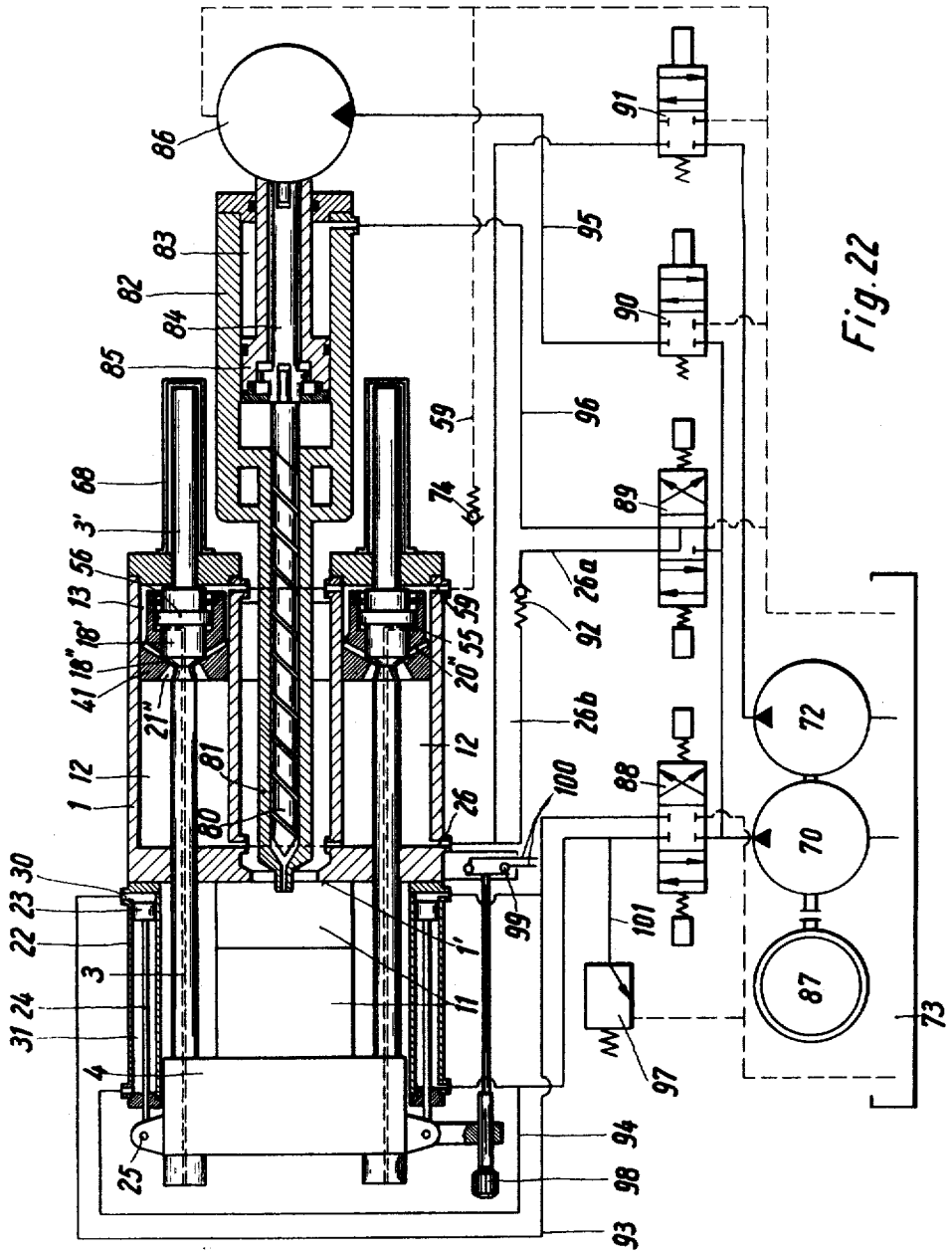


Fig. 22

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HYDRAULIC ARRANGEMENT FOR INJECTION-MOLDING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to an arrangement of hydraulic means for injection-molding apparatus used to process synthetics or similar materials. More particularly, the present invention relates to such apparatus where the injection mold is driven by at least one hydraulic means which exerts a small force on such mold to move the same between open and closed positions, and where such mold is held closed by at least one hydraulic means, which exerts a relatively large force on such mold.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved as well as simplified hydraulic arrangement for injection-molding apparatus used to process synthetics or similar materials.

It is also an object of the present invention to provide an improved hydraulic system for such apparatus so that the injection mold thereof can be opened and closed with substantially greater speed.

In brief, according to the present invention, a first hydraulic means is combined with a second hydraulic means to form a single operating unit. The piston of the first hydraulic means is arranged to coact with the piston of the second hydraulic means. Chambers defined by the second hydraulic means cylinder are disposed on each side of the second hydraulic means piston and such chambers are interconnected by at least one channel. A valve means inserted in the channel is controlled to block such channel during operation of the second hydraulic means and to unblock such channel during operation of the first hydraulic means.

By arranging a connection between the piston of the first hydraulic means with respect to the piston of the second hydraulic means there is provided an operational unit having the prerequisites of a relatively simple, yet effective, design.

The opening and closing movement of the injection mold is accomplished with greater speed due to pressure oil remaining within the confines of the second hydraulic means cylinder and is required to move only a very short distance between the chambers on each side of the piston of the second hydraulic means when such piston is being operated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a longitudinal view, partially in section, of the apparatus according to the present invention with the injection mold closed.

FIGS. 2 to 5 each shows a longitudinal view, partially in section, of other forms of the apparatus according to the present invention with the injection mold closed.

FIG. 6 shows an enlarged partial sectional view of one form of the second hydraulic means piston according to the present invention.

FIG. 7 shows a plan view of the cylinder block according to FIG. 3.

FIG. 8 shows an enlarged, partial sectional view taken along the line 8—8 of FIG. 9 of another form of the second hydraulic means piston according to the present invention.

FIG. 9 is a plan view of the second hydraulic means piston according to FIG. 8.

FIG. 10 is an enlarged sectional view of the second hydraulic means piston according to FIGS. 8 and 9 taken along the line 10—10 of FIG. 9.

FIG. 11 is an enlarged sectional view of another form of the second hydraulic means piston according to the present invention with the valve open.

FIG. 12 is an enlarged sectional view of another form of the second hydraulic means piston according to the present invention with the valve closed.

FIG. 13 is a plan view of the second hydraulic means piston according to FIG. 12 taken along line 13—13 of FIG. 12.

FIG. 14 is an enlarged sectional view of another form of the second hydraulic means piston according to the present invetnion with the valve open.

FIG. 15 is an enlarged sectional view of the second hydraulic means piston according to FIG. 14 with the valve closed.

FIG. 16 is a plan view taken along line 16—16 of FIG. 15 of the second hydraulic means piston according to FIG. 15.

FIG. 17 shows a longitudinal view, partially in section, of yet another form of the apparatus according to the present invention.

FIG. 18 is an enlarged sectional view of the second hydraulic means piston according to FIG. 17 with the valve closed.

FIG. 19 is a plan view taken along line 19—19 of FIG. 18 of the second hydraulic means piston according to FIG. 18.

FIG. 20 is an enlarged sectional view of another form of the second hydraulic means piston according to the present invention.

FIG. 21 is an enlarged sectional view of yet another form of the second hydraulic means piston according to the present invention

FIG. 22 shows a longitudinal view, partially in section of yet another form of the apparatus according to the present invention (which is similar to the apparatus shown in FIG. 17) in connection with the injection unit together with a schematical illustration of the hydraulic arrangement, the oil circuit of which is alternatively or cumulatively driven by two pumps.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 to 5 and 17, one part of the injection mold 11 of two parts is moved relative to the other part between opened and closed positions by application of a small force thereto with the aid of a first hydraulic means having at least one drive piston and cylinder. Moreover, the moved part is held in the closed position by a second hydraulic means which applies a much greater force than the first hydraulic means. The second hydraulic means includes at least one pressure piston and cylinder. In order to provide a relatively simple structural apparatus design, the second hydraulic means including pressure piston 2 (FIGS. 1 to 10) or 41 (FIGS. 11 to 21) arranged in a pressure cylinder 1 is mechanically connected to a first hydraulic means or drive piston 10 (FIGS. 1, 3, 5), 23 and 23' (FIGS. 2 and 17, respectively) or 8 (FIG. 4). In other words, the respective drive piston of all of the embodiments is connected to a pressure piston, either directly (FIGS. 1, 3, 4, 5) or indirectly (FIGS. 2 and 17). Thus, in the operation of the apparatus, when the first hydraulic means piston is operative, the second hydraulic means pistons 2, 41 of the respective embodiments also perform positive strokes in the pressure cylinder 1. This is substantially facilitated by the fact that the chambers 12 and 13 of cylinder 1 are in communication with each other, during the operation of the first hydraulic means piston, via a channel 20, 21 (FIGS. 1 to 4, 6) 35, 36 (FIG. 5), 20', 21' (FIGS. 8 to 10) or 20'', 21'' (FIGS. 11 to 21), respectively, so that when the piston 2, shown, for example, in FIG. 1, is moved to the left by drive piston 10, the oil in chamber 12 flows therefrom into chamber 13. When piston 2 is moved in the opposite direction, the oil now in chamber 13 flows therefrom into chamber 12. A valve 18 in FIGS. 1 to 10 or 18' in FIGS. 11 to 21, respectively, is provided to operate within the channels connecting the chambers 12 and 13. Such valve is controlled to be in closed position during operation of the second hydraulic means piston 2 or 41, respectively. A particularly simple form of such valve, having a relatively large flow-through cross section, is illustrated in FIGS. 14 to 16. This form of valve is also suitable for the embodiments shown in FIGS. 1 to 4.

Referring to FIGS. 1 to 5, a plurality of, e.g. four, pressure cylinders 1 are housed in one cylinder block. The frontal face 1' of the pressure cylinder block serves as a stationary surface for mounting one injection mold half 11. The movable mold clamping plate 4, which holds the other half of the injection mold 11, is held by the free ends of the piston rods 3 of piston 2.

As seen in the embodiments of FIGS. 1 and 3, the first hydraulic means includes a cylinder 5 fastened to the cylinder block for each pressure cylinder 1. The pressure cylinders 5 are concentric with the pressure cylinders 1. Drive pistons 10 are disposed in drive cylinders 5 and are permanently connected via piston rods 9, to associated pressure pistons 2 in the pressure cylinders 1. The chambers 12 and 13, respectively, one on each side of the pressure piston 2, are in communication with each other via the connecting channel portions 20, 21 provided in the pressure piston 2. A pressure valve 18 is provided within the connecting channel 20, 21. The valve 18 includes a body member which is held in a valve seat with the aid of a spring 19. When the pressure in chamber 13 becomes greater than the pressure in chamber 12, the valve 18 is lifted off its seat and oil is allowed to flow from chamber 13 into chamber 12. In the reverse direction (i.e. from chamber 12 to chamber 13) oil can not flow through channel portions 20, 21 unless the valve 18 is caused to be opened by a small hydraulically actuated control device including piston 16, line 17, and piston rod 29 connected to piston 16. This is best seen in FIG. 6, the enlarged view of the valve shown in FIGS. 1 and 3. The small piston 16 is actuated by pressure oil fed in via the control line 17. The piston 16 acts by way of its piston rod 29 on the valve 18 causing the same to open.

The hydraulic arrangement of the apparatus according to the embodiment of FIG. 1 operates as follows:

To open the injection mold 11, the chamber 15 of the drive cylinder 5 is filled with pressure oil from a source (not shown) via line 28, thus also actuating, via control line 17, the valve control piston 16. The piston rod 29 of valve control piston 16 unlocks the valve 18. Drive piston 10 together with pressure piston 2, which is connected to piston 10 and forms an operating unit therewith, are moved toward the left as is piston rod 3. This causes the oil from cylinder chamber 12 to flow into cylinder chamber 13 via connecting channel portions 20, 21. With the movement to the left of piston rod 3 the movable mold clamping plate 4 having half of injection mold 11 thereon, is removed from the stationary mold clamping surface 1'. Thus, the injection mold 11 is opened. To close the injection mold 11 the chambers 14 of the drive cylinders 5 are provided with pressure oil via lines 27. Thus the drive pistons 10 are actuated and moved toward the right within their respective cylinders 5. With this movement pressure pistons 2 connected to drive pistons 10 are carried along. Since the pistons 2 support the movable mold clamping plate 4, via their piston rods 3, the injection mold 11 is closed. With the movement to the right of piston 2 the oil moves from cylinder chamber 13, via connecting channels 20, 21, into cylinder chamber 12. Thus valve 18 automatically opens, due to the pressure difference between the cylinder chambers 12 and 13. During this movement the supply line 28 is open.

For developing the force required to lock the halves of the injection mold 11 in its closed position, the cylinder chamber 12 is supplied oil under pressure via line 26, thus actuating the piston 2, and causing it to move to the right of, for example, FIG. 1. The area of piston 2 against which pressure is applied is many times greater than the corresponding area of each piston 10. Consequently, the force acting on the injection mold 11 applied by piston 2 exceeds by many times the force which is required to open and close the injection mold halves 11 applied by piston 10.

The embodiment shown in FIG. 2 differs from the embodiment shown in FIG. 1 in that, instead of using concentrically disposed drive cylinders 5, the FIG. 2 embodiment provides two diagonally disposed drive cylinders 22, including piston 23 and piston rod 24. The drive cylinders 22 are attached to the mold clamping surface 1'. The piston rods 24 of pistons 23 are attached to the movable mold clamping plate 4. The piston rods 9 of piston 2, however, terminate in a blind end and serve to control piston 16 by connecting the same to a source of pressure oil (not shown).

The FIG. 2 embodiment of the apparatus operates as follows:

To open the parts or halves of the injection mold 11, the cylinder chambers 30 of drive cylinders 22 are supplied with pressure oil from a source (not shown) and the pistons 23 are thus actuated to move toward the left of FIG. 2. Simultaneously, the control lines 17, which are in direct communication with one side of control pistons 16, are supplied with pressure oil. Thus the control pistons 16 are actuated and valves 18 are opened. Pistons 23 continue moving toward the left and push, with the aid of their piston rods 24, the movable clamping plate 4, and the movable injection mold half thereon, in the same direction. The clamping plate 4 carries with it the piston rods 3 and the pressure pistons 2, thus causing oil to flow from the cylinder chambers 12 via connection channel portions 20, 21 into cylinder chamber 13. At the end of the operation the halves of the injection mold 11 are opened. To close the injection mold halves 11, the drive cylinder chambers 31 are supplied with pressure oil. The pressure oil causes the pistons 23, together with the piston rods 24 connected thereto, to move toward the right and carry along, in the same direction, the movable clamping plate 4, which is connected to the piston rods 24. Together with the clamping plate 4, piston rods 3 and pistons 2 are moved toward the right. Thus oil flows from cylinder chambers 13 via the channel portions 20, 21 into cylinder chambers 12. Valve 18 automatically opens, due to the pressure difference between the cylinder chambers 13 and 12. The pressure for locking the halves of injection mold 11 is increased in that the lines 26 to cylinder chambers 12 are supplied with pressure oil.

Referring to FIGS. 3 and 7, this embodiment of the invention differs from that of FIG. 1 in that only two drive cylinders 5 are provided at the cylinder block. These drive cylinders are, as best seen in FIG. 7, diagonally disposed with respect to each other. Moreover, a centrally disposed bore 39 is provided in the cylinder block. The injection cylinder (not shown) for injecting synthetic material into the injection mold 11 extends through the bore 39. Bores 37 are provided for receiving the supporting struts of the injection unit.

Referring to FIG. 4, this embodiment shows tube-like, stationary projections 7 mounted in supports 6 which are flanged to the cylinder block at associated cylinders 1. Projections 7 are supported in concentrically disposed tubular extensions 8 which are permanently connected to pistons 2. The tubular extension 8 include a surface 8' which is also common to piston 2. Oil under pressure is applied against the surface 8'. Such pressure oil is introduced via tube 17 provided in projection 7. The cylinder chambers 38 within pistons 8 are bounded at one end by the frontal face of projections 7 and at the other end by surfaces 8' of pistons 2. Otherwise, the construction corresponds to that of the embodiment according to FIG. 1.

The drive arrangement according to FIG. 4 operates as follows:

To open the injection mold 11, the cylinder chambers 38 are supplied with pressure oil from a source (not shown) via control lines 17, which extend through projections 7. Thus, the surfaces 8' of pressure pistons 2 and, at the same time, a surface of control pistons 16 are acted upon. Consequently, the valves 18 are opened and pistons 2, together with concentric pistons 8, as well as the movable clamping plate 4, are moved toward the left of FIG. 4 and the halves of injection mold 11 are caused to open. To close the mold 11, the pressure in the cylinder chambers 38 is not altered. Via lines 26 the cylinder chambers 12 are supplied pressure oil. Thus the greater areas of the pistons 2 facing the piston rods 3, as well as the smaller areas of pistons 2 facing projections 7, are acted upon by the same pressure sources and at the same pressure. The pistons 2 are moved toward the right, however, due to the greater force being applied from the left against the greater surface area of piston 2. The pistons 2 are moved together with piston rods 3 and clamping plate 4 to thereby close mold 11.

To generate the force necessary to hold the mold 11 closed, pressure is decreased in the cylinder chambers 38. The pressure needed to keep the mold 11 closed thus corresponds to the full force on pistons 2 emanating from chambers 12.

Referring to FIG. 5 this embodiment of the invention differs from that of FIG. 1 in that all chambers 13 are in communication with each other through connecting conduits 33 and all chambers 12 are in communication with each other through connecting conduits 34. The valve 18 is housed in a control block 32 which is laterally flanged to the cylinder block. The chambers 12 and 13 are in communication via channel portions 35, 36 during operation of drive piston 10 i.e. valve 18 is unseated during operation of drive piston 10). While this structure is different from that of FIG. 1, the operation of this embodiment corresponds to that of FIG. 1.

Referring to FIGS. 8 to 10, the embodiment of piston 2 there shown includes a control piston 16 which has a stroke direction running parallel to the stroke direction of piston 2. At the stroke of piston 2, during the drive period, the valve 18 is opened and oil flows through channel sections 20', 40, 21' or vice versa.

Referring to FIGS. 11 to 16, there are shown different forms of the second hydraulic means piston, the pressure piston. A pressure piston rod 3 serves as a valve shaft and is permanently connected to the body member of valve 18'. The piston rod 3 is displaceable within certain limits with respect to pressure piston 41 (which corresponds to piston 2 of the previous embodiments). This will become clearer after considering FIGS. 11 and 12 or 14 and 15, respectively.

In the embodiment of FIGS. 11 to 13 the valve body member 18' is of a cylindrical form and is provided with an annular flange 44 which extends radially within an annular chamber 45 of piston 41. Flow channel portions 20'' and 21'' are arranged in a circle within the piston 41 and open into the annular chamber 45 within piston 41. The arrangement of channels 21'' forms a circle which is smaller in diameter than the arrangement of channels 20''. As shown in FIG. 2, when the valve 18' is closed, the annular flange 44 engages shoulder 18'' and closes the opening of channels 21''. The valve 18' is exclusively hydraulic, as shown in FIG. 11, or partially hydraulic and partially controlled by force of a spring 51, as shown in FIG. 12. When the valve 18' is open, according to FIG. 11, the annular chamber 50 is supplied with oil under pressure via line 47 in piston rod 9. When the valve 18' is closed, the pressure chamber 49 is supplied with pressure oil under pressure via line 48. In the form according to FIG. 12 the valve 18' is opened by supplying oil under pressure to the annular chamber 50 via line 47 in piston rod 9 and is closed by the force of spring 51.

In the embodiment according to FIGS. 14 to 16, the valve body member 18' is of conical configuration on its frontal face 53 which faces the valve seat or shoulder 18''. An annular channel section 21'' defined by piston 2 surrounds a segment of the piston rod 3 and changes into a plurality of circularly disposed channels 20'', which are inclined with respect to the axis of valve 18'. This embodiment has the advantage that, even with a small diameter of piston 41, the annular channel 21'' assures a sufficiently large flow-through cross section. The valve 18' is opened by supplying oil under pressure to the annular chamber 50 formed in part by flange 9' of piston rod 9, via the line 47, and is closed by supplying oil under pressure to the annular chamber 49 via line 48.

In some cases, particularly when the pressure cylinder 1 is constructed so as to occupy as little space as possible, it would be suitable to connect a hydraulic pressure transformer in front of pressure cylinder 1, i.e., on the same side of cylinder 1 as the clamping plate 4 of, for example, the embodiment shown in FIG. 1. This can be done in order to supply the cylinder 1 with oil under pressure which is greater than that supplied by the oil pump (not shown).

In the embodiments of FIGS. 1 to 5, the first hydraulic means are disposed with their frontal faces either in front of or behind the cylinder block containing the pressure cylinders 1. For space-saving reasons or for reasons of better accessibility to the injection mold, the drive 5 cylinders can also be disposed within the cylinder block.

Referring next to FIG. 17, this shows another version of the present invention. As can be seen, the first hydraulic means includes drive cylinders 31 which are disposed within the cylinder block. Drive pistons 23 to which are connected piston rods 24 are disposed in the drive cylinders 31. The piston rods 24 engage the movable clamping plate 4 by means of joints 25. The second hydraulic means includes pressure piston rod 3 and pressure piston 41 connected thereto. The piston rods 3 are connected within piston 41 to an extension 3' which projects rearwardly of piston 41 and, when the injection mold is closed, into protective sleeves 68. The bore 37 in the cylinder block serves to hold the supporting struts of the injection unit (not shown).

As for FIG. 18, this shows an enlarged view of piston 41 and the arrangement therein of a valve 18'. FIG. 19 shows another view of the FIG. 18 arrangement.

Whereas in the embodiments according to FIGS. 11 to 16 special hydraulic or mechanical (spring) means are provided to close the valve as well as to open it, the arrangement shown in FIG. 17 only provides means, whether hydraulic or mechanical, to open the valve . This represents both a simplified structure and control for the apparatus. The closing of the valve 18 is accomplished by providing the surfaces of piston 41, against which the oil under pressure is charged, with different areas. By a sufficient difference in the area between the chargeable surfaces of the piston it is assured that the valve automatically closes at the beginning of the pressure period. For this reason at least one hydraulic pressure chamber required in the embodiments of FIGS. 11 to 16 for controlling the valve 18' is eliminated. Thus, the pressure piston 41 and its structural configuration is greatly simplified. This makes possible a more economical mass-production.

Referring in particular to FIG. 18, the reduction in size of the piston 41 face toward cylinder chamber 13 is achieved by providing a piston 56 which is firmly connected to the piston rod 3 and which is inserted in a cylindrical bore 55, centrally disposed within piston 41. The bore 55 is provided concentric to the face of piston 41 which faces toward chamber 13 or rearwardly. A piston 56 which serves to control valve 18' is inserted in the bore 55. The control piston 55 is so arranged in the piston 41 that the pressure area of piston 41 which faces toward the cylinder chamber 12 and mold 11 is substantially larger than the pressure area of piston 41 which faces cylinder chamber 13 and is remote from mold 11. The difference between the two pressure areas corresponds at least to area of the forward face of the control piston 56. This difference in areas is necessary for the automatic movement of the valve 18' into the closed or seated position against shoulder 18'' at the beginning of the pressure period. The relative movement between piston 41 and the piston rod 3 is limited with the aid of a stop element in the form of a Seeger ring 57 disposed in bore 55. In the embodiment according to FIG. 17 (i.e. with the FIG. 18, 19 form of valve 18') the control piston 56 defines one end of a cylinder chamber 55 into which opens a pressure oil line 54 through the piston rod 3. The pressure oil line 54 in piston rod 3 is guided from the side of the clamping plate 4 which faces away from the injection mold.

Referring to FIGS. 20 and 21, other forms of the piston 41 and valve 18' arrangement are shown therein. According to the FIG. 20 and 21 embodiments, a cylindrical bore 61 is centrally and cylindrically disposed within the face of piston 41 remote from mold 11 and facing chamber 13. In each of these embodiments a spring 58 is provided which presses valve 18' into the open position. The spring 58 abuts the face of piston 41 toward the cylinder chamber 13. Additionally, each of these embodiments includes a conduit 60 through the rod 3' and valve 18'. The conduit 60 opens into cylindrical chamber 61 and serves to equalize pressure during relative movement between piston 41 and control piston 56.

In the embodiment according to FIG. 20, the control piston 56 provides the abutment surface for the spring packet 58 which holds the valve 18' in the open position against shoulder 18''. The forward face of piston 41 faces and defines one end of cylinder chamber 12 and is charged by oil under pressure. This face of piston 41 is larger than the rearward face of piston 41 limiting the cylinder chamber 13.

In the embodiment according to FIG. 21, a Seeger ring 62 is disposed in an annular groove provided in the piston rod 3'. The spring 58 is disposed outside of bore 61 and is supported at one end by Seeger ring 62. The size and pretensioning of the spring packet 58 are so designed that pressure of the packet on piston 41 is less than the principal pressure exerted on the piston during the pressure period by the pressure oil. This is due to the difference in size between the forward and the rearward surface areas of piston 41.

The mode of operation of the FIG. 17 to 21 forms of the present invention corresponds to the mode of operation of the embodiments according to FIGS. 11 to 16. There is, however, a significant difference which simplifies both the structure and operation of the apparatus. At the moment when the locking pressure is being built, the pressure in the cylinder chambers 12 and 13 is approximately the same because the valves 18' are still open. The locking valves 18', however, immediately lock because the area of the side of each piston 41 which faces toward each cylinder chamber 12 is greater than the area of the side of each piston 41 which faces each cylinder chamber 13. By this arrangement, the pistons 41 (FIG. 17) move rearwardly (i.e. in the direction of cylinder chambers 13) until the valves 18' abut against shoulders 18'' which serve as valve seats. Where the piston 41 and valve 18' arrangement according to FIGS. 20 and 21 is used, the pressure of spring 58 must be overcome to make valve 18' abut against shoulder 18'' to close the channel defined by portions 20'' and 21''.

In the embodiments according to FIGS. 20 and 21 the valves 18' are held open with the aid of cup springs 58. These springs 58 hold valve 18' open during the entire drive period, i.e. during operation of the first hydraulic means, and close valves 18' only, as described above, during the pressure period, i.e. during operation of the second hydraulic means.

During normal operation, oil lines 59 which open into cylinder chambers 13 are virtually closed; (in the embodiments according to FIGS. 1 to 16 no oil lines opening into cylinder chambers 13 are provided at all). These oil lines 59 are provided because it is not absolutely necessary that all the oil in the pressure cylinders remain therein during operation. It is conceivable, for example, that a certain, graduated change occurs in the volume of oil disposed in the pressure cylinders. However, in order to keep the oil substantially within the pressure cylinders where it is supposed to remain, a relief valve may be disposed in the oil lines 59. Such a relief valve would be designed to open at a predetermined pressure and permits a flow from the cylinder chambers 13 toward the outside thereof, only when a certain threshold pressure has been exceeded.

The injection unit shown in FIG. 22 comprises a plasticizer-extruder-screw 80 in a heating cylinder 81 which is carried from a hydraulic cylinder 82 with injection piston 85. The screw is driven by a hydraulic motor 86 via connection axis 84.

There are different possibilities of urging the hydraulic means, with two pumps of different output capacities. For example (FIG. 22) it is practicable, that pump 70 with the higher output capacity the producible pressure of which is regulable from maximum to minimum in reciprocation to the output velocidity drives the hydraulic means 22–24 for moving the molds 11 between closed and open positions via the three-port/slide valve 88 and the oil lines. The opening and closing movement of the injection mold 11 is accomplished with the high velocidity of movement and relatively small pressure.

An axially adjustable switching bar 98 is fastened to the movable clamping plate 4. The bar is adjusted to the mounting depth of the mold 11. In this adjusted position (FIG. 22) the bar closes a control circuit 100 by means of a switch 99 when the mold arrives in closed position. This is the case, if the mold closing unit operates flawlessly, that is without foreign bodies disposed between the mold halves.

The closing of said central circuit gives the command to develop the force required to lock the halves of the injection mold 11 in its closed position. This force is developped by pump 70 in co-operation with a second pump 72 with smaller output capacity by supplying the cylinder chambers 12 with oil under maximum pressure via line 26,26*a*,26*b*. For this purpose the valve 88 is in a position shown in the figure, while the three-port slide valve 89 is in a position, in which the oil, coming from pump 70, can pass the valve into line 26 a while the oil of the pump 72 passes the two-port slide valve 91 into line 26 b.

If the operation is disturbed by the presence of foreign bodies disposed between the mold halves, then the switching bar 98 can no longer reach the contacts of the switch 99 during the course of the closing movement of the mold clamping unit.

In this case the oil, which is flowing while closing operation of the mold 11 from pump 70 via line 94 to chamber 31 is turned aside via line 101 and a relief valve 97, which is disposed in the line 101. The relief valve opens at a predetermined pressure and permits a flow of the oil from the pump 70 to the tank 73. If the operation is disturbed by the presence of a foreign body there is no command to develop the force for locking the halves of the mold together. In such way the axially adjustable bar on the control circuit 100 with switch 99 represents a simple safety device for injection mold of high effectivity.

If the operation of the mold is undisturbed the pressure of the pump is taken off from the cylinder chamber 12 when the force is developed which is required to lock the halves of the injection mold in its closed position because this pump 70 now is needed to accomplish the injection of the synthetic material performing the injection strike of the piston 85 connected with the screw 80 and also drives the hydraulic motor 86 for the injection unit 80–85, while the pump 72 maintains the pressure in the cylinder chambers 12 for the time of injection the synthetic material into the mold.

For supplying the hydraulic motor the two-port slide valve 90 is in a position, in which the oil coming from pump 70 can pass the valve into line 95.

For performing the injection strike of the position 85 the oil of the pump 70 passes the valve 89 into line 96; while the oil pressure, established by the pump 72, arrives into chambers 12 via two-port slide valve 91.

The oil line 59 with relief valve 74 leads to the oil tank 73. The pumpes 70,72 are driven by the electromotor 73.

It will be understood that the above discription of the present invention is susceptible to various modifications, changes and adaptations.

I claim:

1. In an injection-molding apparatus for processing synthetics, the combination which comprises:

a. mold means having two parts for receiving injections of synthetic materials, with one of said parts being movable and the other of said parts being stationary, so that said mold means is movable between open and closed positions;

b. first hydraulic means operatively associated with said mold means for moving the same between said closed and open positions, said first hydraulic means including a piston and a cylinder;

c. second hydraulic means also operatively associated with said mold means and forming one operating unit with said first hydraulic means for applying to said mold means a force which is greater than that capable of being applied by said first hydraulic means, to hold said mold means in its closed position,

said second hydraulic means including a piston, a piston rod connected to said piston, a clamping plate connected to said movable part and directly and rigidly connected to said piston rod, and a cylinder,

said piston rod partly supporting said clamping plate,

said second hydraulic means pulling said movable mold part toward said stationary mold part; and

d. means interconnected with said first and second hydraulic means for rendering said second hydraulic means inoperative during operation of said first hydraulic means,

said interconnecting means including at least one channel,

said cylinder of said second hydraulic means defining a chamber on each side of said piston of said second hydraulic means,

said piston of said second hydraulic means being connected by connecting means to said piston of said first hydraulic means,

said channel connecting the chambers on each side of said piston of said second hydraulic means, with valve means disposed within said channel to unblock said channel whenever said first hydraulic means is operated, and to block said channel whenever said second hydraulic means is operated.

2. Apparatus as defined in claim 1 wherein said channel is defined in said piston of said second hydraulic means and wherein said valve means is concentrically disposed within the piston of said second hydraulic means and permanently connected to said piston rod of said second hydraulic means.

3. Apparatus as defined in claim 2, wherein said valve means is controlled, at least in part, by hydraulic means.

4. Apparatus as defined in claim 2, wherein said valve means is controlled by hydraulic means.

5. Apparatus as defined in claim 4, wherein said valve means includes a body member, said channel connecting said chambers of said second hydraulic means extends through said piston of said second hydraulic means and an appropriately shaped seat is provided within said piston of said second hydraulic means at a location along said channel for receiving said valve body member, said valve body member being shaped to correspond to the shape of said seat.

6. Apparatus as defined in claim 5, wherein said seat is conically shaped and said valve body member includes a surface facing said seat which is also conically shaped, and defined within said piston of said second hydraulic means is a portion of said channel in surrounding relationship to a segment of said piston rod of said second hydraulic means and a portion of said channel which is connected to said surrounding channel portion and inclined with respect to the axis of said valve.

7. Apparatus as defined in claim 8 wherein a plurality of said inclined channel portions are provided.

8. Apparatus as defined in claim 5, wherein an annular chamber is provided along said channel within said piston of said second hydraulic means, said valve body member is cylindrically shaped and, at least partially, disposed in said annular chamber, and a radially extending flange is provided on said valve body member which is arranged with respect to said channel to block and unblock the same during operation of the apparatus.

9. Apparatus as defined in claim 5 wherein said piston of said second hydraulic means is directly connected to said piston of said first hydraulic means.

10. Apparatus as defined in claim 1 wherein said piston and cylinder of said first hydraulic means is permanently attached to said piston and cylinder of said second hydraulic means in longitudinally extending serial arrangement, said piston of said first hydraulic means extending from said piston of said second hydraulic means and said cylinder of said first hydraulic means extending from said cylinder of said second hydraulic means; a fixed tube-like projection extending inwardly into said cylinder of said first hydraulic means from the end thereof opposite to where said piston of said first hydraulic means extends from said piston of said second hydraulic means and said fixed tube-like projection being in communication with the outside of said cylinder of said first hydraulic means, said piston of said first hydraulic means being disposed around said fixed tube-like projection.

11. Apparatus as defined in claim 1 wherein a plurality of said second hydraulic means is provided in a single cylinder block.

12. Apparatus as defined in claim 1, wherein said cylinder of said first hydraulic means is disposed on the same side of said cylinder block as said clamping plate, said cylinder of said first hydraulic means being attached at one end to said cylinder block and connected at the other end to said clamping plate.

13. Apparatus as defined in claim 11 wherein a plurality of said first hydraulic means are provided in the same cylinder block as said plurality of said second hydraulic means.

14. Apparatus as defined in claim 2, wherein said piston rod of said second hydraulic means extends partially within said piston of said second hydraulic means and is arranged for limited movement relative thereto, said piston of said second hydraulic means is located on one side of said mold means and the side of said second hydraulic means remote from said mold means includes a cylindrical bore concentrically disposed therein a control piston is disposed for movement in said cylindrical bore, and wherein said valve means in said piston of said second hydraulic means is disposed in said cylindrical bore and inter-connectingly positioned between said piston rod of said second hydraulic means and said control piston, said control piston, hence said piston rod of said second hydraulic means, being moved by pressures built up in the piston chamber of said second hydraulic means adjacent said remote side of said piston of said second hydraulic means.

15. Apparatus as defined in claim 14, wherein the side of said piston of said second hydraulic means which faces toward said mold means has a greater area than the side of said piston of said second hydraulic means remote therefrom, the difference in the areas of the two sides being at least equal to the area of the side of the control piston which is remote from said mold means.

16. Apparatus as defined in claim 14, wherein a stop element is disposed in said cylindrical bore and the control piston abuts against said stop element when said channel is unblocked by said valve means and the relative movement between the piston and the piston rod of said second hydraulic means is limited in one direction by said stop element.

17. Apparatus as defined in claim 16, wherein a chamber is formed in said cylindrical bore with the side of said control piston which faces toward said mold means limiting one end of said chamber and wherein an oil line is defined in said piston rod said second hydraulic means and said valve means which opens into said chamber thereby to deliver thereto oil under pressure.

18. Apparatus as defined in claim 16, wherein a spring is provided having one end in contact with said remote side of the piston of said second hydraulic means thereby to press said piston away from said valve to unblock said channel during operation of said first hydraulic means.

19. Apparatus as defined in claim 18, wherein said spring is disposed in said cylindrical bore and the other end of said spring abuts against said control piston.

20. Apparatus as defined in claim 18, wherein an extended portion of said piston rod of said second hydraulic means is provided through said cylindrical bore and projects beyond said remote side of the piston of said second hydraulic means, wherein an abutment is provided on said extended portion, and wherein said spring is disposed outside said cylindrical bore with one of its ends in abutting engagement with said abutment.

21. Apparatus as defined in claim 18, wherein said control piston is constructed as a separate structural unit.

22. Apparatus as defined in claim 18, wherein the size and pretensioning of said spring is such that the pressure it exerts against said piston of said second hydraulic means is less than the pressure exerted by said piston of said second hydraulic means against said spring during operation of said second hydraulic means, this being due to the difference in area between the side of said piston of said second hydraulic means facing toward said mold means and the side of said second hydraulic means remote therefrom.

23. Apparatus as defined in claim 14 further comprising an oil tank; and wherein the chamber of said second hydraulic means on said remote side of the piston of said second hydraulic means is in communication with said oil tank.

24. Apparatus as defined in claim 23, wherein a conduit is provided which connects said oil tank to said chamber of said second hydraulic means on the remote side thereof, said con-

duit having a pressure valve which allows a flow to take place therethrough when a predetermined pressure threshold has been exceeded.

25. Apparatus as defined in claim 24 further comprising two pumps of different output capacities.

26. Apparatus as defined in claim 1, wherein said second hydraulic means are supplied with oil from two pumps and wherein said first hydraulic means are completed by a switching bar fastened on the plate carrying the movable mold part and are further completed by an electric circuit controlling said two pumps, said switching bar closes only said electric circuit when the mold parts are completely closed together.

27. Apparatus as defined in claim 1, wherein said second hydraulic means are supplied with oil from two pumps, one of which is additionally supplying at subsequent periods said first hydraulic means and additional hydraulic means of an injection unit for injecting the plastic material into the mold means.

28. An apparatus as defined in claim 1, wherein said cylinders of said first and second hydraulic means are concentrically arranged with respect to each other, wherein the piston of said first hydraulic means is permanently connected to the piston of said second hydraulic means by the piston rod of said first hydraulic means, and wherein said channel is disposed within said piston of said second hydraulic means.

29. An apparatus as defined in claim 1, wherein said valve means includes a valve, means biasing said valve into a closed position, and means acting to overcome said biasing means to cause said valve to open, said means including a piston and a stem for engaging said valve and fluid means for actuating said piston.

30. An apparatus as defined in claim 1, wherein said valve of said valve means is biased in one direction and said piston of said valve means is actuated in said one direction, and wherein said direction is substantially normal to the direction of movement of said one of said parts of said mold means.

31. An apparatus as defined in claim 1, wherein said valve of said valve means is biased in one direction and said piston of said valve means is actuated in said one direction, and wherein said direction substantially coincides with the direction of movement of said one of said parts of said mold means.

32. An apparatus as defined in claim 11, wherein said cylinders of said first and second hydraulic means are concentrically arranged with respect to each other, and wherein said channel is disposed in a block laterally flanged to said cylinder block.

33. An apparatus as defined in claim 32, wherein like chambers on each side of said pistons of said plurality of second hydraulic means are interconnected by channels.

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