April 6, 1954 J. C. C. GREEN 2,674,230

AUTOMATIC HYDRAULIC CONTROL FOR MOLDING PRESSES AND THE LIKE

Filed June 27, 1950 2 Sheets-Sheet 1

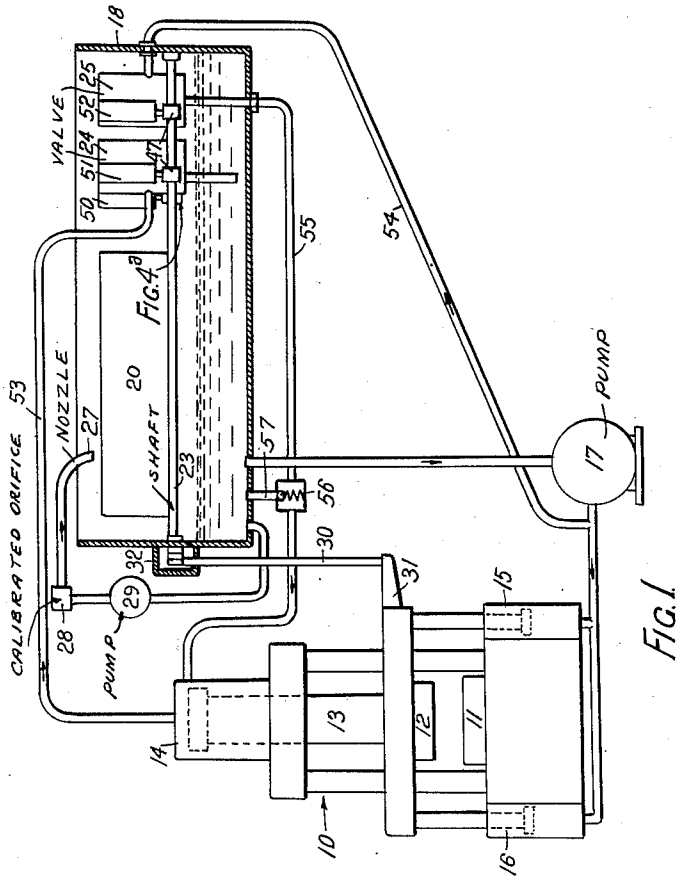


FIG. 1

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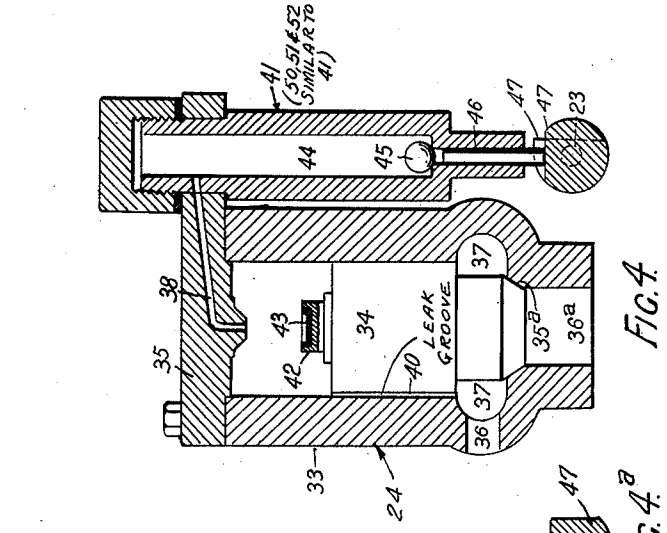


FIG. 4.

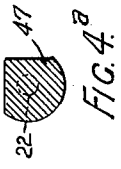


FIG. 4a

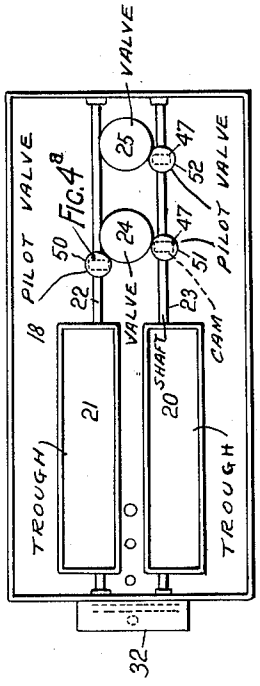


FIG. 2.

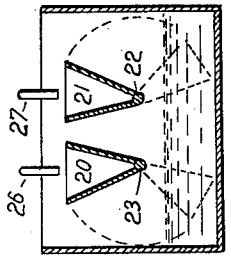


FIG. 3.

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UNITED STATES PATENT OFFICE

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AUTOMATIC HYDRAULIC CONTROL FOR MOLDING PRESSES AND THE LIKE

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Application June 27, 1950, Serial No. 170,532

8 Claims. (Cl. 121—38)

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The invention relates to hydraulic presses and more particularly to presses used in the production of articles by moulding from plastic materials.

The object of the invention is to provide a hydraulic valve and hydraulic control means whereby the operation of a press may be controlled automatically so that when used in conjunction with apparatus for automatically charging the moulds and ejecting the moulded articles from the press, a fully automatic moulding press may be produced.

According to the invention a hydraulic control valve for use in controlling the operation of a hydraulic press comprises a cylinder, a piston slidable therein, said piston having at one end a portion of reduced diameter, the piston and/or the cylinder being constructed to permit a fluid leak past said piston, an outlet from one end of the cylinder, valve means whereby said outlet may be opened or closed, a fluid outlet port in the other end of the cylinder, means on the reduced portion of the piston for closing the outlet port when the piston is at the extremity of its movement towards said other end of the cylinder and a fluid inlet port into said cylinder adjacent said other end.

Further according to the invention a hydraulic control system for automatically controlling the operation of a hydraulic press comprises a source of hydraulic power, a pair of hydraulic valves of the kind set forth in the last preceding paragraph, means for operating said valves whereby the outlet port of one valve is closed when that of the other is open and vice versa, a hydraulic connection between the ram cylinder of the press and the inlet port of one valve, a hydraulic connection between the ram cylinder and the outlet port of the other valve and a hydraulic connection between the said source of hydraulic power and the inlet port of the said other valve, timing means for actuating said operating means whereby hydraulic pressure is alternately applied to and released from the ram cylinder at regular predetermined intervals.

In order that the invention may be more easily understood and put into practice a preferred embodiment thereof is hereinafter described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of a hydraulic press together with its associated hydraulic control means.

Fig. 2 is a diagrammatic plan view of the contents of the tank 18 of Fig. 1.

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Fig. 3 is a diagrammatic end view of the contents of the tank 18 of Fig. 1.

Fig. 4 is a part sectional view of a hydraulic control valve constructed according to the invention.

Fig. 4a is a sectional view of a pilot valve operating cam.

In Fig. 1 a hydraulic moulding press is indicated generally at 10 and consists of a fixed lower die 11 and a movable upper die 12. The upper die is controlled by the main ram 13 which is operated hydraulically by the application of pressure within the ram cylinder 14. Two additional smaller lifting rams 15 and 16 are provided to raise the upper die 12 at the completion of each moulding operation. Hydraulic pressure is supplied by the pump 17 which draws fluid from the tank 18. The construction of the press and pump follow normal lines and will not therefore be described in any further detail.

The essential apparatus for controlling the press is contained within the tank, the contents of which will be described with reference to Figs. 2, 3, 4 and 4a as well as Fig. 1. Within the tank are mounted two tipping troughs 20 and 21; these are attached to shafts 22 and 23 which are journalled in bearings at each end of the tank. The troughs 20 and 21 constitute a timing device for controlling the operation of the hydraulic control valves 24 and 25 which are constructed in the manner shown in Fig. 4. The method of operation of the troughs is as follows: a stream of hydraulic fluid flows continually at a predetermined rate from the nozzles 26 and 27. As shown in Fig. 1 fluid is pumped by pump 29 through a calibrated orifice 28 to nozzle 27. When the troughs are in the position shown in full lines in Fig. 3 fluid flows into them; they are, however, so arranged that as they fill with fluid the centre of gravity of each gradually moves sideways until the trough overbalances and falls to the position shown in dotted lines in Fig. 3. As the troughs fall their contents are spilled into the tank and the shafts 22 and 23 are rotated; shafts 22 and 23 carry cams which operate valves 24 and 25 in a manner to be described below, whereby when valve 24 is open valve 25 is closed and vice versa.

The troughs are returned to an upright position each time the upper die 12 is raised after the completion of a moulding operation. This is effected by means of a mechanical connection represented by the rod 30 between the horizontal member 31 of the press and a system of levers arranged at the ends of the shafts 22 and 23

contained in the casing 32. During their return to the upright position the troughs rotate shafts 22 and 23 to return valves 24 and 25 to their original positions.

Valves 24 and 25 are constructed as shown in Fig. 4. Each valve consists of a cylinder 33 in which a floating piston 34 is slidable. One end of the cylinder is closed by a cover 35 the other end forming a frusto-conical seating 35a which in conjunction with the end of piston 34 provides a means for closing an exit port 36a. An inlet port 36 leads into an annular chamber 37 surrounding the lower end of the piston 34. The passage 38 connects the upper end of the cylinder 34 with the chamber of a pilot valve 41. At the top of the piston 34 is mounted a leather washer 42 held in place by the circlip 43 so as to seal the entrance to passage 38 when the piston 34 is in a fully raised position; this seal is not really necessary in the case of valve 24. A leak groove 40 is formed in the side of the piston 34 and extends throughout its length.

The pilot valve 41 consists of a chamber 44, the lower end of which forms a seat for the ball 45. A pin 46 is a loose fit in and is slidable in the restricted bore at the lower end of the chamber 44. Pin 46 rests on cam 47.

Both valves 24 and 25 are of similar construction with the exception that valve 24 is provided with two pilot valves identical with pilot valve 41 of Fig. 4. The arrangement is shown clearly in Fig. 2 where valve 24 is shown as having two pilot valves 50 and 51 and valve 25 has one pilot valve 52. Shaft 23 carries two cams similar to cam 47 shown in Fig. 4, arranged to operate pilot valves 51 and 52. Shaft 22 carries one cam of the shape shown in Fig. 4a, arranged to operate pilot valve 50.

The method of operation of the valves is as follows. If hydraulic fluid under pressure is supplied through line 54 via port 36 to the annular space 37 the piston 34 will be lifted to allow fluid to escape through port 36a to line 55. The piston will then take up a position of balance according to the relative rates of inflow and outflow of the fluid. Owing, however, to the existence of the leak groove 40 fluid will gain entrance to the part of the cylinder above piston 34, and, assuming the ball 45 is on its seat, will act over the whole area of the top of the piston to force the piston 34 downwardly onto the frustro-conical seating 35a thus closing port 36a. If the pilot valve 41 (50, 51 and 52) is now opened by raising ball 45 fluid will escape past the pin 46 the piston 34 will rise and then take up the position of balance mentioned above owing to the removal of pressure from the upper surface of the piston.

Should pressure build up at the lower end of the piston 34 due to conditions in the hydraulic circuit to which it is connected, it will force the piston upwards and maintain it in that position, the entrance to the passage 38 being sealed by the washer 43 and thus preventing fluid from leaking from port 36 via groove 40 and out of the cylinder through the open ball valve of the pilot valve. The arrangement is such that when the ball 45 of the pilot valve is held up the piston 34 is raised and vice versa.

If when in this condition the pilot valve 41 (50, 51 and 52) is closed and the pressure at the lower end of piston 34 released the piston will fall.

Turning again to Fig. 1 and assuming that the upper die 12 has just been raised to its highest position and that the troughs 20 and 21 have been raised to the upright position through the action of the rod 30 then valve 24 will be closed, that is to say its piston will be in the down position, and valve 25 will be open. With this arrangement the exit from the ram cylinder 14 via pipe 53 and valve 24 will be sealed and fluid under pressure will be fed from pump 17 via pipe 54 valve 25 and pipe 55. Pressure is also supplied to the lifting rams 15 and 16 but as these are very much smaller in area than the main ram 13, their effect, though in opposition to the main ram, will be small.

As is explained above the valve 25 is opened by pressure building up at the lower end of piston 34 provided ball 45 of its pilot valve 52 is unseated. This is due to the build-up of pressure in the ram cylinder. For a short time after the opening of valve 25 the pressure in lines 54 and 55 will be low and the upper die 12 and ram will tend to fall under their own weight; to ensure a supply of fluid to the ram cylinder during this time a check valve 56 is provided in pipe 55 and is connected to the fluid in the tank, by pipe 57, whence fluid may be sucked by the descending ram.

With the valves in the position described the upper die 12 will descend under pressure to effect the moulding operation. The charging of the moulds will have been effected during the previous upward movement of die 12.

The moulding operation is continued until the trough 20 has been filled with fluid and has overbalanced to rotate shaft 23 thus opening valve 24 and closing valve 25. (The purpose and effect of the overbalancing of trough 21 will be described below.) As soon as this happens the supply of fluid under pressure to the ram cylinder via valve 25 is cut off and the fluid is able to escape from the ram cylinder via pipe 53 and valve 24. Pressure continues to be applied to the lifting rams 15 and 16 which then raise the upper die 12 and a new cycle of operations commences.

During the molding operation gases are generated within the closed dies and it is desirable that these should be allowed to escape during the operation. This is effected by means of trough 21 and pilot valve 50. The flow of fluid into trough 21 is so adjusted that the trough overbalances some time before trough 20, that is to say, during the moulding operation. The overbalancing of trough 21 rotates shaft 22 and the cam shown in Fig. 4a acts on pilot valve 50. The cam is so shaped that pilot valve 50 is normally closed but during the partial rotation of shaft 22 it is momentarily opened and then closed again. The effect of this is to open the valve 24 momentarily and thus allow some fluid to escape from the ram cylinder 14. This momentarily releases the pressure on die 12 and allows gases formed in the die to escape. As soon as valve 24 closes pressure is reapplied to ram 13 to complete the moulding operation.

It is contemplated that the invention will be employed in conjunction with means for automatically charging the moulds and means for ejecting the moulded articles therefrom which come into operation during the upward movement of die 12.

What I claim is:

1. A hydraulic control system for automatically controlling the operation of a hydraulic press, comprising a source of hydraulic power; a hydraulic control valve consisting of a cylinder

and a piston slidable therein, said piston having at one end a portion of reduced diameter, means to permit a fluid leak past said piston, an outlet from one end of the cylinder, valve means whereby said outlet may be opened or closed, a fluid outlet port in the other end of the cylinder, means on the reduced portion of the piston for closing the outlet port when the piston is at the extremity of its movement towards said other end of the cylinder and a fluid inlet port into said cylinder adjacent said other end, a hydraulic connection between the ram cylinder of the press and the inlet port of said valve, a hydraulic connection between said source of hydraulic power and the ram cylinder, means for operating said valve means controlling the outlet and timing means connected thereto to close said valve means and after a predetermined interval to open same thus causing said piston to be lowered and then raised thereby applying pressure from said source of hydraulic power to said ram cylinder and releasing it therefrom after said predetermined interval.

2. A hydraulic control system for automatically controlling the operation of a hydraulic press, comprising a source of hydraulic power, a hydraulic control valve consisting of a cylinder and a piston slidable therein, said piston having at one end a portion of reduced diameter, means to permit a fluid leak past said piston, an outlet from one end of the cylinder, valve means whereby said outlet may be opened or closed, a fluid outlet port in the other end of the cylinder, means on the reduced portion of the piston for closing the outlet port when the piston is at the extremity of its movement towards said other end of the cylinder and a fluid inlet port into said cylinder adjacent said other end, a hydraulic connection between the ram cylinder of the press and the inlet port of said valve, a hydraulic connection between said source of hydraulic power and the ram cylinder, means for operating said valve means controlling the outlet and timing means connected thereto to close said valve means and after a predetermined interval to open same thus causing said piston to be lowered and then raised thereby applying pressure from said source of hydraulic power to said ram cylinder and releasing it therefrom after said predetermined interval.

3. A hydraulic control system for automatically controlling the operation of a hydraulic press comprising a source of hydraulic power, a first hydraulic valve and a second hydraulic valve each consisting of a cylinder and a piston slidable therein, said piston having at one end a portion of reduced diameter, means to permit a fluid leak past said piston, an outlet from one end of the cylinder, valve means whereby said outlet may be opened or closed, a fluid outlet port in the other end of the cylinder, means on the reduced portion of the piston for closing the outlet port when the piston is at the extremity of its movement towards said other end of the cylinder and a fluid inlet port in said cylinder adjacent said other end, a hydraulic connection between the ram cylinder of the press and the inlet port of the first valve, a hydraulic connection between the ram cylinder and the outlet port of the second valve, a hydraulic connection between the source of hydraulic power and the inlet port of the second valve, timing means, means actuated by said timing means for operating the valve means controlling the outlets of each of said hydraulic valves which is moved by said timing means from a first position in which the outlet of the first valve is open and that of the second valve is closed to a second position in which the outlet of the first valve is closed and that of the second valve is open at the termination of the opening of the dies of the press and after a predetermined interval is returned to the first position, whereby hydraulic pressure is applied to the ram of the press for a predetermined period and thereafter released.

4. A hydraulic control system as claimed in claim 3 wherein the said first hydraulic valve has on the piston thereof sealing means for sealing the outlet from the said one end of the cylinder when the piston is at the extremity of its movement towards that end.

5. A hydraulic control system as claimed in claim 3 wherein the means actuated by the timing means comprises a cam shaft carrying a pair of cams each cam being arranged to act on the valve means controlling the outlet of one of said hydraulic valves to open and close the outlet.

6. A hydraulic control system as claimed in claim 3 wherein the means actuated by the timing means comprises a cam shaft carrying a pair of cams each cam being arranged to act on the valve means controlling the outlet of one of said hydraulic valves to open or close the outlet, and said timing means comprises a container mounted on the cam shaft, a supply of liquid directed to flow into said container at a predetermined rate, the container being so shaped and mounted that when the level of the liquid in it reaches a given height the container overbalances and in doing so partially rotates said cam shaft, means being provided for returning the container to an upright position in timed relation with the operation of the press, the said predetermined interval being fixed by the time taken by the container to overbalance.

7. A hydraulic control system as claimed in claim 3 wherein the means actuated by the timing means comprises a cam shaft carrying a pair of cams each cam being arranged to act on the valve means controlling the outlet of one of said hydraulic valves to open and close the outlet, and said timing means comprises a container mounted on the cam shaft, a supply of liquid directed to flow into said container at a predetermined rate, the container being so shaped and mounted that when the level of the liquid in it reaches a given height the container overbalances and in doing so partially rotates said cam shaft, the container being returned to its upright position by means of a mechanical connection with a moving portion of the press at the termination of the opening of the dies, the said predetermined interval being fixed by the time taken by the container to overbalance.

8. A hydraulic control system as claimed in claim 3 wherein the said second hydraulic valve is provided with a second valve means whereby the outlet thereof may be opened or closed, a second means for operating said second valve means and a second timing means connected thereto, the said second timing means being set in operation at the termination of the opening of the dies of the press to act after a predetermined interval, at a moment during the time pressure is being applied to the dies, to operate said second valve means to open said second hydraulic valve momentarily whereby pressure is released from the said dies allowing them to separate

momentarily and thus permit the escape of gas generated during the operation.

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