April 25, 1961 D. CROPP 2,980,960

ROTARY HYDRAULIC PRESS

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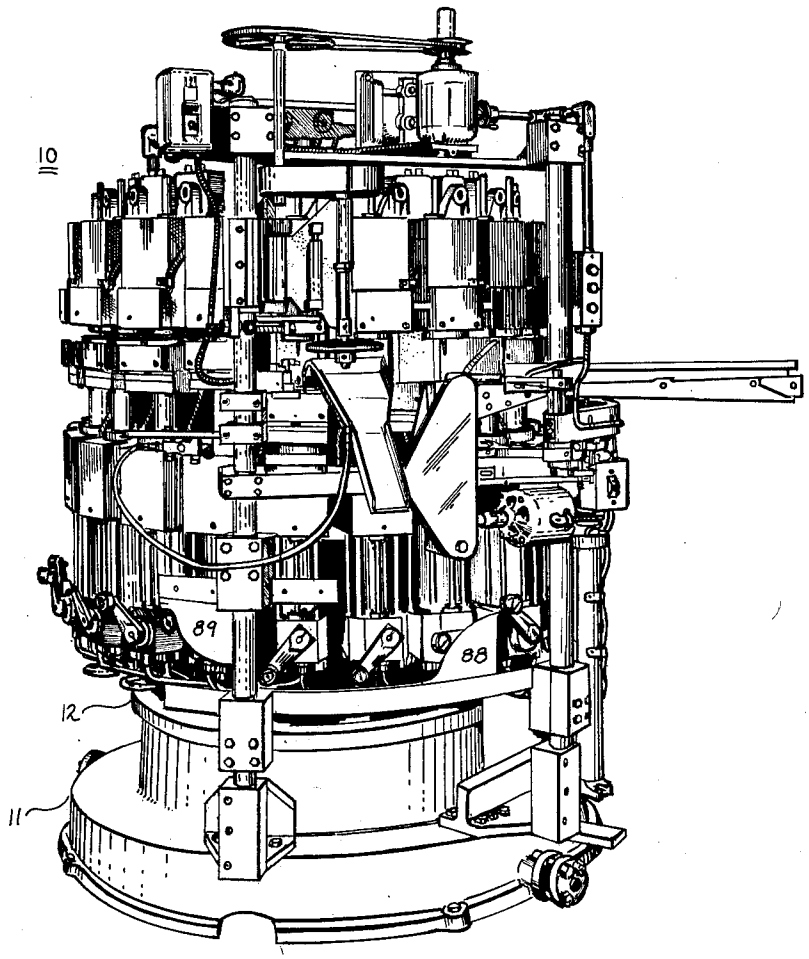



Fig. 1

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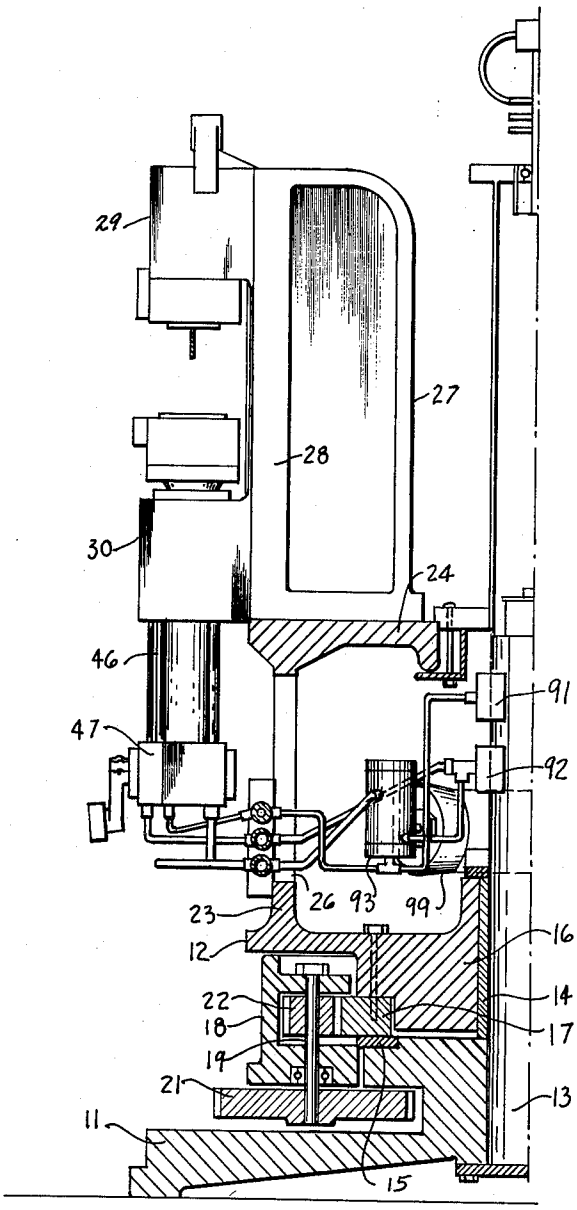



Fig. 2

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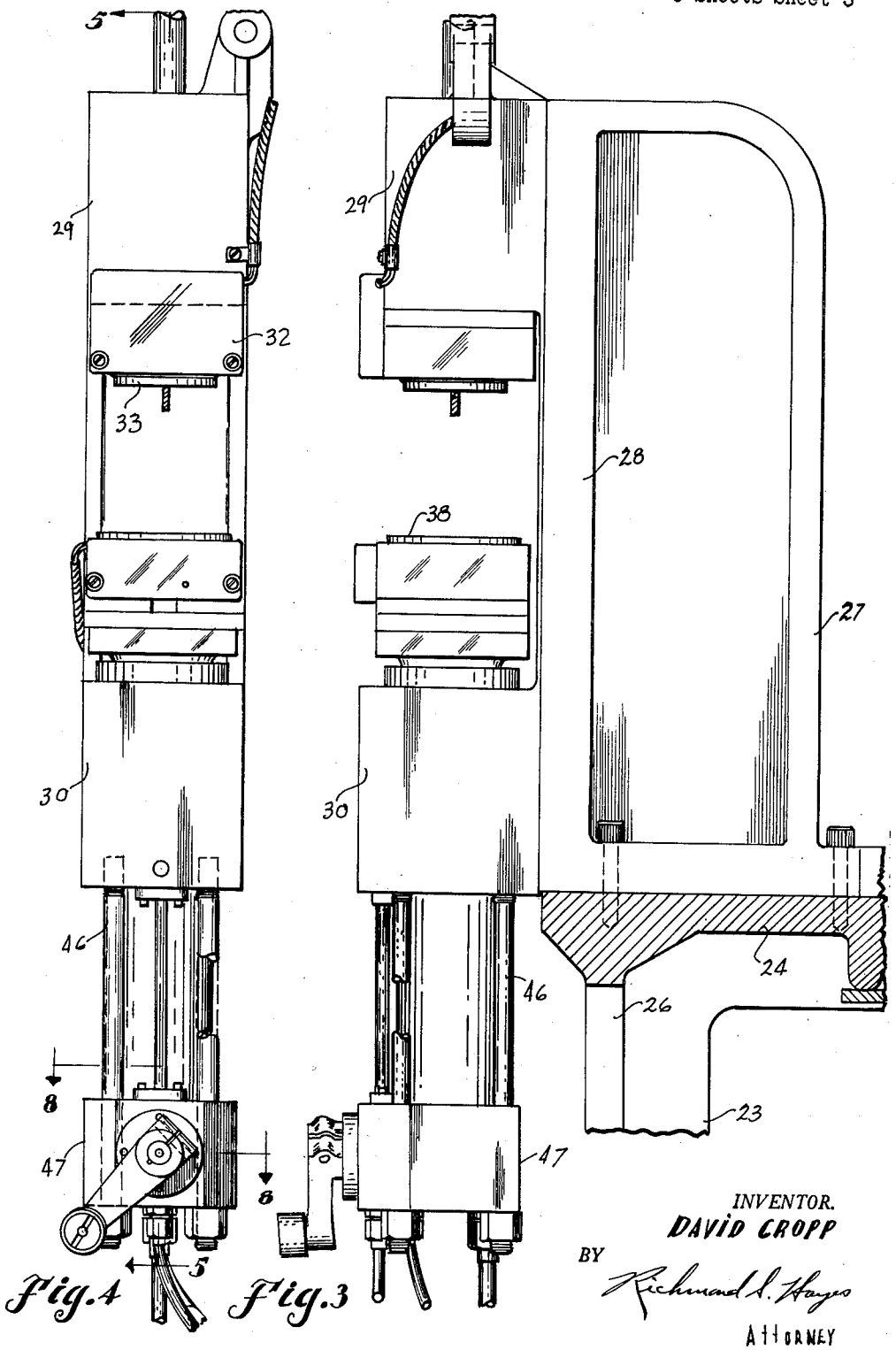



Fig. 4 Fig. 3

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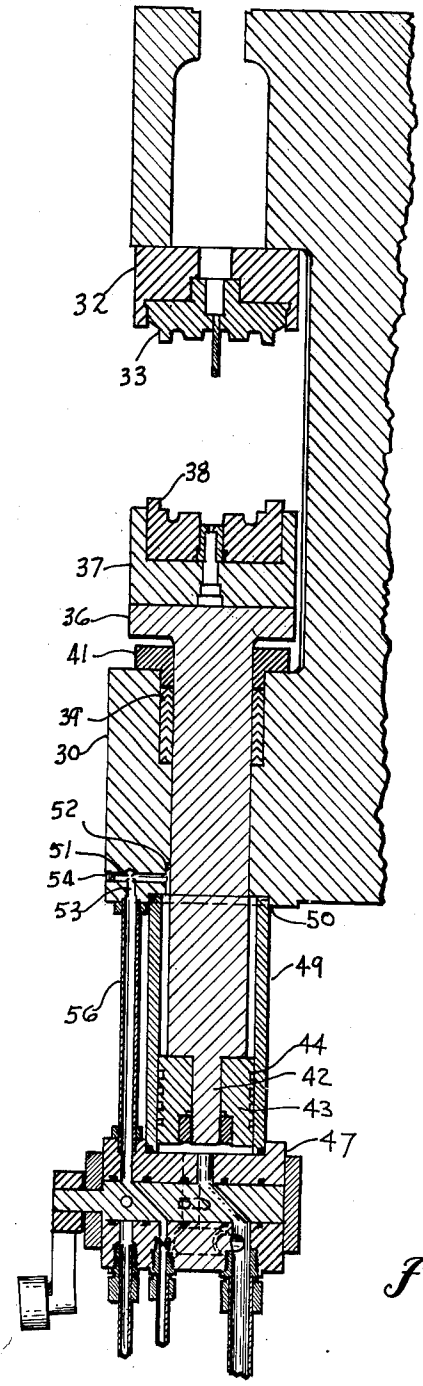



Fig. 5

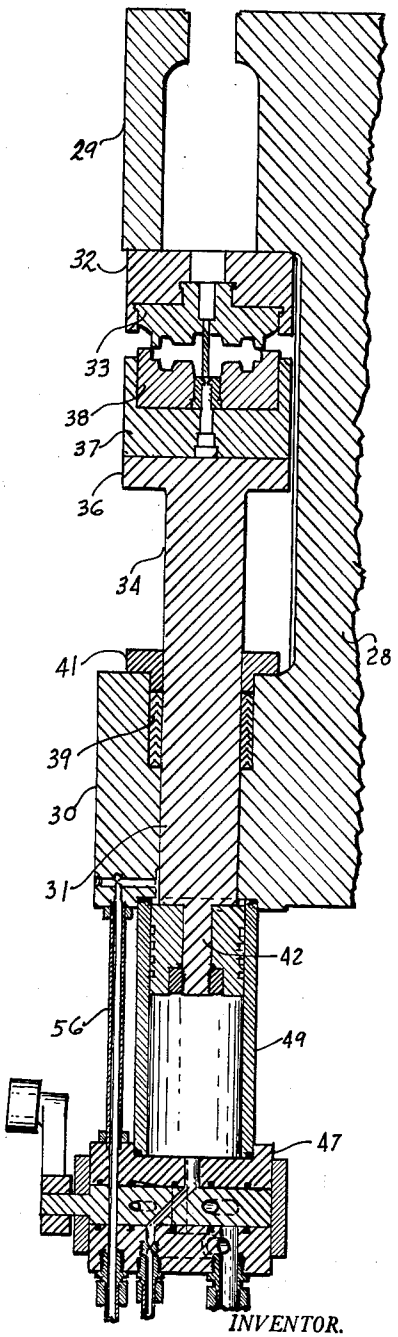



Fig. 6

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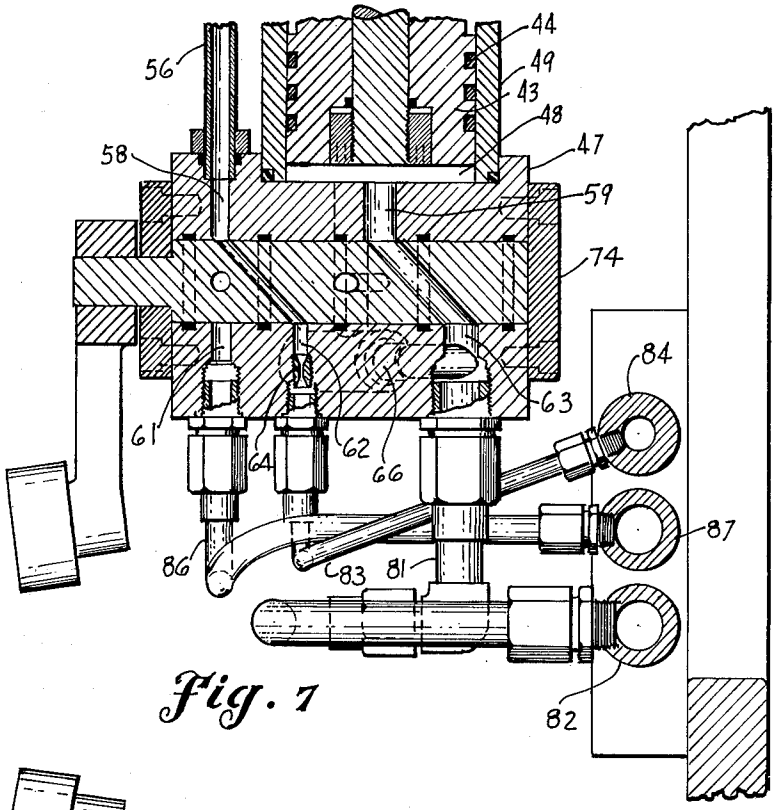



Fig. 7

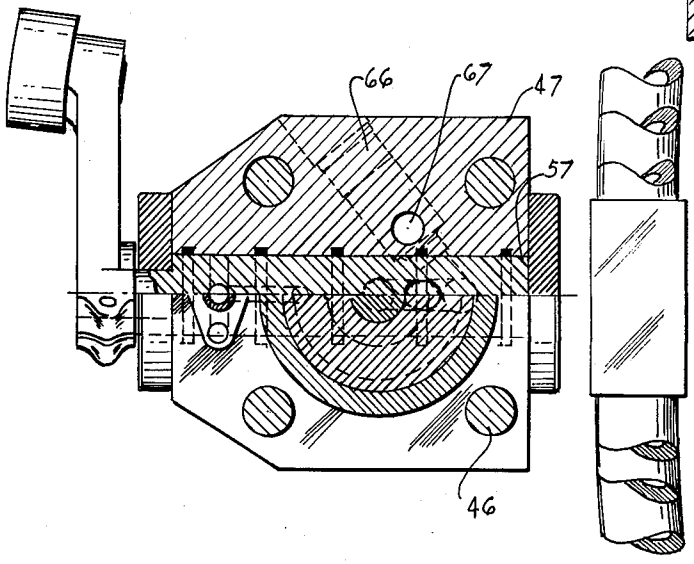



Fig. 8

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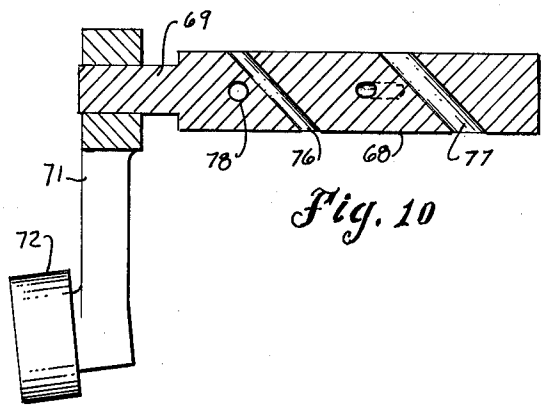



Fig. 10

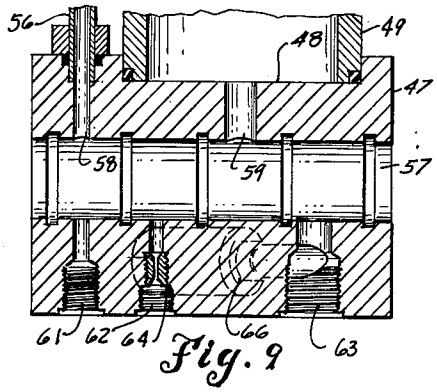



Fig. 9

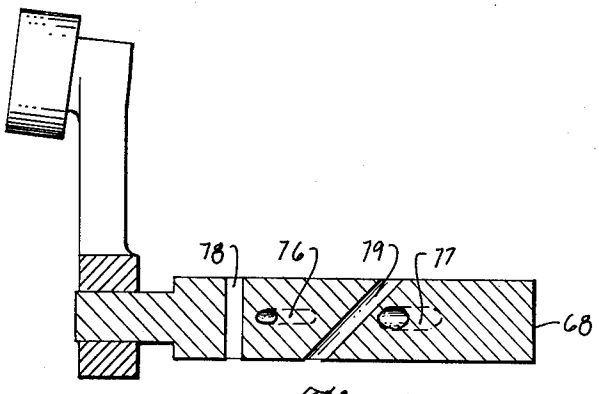



Fig. 11

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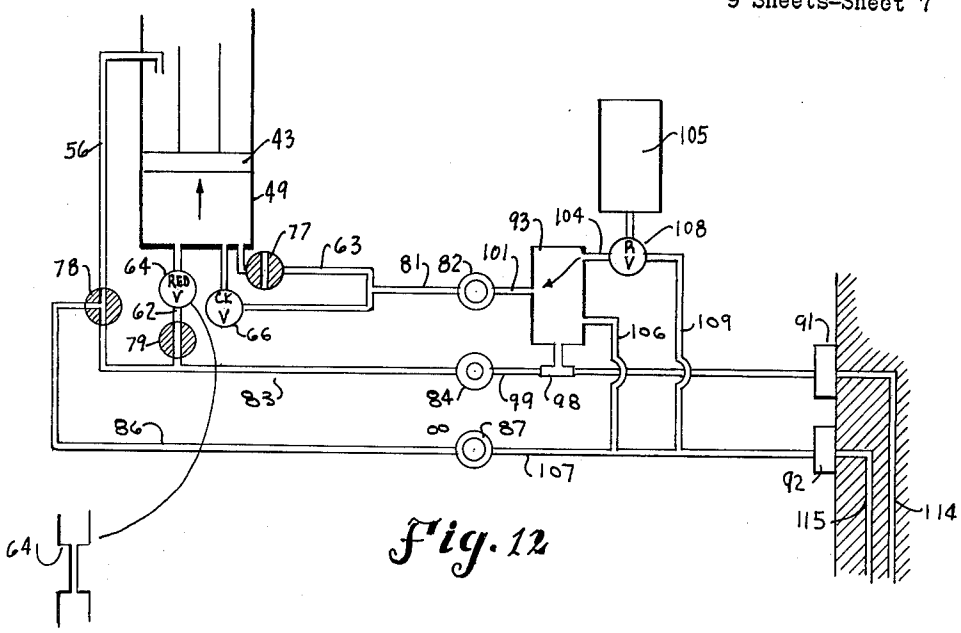



Fig. 12

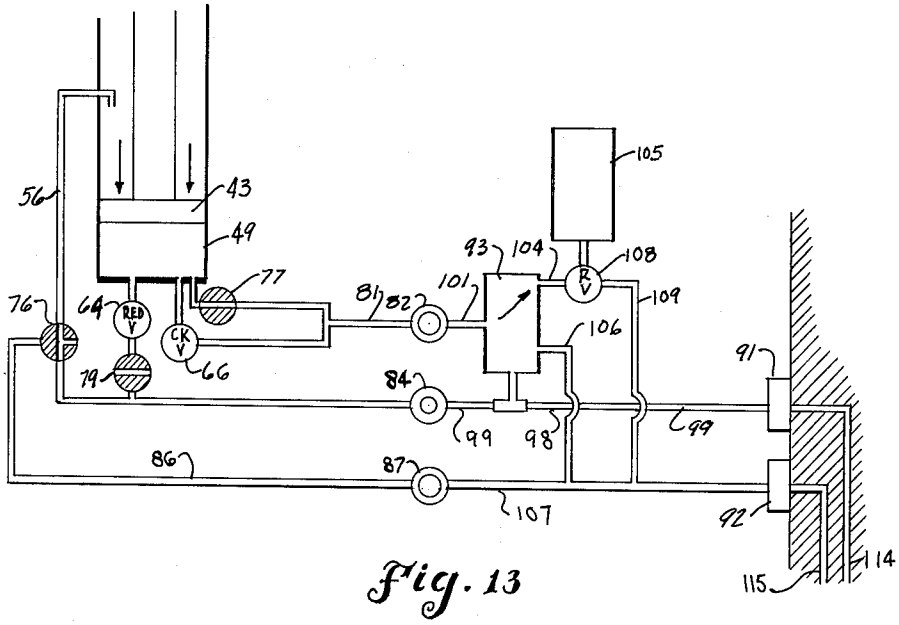



Fig. 13

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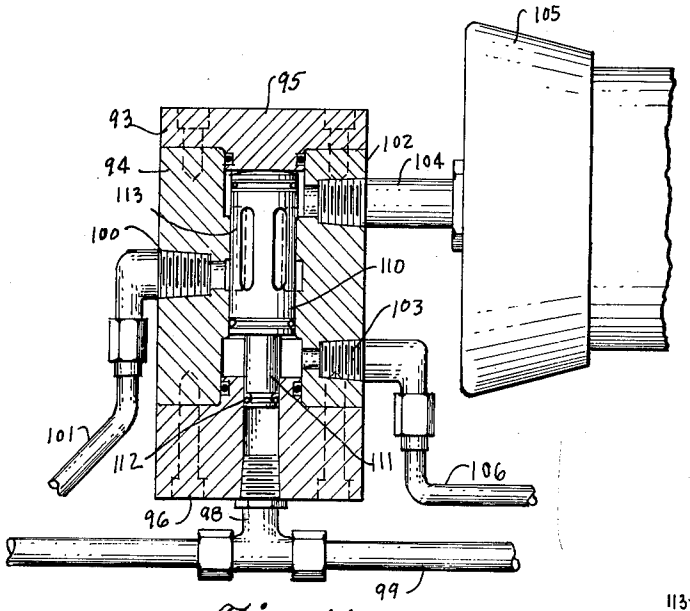



Fig. 14

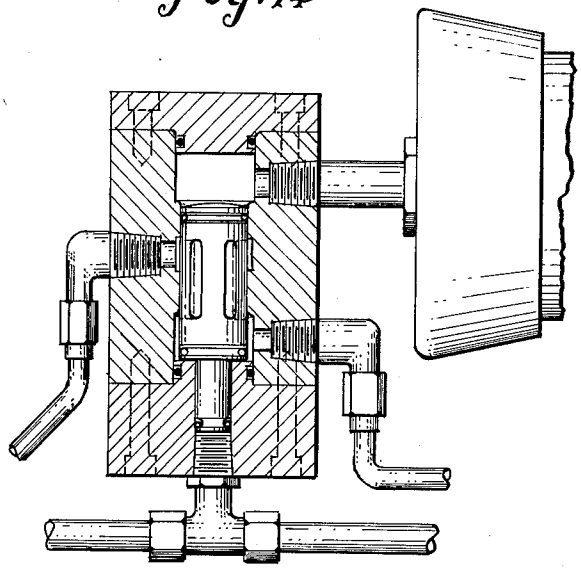


Fig. 15

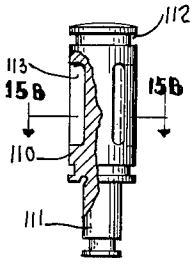



Fig. 15A

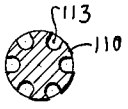



Fig. 15B

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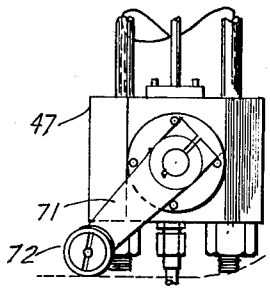



Fig. 16

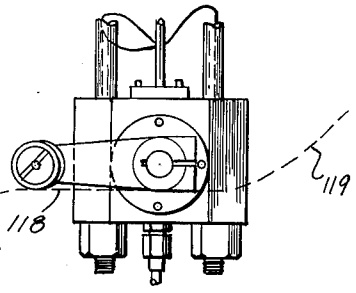



Fig. 17

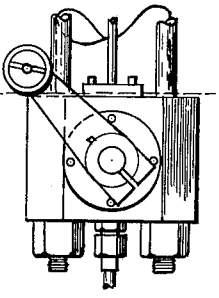


Fig. 18

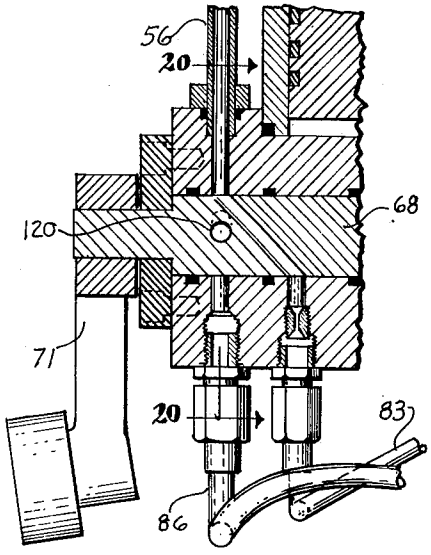



Fig. 19

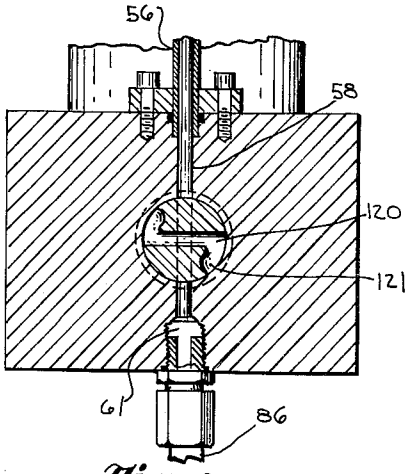



Fig. 20

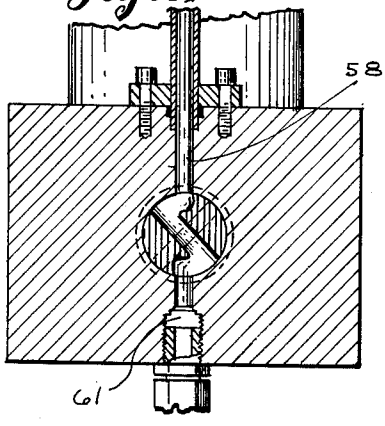



Fig. 21

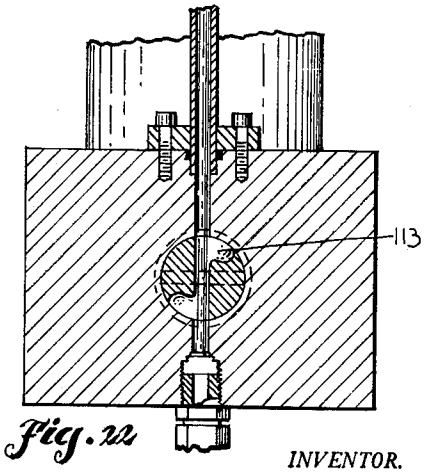



Fig. 22

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United States Patent Office 2,980,960 Patented Apr. 25, 1961



2,980,960

# ROTARY HYDRAULIC PRESS

David Cropp, Warren, Pa., assignor to Warren Components Division of El-Tronics, Inc., Philadelphia, Pa., a corporation of Pennsylvania

Filed May 27, 1957, Ser. No. 661,959

7 Claims. (Cl. 18—20)

This invention relates to improvements in a machine for compression molding articles from various materials that are introduced thereto in powdered, plastic, or pallet form. More particularly, the invention deals with a rotary hydraulic press for use in the continuous molding of such articles.

It is known that a variety of machines have heretofore been produced for use in the continuous molding of articles and that such machines, to a varying extent, have served their intended purpose. However, in a rapid or high speed press, difficulty has always been encountered not only in designing operative structure by which to obtain and accurately maintain time sequences, but also in closing and opening the molding elements of each unit with necessary speed and accuracy, together with maintaining necessary molding heat and pressure in order to assure exact duplication, one molded piece with respect to another. It is true that some currently manufactured molding machines are capable of high speed production, but objection is had to many of these machines by reason of the fact that the operation of closing and opening each molding unit is accomplished entirely by mechanical means. Mechanical operation may constitute no serious objection in the molding of certain materials or in molding small parts of a simple nature. However, it is very often necessary to generate a high clamping force in a molding operation, and the physical size of the units, to enable this in a mechanically operated press, results in a bulky construction. Cost of materials and labor, to say nothing of assembly, suggests that there is a limit beyond which it is impractical to produce presses in which high clamping force is required. Furthermore, to maintain such units in proper cyclical operation with given pressure during each molding period, a number of operative parts, embodied in each unit, must not only be accurately produced and adjusted, but the parts of each unit must be continually checked by spot examination of the pieces as they are molded to determine whether or not the operative parts of one or more of the units has become misaligned or misadjusted. Obviously, it is necessary that either or both elements of a molding unit must be movable toward and away from each other, but when the means by which these elements are operated is entirely mechanical, the question of accuracy of alignment of parts and maintenance of proper adjustment thereof becomes extremely important. This is particularly true, of course, in the high speed production of molded articles.

Generally, it is the object and purpose of the present invention to provide a turret type molding machine in which many of the heretofore required operative mechanical parts commonly found necessary in the operation of the elements of a molding unit are eliminated and the substitution for these parts of hydraulic means that is controlled by valves which can be easily and accurately set with the expectation that identical molded articles may be produced throughout long periods of operation and at a higher rate of production than would conceivably



be possible through use of the mechanical parts so replaced.

Specifically, the invention discloses a hydraulic press in which a multiplicity of identical molding units are radially arranged on a rotatable turret. Each unit includes a pair of relatively movable mold mounting elements, one of the elements of each unit being supported by a piston enclosed within a cylinder, the piston being caused to reciprocate through admittance of fluid under pressure to one or the other ends of the cylinder. The fluid serving to operate the elements of such a unit is controlled by a selector valve. Multiple passageways in the selector valve are caused to register at predetermined stations, during complete rotation of the turret, to so admit and/or relieve fluid under pressure as to cause the piston to separate the molding elements for the introduction of moldable material, or engage these elements under such pressure as may be required for the molding of an article. These stations take the form of cam plates which are successively contacted by a cam lever extending from the selector valve of each unit. Since these plates are not only relatively adjustable toward or away from each other, but are also replaceable with plates of different contour, it follows that adjustment of one or both plates will alter the molding cycle. Also, replacement of a plate with another of different contour may serve to change the time period required to so actuate the valve as to close or open a mold.

The present invention further proposes, in conjunction with the above mentioned valve controls, to eliminate the costly provision of heavy duty, high volume, pumping units by incorporating in one pumping system, high and low pressure means. To accomplish this, an accumulator tank is provided wherein fluid is stored under pressure generally not in excess of two hundred and fifty (250) pounds. Fluid from this tank is utilized to move the piston of a molding unit to an extent to bring the mold elements into close proximity. Essentially, a rather large volume of fluid is required to move each piston, but the pressure of this fluid may be relatively low. However, to assure such pressure contact of the mold elements as to properly compress the material to be molded, an additional force must be exerted, and such force is applied by a minute quantity of fluid from a high pressure line. The high pressure source of fluid is also connected with the other end of the cylinder through this valve and high pressure fluid thus serves to move the piston in the opposite direction for the purpose of separating the mold elements upon completion of a molding operation. Simultaneously with this separation of the molding elements, the valve enables return of fluid from beneath the piston to the accumulator tank. Thus, the quantity of fluid required to move each piston in one direction is returned to the tank and available to move the next piston when the valve therefor has been actuated. Upon complete operation of a given unit of the devices, a slight increase in fluid bulk has been produced by reason of the small addition of fluid from the high pressure line. If this additional bulk was returned to the accumulator, the pressure therein would increase beyond that desired and so, a valve in this return line is provided which allows excess fluid to return to the main storage tank and thus limit not only the quantity of fluid but the pressure thereof in the accumulator tank.

Many additional objects and advantages of the invention will be more clearly apparent from a consideration of the following specification, taken in conjunction with the accompanying drawings; in which:

Fig. 1 is a front elevational view of an automatic hydraulic turret press in which one form of the invention is embodied;

Fig. 2 is an enlarged fragmentary vertical view, partly

in section, of one of the molding units, the supporting structure therefor, and certain of the hydraulic connections to the units;

Fig. 3 is an elevational view of one of the molding units and a portion of the supporting structure, being substantially identical, but on a larger scale, with the disclosure of such a unit in Fig. 2;

Fig. 4 is a front elevational view of the unit shown in Fig. 3;

Fig. 5 is a vertical sectional view of one of the units, being taken substantially as suggested by the line 5—5 of Fig. 4, and shows one extreme position of one of the mold elements and position of the selector valve therefor;

Fig. 6 is a view similar to Fig. 5, showing the other extreme position of the same mold element, together with the changed position of the selector valve;

Fig. 7 is a greatly enlarged vertical sectional detailed view of the selector valve shown at the base of the unit in Fig. 5;

Fig. 8 is a horizontal view, partly in section, of the selector valve, being taken substantially as suggested by the line 8—8 of Fig. 4;

Fig. 9 is a vertical sectional view of the box in which a selector valve is mounted, this view showing all passageways entering and leaving the box;

Fig. 10 is a vertical sectional view of the valve that is mounted in the box shown in Fig. 9;

Fig. 11 is a view similar to Fig. 10 showing the valve in a ninety degree rotated position with respect to that of Fig. 10;

Fig. 12 is a hydraulic diagram showing the position of the various control valves when the hydraulic fluid has functioned to move the piston into the position shown in Fig. 5;

Fig. 13 is another diagram showing the position of the valves when fluid has moved the piston into the position shown in Fig. 6;

Fig. 14 is an enlarged vertical sectional view of the safety valve incorporated in the hydraulic circuit, the piston therein being positioned to permit fluid to flow from the accumulator to the low pressure manifold (see Fig. 12);

Fig. 15 is a view similar to Fig. 14 and shows the piston in a position to close off the accumulator and permit fluid from the press to the storage tank;

Fig. 15A is a side elevational view, partly in section, of the piston in the safety valve shown in Fig. 14;

Fig. 15B is a horizontal sectional view, taken substantially on the line 15B—15B of Fig. 15A;

Figs. 16, 17, and 18 are identical fragmentary front elevational views of the selector valve showing two stages of operation thereof as required in the modified valve structure shown in Figs. 19 and 20;

Fig. 19 is a fragmentary vertical sectional view of a modification of the valve structure shown in Fig. 5;

Fig. 20 is a vertical sectional view, taken substantially on the line 20—20 of Fig. 19 and shows the position of the valve parts when the control lever is in the position shown in Fig. 16;

Fig. 21 is a view similar to Fig. 20 and shows the position of the valve parts when the control lever is in the position shown in Fig. 17; and

Fig. 22 is a view similar to Fig. 20, showing the position of the valve parts when the control lever is in the position shown in Fig. 18.

Referring more particularly to the drawings, the reference numeral 10 is employed to generally designate one form of a rotary turret press with which the presently disclosed invention is associated. The press comprises two general parts; namely, a pedestal 11 and a rotatable turret 12. The press includes an upstanding center post 13 that is supported at its lower end upon the pedestal 11. Above the pedestal, a suitable bearing 14 and thrust bearing 15 mount the base portion 16 of the turret 12 on the post. The turret base 16 mounts a ring gear 17. A housing 18, fixed in any suitable manner to the pedestal 11, mounts a vertical shaft 19, to the lower end of which is secured a large gear 21. Near its upper end, the shaft mounts a small gear 22 which meshes with the ring gear 17. Any suitable means may be employed to drive the gear 21, and through the small gear 22 and ring gear 17, the turret is caused to rotate about the post 13. Radially offset from the center post, the turret base 16 includes a circular upstanding support 23, the upper edge of which terminates in a radially inwardly extending annular shelf 24. Suitable vertical slots 26 are distributed about the support 23 for the purpose of providing access to the molding units from the interior of the turret in order to provide rotatable hydraulic connections for each unit. Further description will set forth the means by which fluid from a common pressure source and under two different pressures, may be selectively fed to the molding units at predetermined stations as these units move through a complete circle with the rotatable turret.

Mounted on and extending radially outwardly of the shelf 24 are a plurality of individual uprights 27. They are uniformly distributed about the turret and are of a number corresponding to the number of molding units on the press. Although the structural and operational details of only one molding unit will be specifically described, it will be understood that all of the units of the press are identical and are sequentially operated in the manner hereinafter set out. Integral with and extending radially outwardly from the vertical reinforced portion 28 of each upright are housings 29 and 30 which serve to mount and guide the relatively movable elements of a mold. The upper housing 29 is intended to carry a receiver 32 that in turn mounts the upper element 33 of a mold. This element is connected, as suggested in the drawings, with a suitable source of current supply which, in conventional manner, is automatically controlled to provide required molding heat. The lower housing 30 has a vertical opening 31 to receive a shaft 34. At the upper end of this shaft is a seat 36 on which is located a receiver 37 for the lower element 38 of the mold. This element is also connected with a source of current supply, the heat thereof being automatically controlled. At the point of entry of the shaft 34 into the housing 30, the housing opening is enlarged to receive packing 39 which may be held in place by a collar 41. The shaft 34 is of a length to at all times extend completely through the housing 30, the lower end thereof taking the form of a pin 42 to which is attached a head 43. This head is of the nature of a piston head and includes a series of annular grooves in which sealing rings 44 are located.

A series of rods 46 depend from the housing 30 and, at their lower ends, engage and support a selector valve box 47. In the top, flat face of this box is a cylindrical recess 48 (see Fig. 7) which receives and fluid seals the lower end of a sleeve 49. The upper end of this sleeve has fluid sealing engagement with the walls of a recess 50 in the lower face of the housing 29 (see Figs. 5, 6, and 7). This sleeve is centered with the shaft 34 and serves as a cylinder within which the piston head 43 is movable. A small horizontal opening 51 is made in the lower end of the housing 30 and opens into a small offset 52 of the opening through which the shaft 34 projects. Extending upwardly from the bottom of this housing is a further opening 53 which connects with the opening 51. A plug 54 closes the exterior end of the opening 51 and these openings thus provide for fluid passage between the exterior and the upper interior end of the sleeve 49. A tube 56 is connected with the opening 53 of the housing 30 at one end and at its other end extends into the top of the box 47.

For convenience of operation and location, each selector valve box 47 is arranged with its moving parts operable about a horizontal axis. The box is formed

with a generally centered cylindrical, horizontal opening 57 extending from one end to the other. In the top of this opening, a passageway 58 connects with the tube 56. Also, there is a passageway 59 that connects the opening 57 with the recess 48, the base of which constitutes the lower end of the cylinder 49. Connecting the base exterior of the box with the opening 57 are three passageways; namely, 61, 62, and 63. Passageway 61 is adjacent one end of the box and more nearly centered is passageway 62 which has a reduced diameter orifice 64. Passageway 63 is of considerably larger proportions and opens into a check valve 66, built into the base of the box, as well as into the opening 57. From this valve an opening 67 is made upwardly through the box, adjacent to but not connected with opening 57, and this opening 67 connects the check valve with the interior of the cylinder in the recess 48. It is the purpose of the check valve 66 to permit fluid flow from the passageway 63 into the base of the cylinder through opening 67 but prevent return of fluid through said opening into passageway 63.

Mounted in the opening 57 and extending the full length of the box 47, is a shaft 68. One end 69 of this shaft is of reduced diameter and extends beyond the box and is fitted with a crank arm 71, the free end of which mounts a roller 72. Since the shaft is of the nature of a rotatable valve and must be fluid tight, suitable packing glands encircle it, being carried by the walls of the opening 57. The ends of the shaft are suitably sealed against fluid leakage and held in place by end plates 74, the end plate adjacent the crank serving as a spacer therefor. The shaft 68 has a series of four passageways extending diametrically therethrough. Two of the passageways are at right angles to the other two passageways. Considering Fig. 5 or 7 for the moment, in conjunction with Figs. 9 and 10, it wil be noted that with the crank arm 71 in its lowermost position, an inclined passageway 76 connects the reduced orifice passageway 62 with the tube 56 through passageway 58. A further inclined passageway 77 connects the large passageway 63 with the passageway 59 opening into the base of the cylinder 49. Referring now to Fig. 6, in conjunction with Figs. 9 and 11, it will be noted that when the crank arm 71 has been rotated upwardly ninety degrees, the other two passageways in the shaft 68 come into use; that is, passageway 78 now connects passageway 61 with the tube 56 and a small inclined passageway 79 now connects the reduced orifice passageway 62 with the passageway 59 that leads into the base of the cylinder 49. Of course, when passageways 78 and 79 are in position of use, passageways 76 and 77 are closed, and vice versa. One end of a tube 81 is connected with the base of the valve box 47 at the passageway 63. The other end of this tube is joined to a manifold 82 that encircles the turret 12 and rotates therewith. A further tube 83 connects passageway 62 with another manifold 84 which is also carried by and rotatable with the turret 12. The exterior end of the passageway 61 is coupled through a tube 86 with a further manifold 87 carried by the turret.

It is the purpose of the crank arm 71 to rotate the valve shaft 68 ninety degrees first in one direction and then in the other. To accomplish this, two cam plates 88 and 89 are supported in any suitable manner on the base of the press. Cam plate 88 is so designed that when a crank roller 72 contacts it, the roller will move up the inclined surface and rotate the crank arm ninety degrees. Such rotation of the crank arm changes the position of the passageways in the selector valve box from that of Fig. 5 to that of Fig. 6 (see also Figs. 10 and 11, respectively). Cam plate 89 is reversely positioned to plate 88 and is intended to be contacted by roller 72 when the crank arm 71 is in raised position and, by moving the roller downwardly of the inclined surface, this arm is rotated ninety degrees in the opposite direction, returning the position of the passageways in the valve box to that of Fig. 5.

There are only two fluid connections leading to the turret supporting post 13; namely, a high pressure line and a return line. These lines extend upwardly through the post and terminate in collector rings 91 and 92 which are shown in Fig. 2 and indicated in the diagrams of Figs. 12 and 13. Ring 91 provides fluid take-off from the high pressure line and ring 92 for return of fluid to the post return line. The means by which it is possible to pass fluid from stationary lines to rotating lines, such as are provided in the turret 12, may be accomplished in any of several ways and, since this structure forms no part of the present invention, it is not shown or described in detail. As will hereinafter be clearly set out, the high pressure ring 91 is connected with the manifold 84 and the ring 92 is connected with manifold 87. The further manifold 82 has connection with a source of fluid that is under a pressure of less value than that supplied to the high pressure manifold 84. To obtain fluid pressures of two different values, an accumulator tank is provided and in order to adequately protect the operative parts of the units, a safety valve of particular structure and operation is installed in the system.

Attention is now particularly directed to the operation of each of the molding units and the means by which it is possible to quickly, accurately, and easily open and close them through the use of a single fluid pressure line and a fluid return line. Referring more particularly to Figs. 5 through 8, it is to be observed that each molding unit, at the base thereof, has a selector valve 47 and that the passageways to this valve are joined by fluid carrying tubes with the three manifolds, 82, 84, and 87. In other words, the number of molding units that may be mounted on the turret is limited only to the lateral proportions of each unit inasmuch as control, by way of the selector valves, is made possible by the circular manifolds which may be tapped at any point as required. It is to be particularly noted that since the selector valve 47 of each molding unit is individually operated by cam plates 88 and 89, it is unnecessary to provide an equivalent number of high, low, and return fluid lines due to the manifolds 82, 84, and 87. In other words, a single high pressure line, connected with a pump, will feed high pressure into manifold 84 and at such time as the selector valve of a given unit is operated, high pressure fluid will be utilized in the opening or closing of a given molding unit. Similarly, there is only a single return line to the fluid storage tank of the pump that is connected with the return manifold 87 and, consequently, all fluid to be returned to the tank flows into this single line through the collector ring 92 and back to the tank.

Referring now to Fig. 2 and the diagrams of Figs. 12 and 13, it will be noted that between the collector rings 91 and 92 mounted on the post 13 and the three manifolds 82, 84 and 87, a safety valve and an accumulator or low pressure tank are located. The safety valve, indicated at 93, serves to prevent the closing of any molds that may be open if, for any reason, pressure from the fluid pump should drop below a certain value while the accumulator is still capable of delivering fluid under pressure. Thus, this valve is interposed between the accumulator and the low pressure manifold 82. More specifically, this valve consists of a sleeve 94 that is closed at its ends by suitably attached plugs 95 and 96. A relatively small opening 97 extends through the plug 96. Threaded into the outer end of this opening is the stem of a three-way coupling 98. This coupling is in the high pressure line 99 that connects the manifold 84 with the collector ring 91 and permits entry of high pressure fluid to this end of the valve. Three openings are made in the sleeve 94. Opening 100, through tube 101, is directly connected to manifold 82. Diametrically opposite opening 100 are openings 102 and 103. A tube 104 connects opening 102 with the accumulator tank 105. A further tube 106 connects opening 103 with a return tube 107. This last tube connects the return manifold

87 with the return collector ring 92. Either in the line between the tank 105 and valve 93, or built into the tank, is a pressure relief valve 108, which is so designed that fluid pressure beyond its set value cannot enter the tank 105 but must by-pass through a tube 109 into the return collector ring 92. Within the sleeve 94 is a free piston 110. From one end of this piston, a stem 111 extends into the opening 97, being provided with suitable packing by which to prevent entrance of fluid into the sleeve from the high pressure line 99.

The piston 110, as shown in Fig. 15A, has annular grooves at its ends in which suitable packing 112 is mounted. Between these packings are a series of radially outwardly opening lengthwise grooves 113. These grooves, when the piston is in one or the other of the positions shown in Figs. 14 and 15, connects the openings 100, 102, and 103 in a predetermined manner. During normal operation of the press, fluid in the high pressure line 99 acts upon the stem 111 to force the piston 110 into the position shown in Fig. 14 and to so maintain it as long as high pressure is available. In this position, the piston grooves 113 provide fluid connection between openings 102 and 100, thus, through tubes 104 and 101 fluid under low pressure from the accumulator 105 is made available to the manifold 82. However, should the pressure in line 99 drop below the pressure maintained in the accumulator 105, the piston will move into the position shown in Fig. 15. In this instance, fluid in the press will be permitted to pass through the valve 93 from opening 100 to opening 103 and thence, by way of tubes 106 and 107, to the return collector ring 92.

As has already been stated, the present invention is particularly directed to means for controlling the sequential operation of the molding units of a press by hydraulic pressures of two different values. To enable a full and clear understanding of the invention, attention is now directed to Figs. 9, 10, and 11 and the diagrams of Figs. 12 and 13 in connection with operation of the press. Although operation of only one molding unit will be described in detail, it will be obvious that the remaining molding units in the press will operate in like manner as the control crank arms 71 are sequentially moved by reason of the rollers 72 thereof coming in contact with cam plates 88 and 89. It will be assumed that the fluid pump has been set in operation and that fluid under high pressure is supplied to the line 114 that leads upwardly through the hollow post 13 into the collector ring 91 and supplies fluid to the manifold 84. With the crank arm in the position shown in Figs. 5, 7, and 10, it will be noted that fluid from the pump flows through passageway 76, tube 56, and exerts a downward force on the piston 43 for the purpose of holding the elements of the mold in separated or opened position.

As a given molding unit reaches the point where the roller 72 contacts plate 88, the arm 71 of this unit is rotated from the position shown in Fig. 5 or 10 to that of Fig. 6 or 11, thus causing the valve shaft 68 to rotate ninety degrees and change the position of the passageways therein. In this position of the shaft, passageway 63 is blocked or closed by a solid portion of the shaft. However, low pressure fluid in tube 81 will pass through check valve 66 and opening 67 directly into the base of the cylinder 49, thus exerting a force against the under face of the head 43. Passageway 79 of the shaft 68 now connects the reduced orifice passageway 62, with opening 59 in the base of the cylinder 49. Passageway 62, being connected with the manifold 84, now permits restricted flow of high pressure fluid from the pump into the cylinder 49 beneath the head 43. In other words, the mold is caused to close through the application of a large volume of low pressure fluid, aided by a restricted amount of high pressure fluid. As a result of this rotation of the shaft 68, the passageway 78 connects tube 56, through passageway 58, with the return line 86 that is joined to the return manifold 87. Thus, as fluid under both high and low pressure forces the piston upwardly, fluid above the piston is enabled to return, through manifold 87, tube 107, collector ring 92, to the line 115 in the post which opens into the fluid reservoir. Inasmuch as cam plate 89, which serves to rotate the arm 71 to open a molding unit, is adjacent the cam plate 88 by which the unit is closed, it is evident that the turret makes almost a complete rotation between mold closing and mold opening positions. Consequently, molding material supplied to a given unit is held under pressure throughout the time it takes the press to revolve between these two points and, of course, the elements of each molding unit being electrically heated, the material will be properly processed by heat and pressure by the time the elements of the mold are again opened.

The return of the arm 71 of a unit to the position of Fig. 5 or 10 causes the selector valve shaft 68 to again connect the passageways and fluid tubes in the relationship described when a given unit is at rest. It has been stated that operation of each molding unit is obtained through use of fluid under relatively high and low pressure, although only a single high pressure fluid line enters the press. Attention is particularly directed to Figs. 5 and 7 and diagram 13. Herein high pressure fluid, applied to the top of the piston 43, through tube 56, has forced the piston downwardly in the cylinder 49 against low pressure fluid therebeneath. Of course, the fluid beneath the piston must be evacuated, and such evacuation occurs by this fluid flowing through the large passageway 77 of the selector valve, tube 81, manifold 82, and tube 101 into the safety valve 93. Since the pressure in line 99 is holding the safety valve piston 110 in the position shown in Fig. 14, fluid will flow freely through valve 93 from tube 101 to tube 104 and thence into the accumulator tank 105. The cubic capacity of the accumulator tank 105 is greater than the cubic content of the cylinder 49 when the piston is in raised position. Thus, the closing and opening of one molding unit will not fill the accumulator with fluid under desired pressure. However, the subsequent sequential closing and opening of only a few of the molding units will build up the desired operative pressure in the accumulator. It will be understood that the fluid entering the press may do so under pressure of many hundred pounds, whereas pressure in the accumulator, which is the source of low pressure in the device, would preferably not exceed two hundred and fifty (250) pounds. The relief valve 108, at the entrance to the accumulator, has a value such that when pressure in the accumulator reaches a predetermined point, the valve opens and by-passes excess fluid through the return lines 109 and 107, to the collector ring 92, and thence out of the press through tube 115.

Now that the press contains adequate fluid under a controlled low pressure in the accumulator, molding may take place. When the crank arm 71 has moved upwardly, fluid in considerable volume, at low pressure, from the accumulator 105, flows through the safety valve 93, manifold 82, and into and through the one-way check valve 66, from which it enters the cylinder beneath the piston 43. Simultaneously with this low pressure flow, passageway 79 of the selector valve has been opened and thus high pressure, through the flow restricting valve 64, also enters the cylinder beneath the piston. It is not only contemplated, but in actual productive operation it has been proven, that through the use of fluid under low pressure automatically provided in the press, it is only necessary to supply a small volume of fluid under high pressure not only to raise the piston and close the molding elements, but to hold these elements in desired pressure engagement for a given molding operation. In this way, each press, in which the invention is utilized, need only be provided with a fluid pumping unit capable of producing a minimum quantity of fluid under high pressure, and it has been found that a considerable econ-

omy is effected through the use of smaller pumping equipment, smaller fluid reservoir, and also by reason of the elimination of all but two lines; one into and the other out of the press.

Fluid under low pressure from the accumulator serves only to raise the piston **43** and may not completely close the molding elements or hold them in desired pressure contact through a molding operation. However, fluid from the high pressure line, through passageway **79** and flow restricting valve **64**, supplies fluid for this purpose. Consequently, when the piston has reached its uppermost position there is more fluid beneath the head **43** than entered the cylinder **49** by way of the low pressure line from the accumulator. Thus, when the mold is caused to open by reason of supplying fluid under high pressure to the top top of the piston, the fluid provided from the accumulator has been increased in volume to the extent of flow from the high pressure line during raising the piston. And, of course, the pressure of this fluid is greater than that required or supplied by the accumulator. In this conenction, it will be noted that the passageways **59**, **77**, and **63** (see Figs. 9 and 10) are relatively large and thus the moment the piston is forced downwardly, fluid therebeneath is free to pass through the manifold **82**, tube **101**, safety valve **93**, and into the accumulator. As has been mentioned, if the pressure of this return of fluid is greater than the value set for the accumulator, and because more fluid is available to the accumulator than previously, the relief valve will function to by-pass this excess fluid, returning it to the tank of reservoir of the pumping unit.

It is to be understood that during operation of the press there is no period when fluid, under low pressure, is not applied to the cylinder **49** beneath the piston **43**. In other words, it is the difference in force as between the accumulator and the high pressure line, that causes downward movement of the piston, or, when high pressure is cut off, enables upward piston movement. This constant availability of fluid under low pressure to the units is to be kept in mind not only in connection with the provision of a safeguard to withhold this fluid but also with respect to a modification of the invention as hereinafter set out.

Following a period of operation of the press, the fluid pressure pump and the turret drive may be shut off. Obviously, the elements of a number of molding units will be in open position at the time of such shut-down, at least as many as are between the cam plates **88** and **89**. Now, there would be no pressure in line **99** and, even though certain crank arms **71** are in their lowered position, no fluid pressure would be applied to the top of the pistons **43**. However, with the selector valve in a position to separate the mold elements, passageway **77** of shaft **68** still connects passageway **63** with **59** which opens into the base of the cylinder **49**. And, of course, passageway **63** connects through tube **81**, manifold **82**, tube **101**, safety valve **93**, and tube **104** with the accumulator. Since the pressure in the accumulator tank has not been relieved, fluid therein would flow through the passageway **77**, raise the piston **43** and at least partially close the mold of one or more of the units, this in spite of the fact that the press and the fluid pressure pump have been stopped. With any of the movable elements of the units partially raised in that area between cams **88** and **89**, it is conceivable that the material feeding mechanism for the molding units would be interfered with when these partially or fully closed units were presented to it at the time of again starting operation of the press. Also, at the time of a shut-down of the press for repairs or examniation, it would be unsafe to continue the availability of fluid under pressure even though the pressure is low and only supplied from the accumulator tank. The safety valve **93** overcomes this hazard.

As has been previously stated, the safety valve piston **110** is held in the position shown in Fig. 14 only so long as there is fluid under high pressure in the incoming line **99**. As soon as this pressure drops, the piston **110** is forced into the position shown in Fig. 15, by reason of fluid pressure from the accumulator. This, of course, closes the opening in the valve to tube **104** leading to the accumulator and opens the valve to the return line **106**. This adjustment of the valve serves two purposes; (1) to prevent fluid under pressure in the accumulator from raising any of the pistons **43**; and (2) permits releasing pressure of any fluid beneath the pistons into the return line. Since pressure from the accumulator is shut off, and pressure both above and below the piston **43** is relieved, there can be no indavertent movement of parts when an operator shuts down the press. Of course, when the press is again put into operation, fluid under pressure in the line **99** will move the piston **110** to the position in Fig. 14 and again permit flow of fluid to and from the accumulator tank through the safety valve **93**.

In the compression molding of certain articles or of articles from certain materials, it is sometimes desirable, or even necessary, to bring together the elements of a mold under a low clamping force. This serves to delay, from the time of filling a mold cavity, the moment at which the mold elements are subjected to full molding pressure. In effect, this provides a relatively short period in which the material is pre-warmed or heated and, of course, this period must be variable. Attention is now directed to a modification of the invention shown in Figs. 16 to 22 of the drawings. In Figs. 16, 17, and 18, an exterior portion of the base of a molding unit is shown. In Fig. 16, the crank arm **71** occupies the same position as it does in Figs. 2, 5, and 7. The roller **72** of this arm is intended to have a two-stage movement into its uppermost position, shown in Fig. 18, which is similar to Figs. 6, 8, and 11. Herein, a cam plate **116**, shown in dash line, is substituted for the plate **88** and has a first incline **117**, a flat step **118**, and a second incline **119**. Thus, as the turret revolves, the selector valve, by means of the arm **71**, is turned as a first step to a forty-five degree extent and, following a short distance of rotation of the turret, the arm **71** rotates the selector valve a full ninety degrees. It is with this step rotation that this modification is particularly concerned, and attention is now directed to Fig. 20.

With one exception, the shaft **68** of the selector valve is identical with the shaft previously described. This exception has to do with the passage of fluid through tube **56** to the return line **86**. In this modification, a passageway **120** is substituted for the passageway **78** previously described. The passageway **120**, at its ends, is of enlarged proportions to create pockets **121** which extend circumferentially of the shaft in opposite directions in the manner and substantially to the extent shown in the drawings. As may be seen in Figs. 19 and 20, passageway **120** is at right angles to passageways **58** and **61** and, thus, with the arm **71** in its lowermost position, there can be no flow of fluid from the top of the piston to the return line **86**. However, as the roller **72** rides up the incline **117** of cam plate **116** and onto the flat step **118**, the shaft **68** of the selector valve has rotated from the position shown in Fig. 16 to that of Fig. 17. In this latter figure (see also Fig. 21) it will be apparent that the beginnings of the pockets **121** register with passageways **58** and **61**. Thus, although fluid from the high pressure line **83** has not yet been admitted to the cylinder **49** beneath the piston **43**, pressure of fluid above the piston is now relieved and may commence flowing back into the return line **107**. It will be recalled that at all times during operation of the press, low pressure fluid from the accumulator is connected with the cylinder **49** beneath the piston **43**. Consequently, when high pressure above the piston is thus relieved, low pressure will force the piston upwardly and bring the elements of a mold into close proximity. The length of step **118** determines the length of time the mold elements are held closed under low pressure and, of course, this

time period may be increased or decreased by changing the length of the step. When the crank 71 moves up the further incline 119 to the position shown in Fig. 18, the selector valve shaft 68 will have rotated ninety degrees, with the passageway 120 remaining open. However, at this point, fluid from the high pressure line is now admitted to the cylinder 49 through passageway 79. The cam plate that serves to move the crank arm 71 into its lowermost position is the same as cam 89 already described. During this direction of rotation of the valve shaft 68, it is unimportant that the passageway 120 does not close immediately, inasmuch as it is only necessary to be fully closed by the time the passageways 76 and 77 register with their respective openings or passageways in the valve box.

Although applicant has shown and described only one form of his invention, together with a modification in the selector valve for preliminary relief of fluid pressure on the piston head of each molding unit, it will be understood that variations of the structure shown and described may be made and are contemplated insofar as such variations are within the spirit and scope of the annexed claims.

Having thus set forth my invention, what I claim as new and for which I desire protection by Letters Patent is:

1. In a molding machine having a rotatable turret, a plurality of molding units disposed radially about said turret, hydraulically operated mechanism for closing and opening the molding elements of each of said units, an external source of high pressure fluid entering said turret, an accumulator in said turret providing fluid under low pressure, a cylinder having a piston therein joined to one of the elements of each of said units, a valve for each of said units interposed between said cylinder and lines from said high pressure source and said accumulator, said valve having two sets of passageways, one of said sets being connected with said cylinder, the other of said sets being connected with said sources of fluid under high and low pressure, a rotatable shaft in said valve, further passageways in said shaft, said shaft being rotatable to connect certain passageways of said sets whereby to selectively present high pressure fluid to the top and bottom of said piston and to at all times present low pressure fluid to the bottom of said piston during operation of said machine.

2. In a molding machine having a rotatable turret, a plurality of molding units disposed radially about said turret, hydraulically operated mechanism for closing and opening the molding elements of each of said units, an external source of high pressure fluid entering said turret, an accumulator in said turret providing fluid under low pressure, a cylinder having a piston therein joined to one of the elements of each of said units, a valve for each of said units interposed between said cylinder and lines from said high pressure source and said accumulator, said valve having two sets of passageways, one of said sets being being connected with said cylinder, the other of said sets being connected with said sources of fluid under high and low pressure, a rotatable shaft in said valve, further passageways in said shaft, said shaft being rotatable to connect certain passageways of said sets whereby to selectively present high pressure fluid to the top and bottom of said piston and to at all times present low pressure fluid to the bottom of said piston during operation of said machine, and a safety valve consisting of a cylinder and a piston therein, connection of said high pressure fluid with said cylinder serving to hold said piston in a position to permit low pressure fluid from said accumulator to pass through said safety valve to the first mentioned cylinder when said high pressure fluid is above a given value.

3. In a molding machine having a rotatable turret equipped with a plurality of molding units, each of said units including a pair of complemental elements relatively movable into and out of molding relationship, a cylinder having a piston therein connected with one of said elements, a single line of high pressure fluid entering said turret, a low pressure accumulator within said turret, mechanism for controlling movement of said piston including a valve having multiple passageways therein, one of said passageways, when said valve is actuated in one direction, connecting the base of said cylinder with said accumulator, said one passageway permitting fluid, in relatively large volume, to effect any desired extent of movement of said piston in a direction to bring said elements into approximate molding relationship, another of said passageways simultaneously connecting the base of said cylinder with said high pressure fluid line to an extent to effect complete molding relationship of said elements, still another of said passageways, when said valve is actuated in the opposite direction, connecting the top of said cylinder with the high pressure fluid source whereby to effect separation of said pair of elements, a further of said passageways connecting the base of said piston with the source of said low pressure fluid, and a safety valve consisting of a cylinder and a piston therein, connection of said high pressure fluid with said cylinder serving to hold said piston in a position to permit low pressure fluid from said accumulator to pass through said safety valve to the first mentioned cylinder when said high pressure fluid is above a given value.

4. In a molding machine having a rotatable turret equipped with a plurality of molding units, each of said units including a pair of complemental elements relatively movable into and out of molding relationship, a cylinder having a piston therein connected with one of said elements, a single line of high pressure fluid entering said turret, a low pressure accumulator within said turret, mechanism for controlling movement of said piston including a valve having multiple passageways therein, one of said passageways, when said valve is actuated in one direction, connecting the base of said cylinder with said accumulator, said one passageway permitting fluid, in relatively large volume, to effect any desired extent of movement of said piston in a direction to bring said elements into approximate molding relationship, another of said passageways simultaneously connecting the base of said cylinder with said high pressure fluid line to an extent to effect complete molding relationship of said elements, still another of said passageways, when said valve is actuated in the opposite direction, connecting the top of said cylinder with the high pressure fluid source whereby to effect separation of said pair of elements, and a further of said passageways connecting the base of said piston with the source of said low pressure fluid, and other valve means in the high pressure line operable to prevent flow of fluid from said accumulator into said cylinder when the pressure in said high pressure line drops below a given value.

5. In a molding machine having a rotatable turret, a plurality of molding units disposed radially about said turret, hydraulically operated mechanism for closing and opening the molding elements of each of said units, an external source of high pressure fluid entering said turret, an accumulator in said turret providing fluid under low pressure, a cylinder having a piston therein joined to one of the elements of each of said units, a valve for each of said units interposed between said cylinder and lines from said high pressure source and said accumulator, a passageway in said valve providing continuous low pressure fluid to the base of said piston, means in said valve in one operative position connecting the base of said piston with said high pressure source, said means also serving to connect the top of said piston with a fluid return line, said means, in another operative position, connecting the base of said piston with said accumulator and the top of said piston with said high pressure source, and other means enabling fluid from the base of said piston to by-pass said accumulator and enter said fluid

return line when pressure in said accumulator attains a given value.

6. In a molding machine having a rotatable turret, a plurality of molding units disposed radially about said turret, hydraulically operated mechanism for closing and opening the molding elements of each of said units, an external source of high pressure fluid entering said turret, an accumulator in said turret providing fluid under low pressure, a cylinder having a piston therein joined to one of the elements of each of said units, a valve for each of said units interposed between said cylinder and lines from said high pressure source and said accumulator, said valve having two sets of passageways, one of said sets being connected with said cylinder, the other of said sets being connected with said high pressure source and said accumulator, a rotatable shaft in said valve, said shaft having further passageways for connecting certain passageways of said sets when said shaft is rotated whereby to selectively present high pressure fluid to the top and bottom of said piston and to at all times present low pressure fluid from said accumulator to the bottom of said piston during operation of said machine, and other valve means in said high pressure line operable to prevent flow of fluid from said accumulator to said cylinder when the pressure in said high pressure line drops below a given value.

7. In a molding machine having a rotatable turret, a plurality of molding units disposed radially about said



turret, hydraulically operated mechanism for closing and opening the molding elements of each of said units, an external source of high pressure fluid entering said turret, an accumulator in said turret providing fluid under low pressure, a cylinder having a piston therein joined to one of the elements of each of said units, a valve for each of said units interposed between said cylinder and lines from said high pressure source and said accumulator, said valve having two sets of passageways, one of said sets being connected with said cylinder, the other of said sets being connected with said high pressure source and said accumulator, a rotatable shaft in said valve, said shaft having further passageways for connecting certain passageways of said sets when said shaft is rotated whereby to selectively present high pressure fluid to the top and bottom of said piston and to at all times present low pressure fluid from said accumulator to the bottom of said piston, and other valve means in the high pressure line operable to prevent flow of fluid from the accumulator into said cylinder when the pressure in said high pressure line drops below a given value.

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