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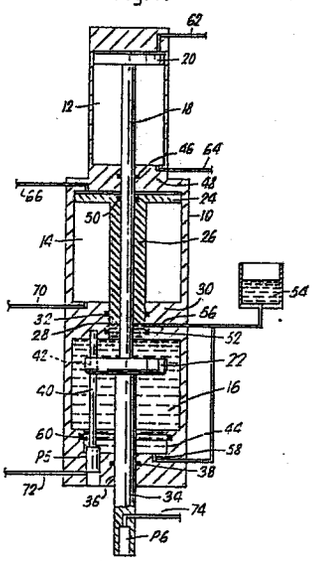
(54) A ram for a press.

(57) A ram for a press, comprising an hydraulic piston and cylinder arrangement (10,22) which is operated by the application of pressure to hydraulic fluid in a region of the hydraulic chamber (16) within the cylinder (10) which is on one side of the piston (22). Hydraulic fluid is free to flow into and out of the said region until the hydraulic piston (22) nears the end of its stroke. The bottom end (44) of the chamber (16) is narrowed, to cut off such flow at that point, so that subsequent application of pressure to the hydraulic fluid in the said region effects a movement of the hydraulic piston (22) under the full operating force of the arrangement (10,22).

Fig.1.



EP 0 285 435 A2

Description

A ram for a press

The present invention relates to a ram for a press, in which the full force of the ram can only be exerted when the ram approaches the end of its stroke.

Such a press is described in our EP-A- 0 076 556. The ram in that earlier construction is an hydraulic ram, and the means used to effect switching, so that the full force of the ram cannot be exerted until it approaches the end of its travel, is electrical. Risks may be incurred during its use therefore owing to electrical failure, such as short circuiting. The present invention seeks to avoid this drawback.

Accordingly, the present invention is directed to a ram for a press, comprising an hydraulic piston and cylinder arrangement which is operated by the application of pressure to hydraulic fluid in a region of the hydraulic chamber within the cylinder which is on one side of the piston, in which hydraulic fluid is free to flow into and out of the said region until the hydraulic piston nears the end of its stroke, means being provided to cut off such flow at that point, so that subsequent application of pressure to the hydraulic fluid in the said region effects a movement of the hydraulic piston under the full operating force of the arrangement.

Thus it will be appreciated that the full operating force of the ram can only be applied when the hydraulic piston and cylinder arrangement is about to bottom out, preferably within say 4 mm of the end of its stroke, 4 mm being a distance which is sufficient to clinch a hank bush for example but too small for a finger to get caught in.

One way of cutting off such flow of hydraulic fluid into and out of the said region of the hydraulic chamber is to have one end thereof narrowed, with the cross-section of the hydraulic piston corresponding precisely with the cross-section of the chamber at that narrowed end. Therefore, when the piston reaches that end, hydraulic fluid can no longer pass into the said region through the annulus defined between the periphery of the piston and the larger diameter of the chamber.

A second way of preventing such flow is to have a passageway which communicates with the said region of the hydraulic chamber, the communication therewith being cut off when the pneumatic piston is near the end of its stroke.

Both ways of preventing such flow may be present in the same ram.

In one advantageous construction that is particularly adapted for pneumatic switching, the hydraulic piston and cylinder arrangement is part of a pneumatic/hydraulic intensifier in which operation of the pneumatic piston and cylinder arrangement is used to apply pressure to the said region of the hydraulic chamber. Preferably, a pneumatic piston rod or sleeve which is urged into the said region to apply such pressure covers an hydraulic fluid inlet/outlet of the said region when the pneumatic piston and cylinder arrangement is operated. Pneumatic switching may be provided to ensure that the pneumatic piston does not commence its stroke until the hydraulic piston is near the end of its stroke.

A particularly effective construction is obtained if the pneumatic piston and cylinder arrangement is juxtaposed with the hydraulic piston and cylinder arrangement, with the piston rod or sleeve of the pneumatic piston and cylinder arrangement extendable into the said region of the hydraulic piston and cylinder arrangement. An auxiliary pneumatic piston and cylinder arrangement may then be juxtaposed to the main one, with the piston rod of the auxiliary arrangement extending through that of the main one to the piston of the hydraulic arrangement. The auxiliary arrangement may then be used to move the hydraulic piston under a relatively weak force that could not cause injury, up to a position near the end of its travel, where cut off of the flow into or out of the said region occurs, whereafter the main pneumatic piston and cylinder arrangement can be effective in moving the hydraulic piston through the remainder of its travel. This enables the ram to have a large overall movement but only a short full-power drive.

A further aspect of the present invention is directed to a ram comprising a pneumatic piston and cylinder arrangement juxtaposed with an hydraulic piston and cylinder arrangement, with the piston rod of the pneumatic piston and cylinder arrangement extendable into the hydraulic chamber of the hydraulic piston and cylinder arrangement to operate the latter arrangement.

The pneumatic switching may comprise a switch provided in the ram, for example in the hydraulic piston rod thereof, which switch is triggered in the event that the latter experiences a resistance to the force exerted by the ram, for example, owing to the operator's hand being accidentally trapped between a punch of a press of which the ram forms a part, and an anvil thereof. This switch may be connected to pneumatic circuitry to cause "flyback" of the ram, in which the main piston rod is retracted. A second pneumatic switch may be provided which is triggered when the hydraulic piston is within a few millimetres of bottoming out. This second pneumatic switch inhibits the "flyback" action. The effect of the first and second switches is too ensure that full pressure can be exerted by the ram only when there is a few millimetres travel remaining before the ram bottoms out, this gap being too small for an operator's finger to be caught in.

An example of a ram made in accordance with the present invention is illustrated in the accompanying drawings, in which :

Figure 1 is a diagrammatic axial sectional view through the ram; and

Figure 2 shows pneumatic circuitry used with the ram.

The ram shown in Figure 1 comprises a housing 10 defining an upper low pressure pneumatic chamber 12, a lower pneumatic high pressure chamber 14, and an hydraulic chamber 16. A connecting shaft 18 is fixed to and interconnects an upper pneumatic

piston 20 within the upper pneumatic chamber 12 and an hydraulic piston 22 in the hydraulic chamber 16. Consequently, downward movement of the piston 20 causes downward movement of the piston 22. The shaft 18 extends through the centre of the second pneumatic chamber 14 which is between the upper chamber 12 and the hydraulic chamber 16. A second pneumatic piston 24 within the second pneumatic chamber 14 is provided with a sleeve 26 which is coaxial with the shaft 18 and is sufficiently long to extend from the piston 24 when the latter is in its uppermost end of travel to a central aperture 28 in the dividing wall 30 between the second pneumatic chamber 14 and the hydraulic chamber 16 where an O-ring seal 32 stops fluid passing between those two chambers. A lower main piston rod 34 extends from the underside of the hydraulic piston 22 and out through an axial aperture 36 in the bottom end of the housing 10. That aperture is also sealed by means of an O-ring 38 to prevent leakage of hydraulic fluid from the hydraulic chamber 16.

A guide rod 40 extends through the hydraulic chamber 16 parallel to the axis of the ram. It also passes through an aperture 42 through the piston 22 to prevent the latter, and also to prevent the piston rod 34, from rotating. A normally open pneumatic limit switch P5 is provided at the lower end of the guide rod 40 and is engaged by the hydraulic piston 22 when the latter is within a few millimetres of the lower end of its travel. A further pneumatic switch, in this case a normally closed pneumatic "flyback" sensor switch P6, is provided in the piston rod 34, and is operated when the latter experiences a resistance to movement owing to an obstruction between a punch (not shown) at the bottom end of the shaft 34 and a fixed anvil (not shown). The hydraulic chamber 16 is narrowed at its bottom end 44 where its cross-section corresponds to that of the hydraulic piston 22.

A further O-ring seal 46 is provided in a dividing wall 48 between the upper and lower pneumatic chambers 12 and 14. There is also an O-ring seal 50 between the shaft 18 and the second pneumatic piston 24 and a further O-ring seal 52 in the aperture 28 at a lower end thereof which engages the sleeve 26 when the piston 24 is depressed.

The hydraulic chamber 16 is filled with hydraulic fluid and is provided with an hydraulic fluid reservoir 54 connected via an inlet/outlet 56 to an upper part of the hydraulic chamber 16, and via inlet/outlet 58 to a bottom part of the hydraulic chamber 16. The upper inlet/outlet 56 opens out into the aperture 28 at a position between the O-ring seals 32 and 52. It is therefore closed by the lower end of the sleeve 26 when the pneumatic piston 24 is depressed.

A further O-ring seal 60 is provided around the narrowed end 44 of the hydraulic chamber 16 which is engaged by the piston 22 when the latter is at the lower end of its travel.

The following pneumatic inlet/outlets to the various parts of the ram are illustrated in Figure 1: inlet/outlet 62 to the upper end of the pneumatic chamber 12; inlet/outlet 64 to the lower end of that chamber; inlet/outlets 66 to the upper end of the pneumatic chamber 14; an inlet/outlet 70 to the lower end of the pneumatic chamber 14; and finally inlet/outlets 72 and 74 to the pneumatic limit switch P5, and the pneumatic "flyback" sensor switch P6, respectively.

Referring now to Figure 2, the pneumatic circuitry which controls operation of the ram comprises a pressurized air source 100 connected, via a gauge and relief valve assembly 110, to a foot pedal valve 118 by which air under pressure may be passed selectively to one of two passageways connected respectively to a first input of a pneumatic mains OR element 120 and to a first input of an AND element 160 the output of which is connected to an input of a pulse former element 122. A line from the latter connects it to a first input of an AND element 124, an output of which is connected to a first control input of a 5/2 valve 125 operable to connect selectively one of two lines to pressure and the other to exhaust. One of those two lines is connected, via a quick exhaust valve 128, to the inlet/outlet 62 of the ram, and the other is connected, via a bleed valve 130 to a first input of a normally open 3/2 valve 161 an output of which is connected to the inlet/outlet 64 to the lower end of the chamber 12.

The outlet from the OR element 120 is connected to a first input of a further OR element 132, an only outlet from which is connected to a second control input of the 5/2 valve 125. The second input of the OR element 132 is connected, via a first input of an AND element 136, to receive pressure from a leak sensor relay 134. Operation of the pneumatic switch P6, so that the inlet/outlet 72 is connected to exhaust in the event of the switch being operated, triggers the leak sensor relay 134 so that it no longer applies pressure through its only outlet, by virtue of a connection of a negated input of the relay 134 to the switch P6. That outlet is also connected to a first input of an AND element 138 an only output of which is connected, via a selector valve 142, to a first input of an AND element 162 the only output of which is connected to a first control input of a second 5/2 valve 144. The second input of the AND element 138 is connected, via a first input of a second leak sensor relay 146, to the inlet 74 of the pneumatic limit switch P5. The second input of the AND element 138 is also connected to second, negated, inputs of the AND element 136 and the AND element 124. A second input to the leak sensor relay 146 is connected to a point between elements 122 and 160. From that line a connection also passes to the operating input of the 3/2 valve 164. A second control input to the 5/2 valve 144 is taken from a point between elements 125 and 130. The 5/2 valve 144 operates to connect selectively one of two outputs thereof to pressure, with the other one being connected to exhaust. One output leads to a quick exhaust valve 165 and one to the cylinder input 66. Its other line feeds the first input of the 3/2 valve 164 and via a quick exhaust valve 148, the cylinder input 70. An hydraulic pressure device sensing element 163 with a connection from the hydraulic chamber 16 of Figure 1 actuates a normally-open held-closed microvalve within the element 163. The input to this valve is connected to the main air supply to the relief valve assembly 110. The output from this valve, providing a

signal when there is a rise in hydraulic pressure and having an adjustable pressure range, is connected to a second input of the OR element 120.

The ram operates as follows :

The circuit is drawn with the selector valve 142 in a press SET mode which allows the operator to close the press and make a depth adjustment setting. The normally closed "flyback" sensor switch P6 remains fully effective during this procedure.

Actuation of the foot pedal valve 118, causes operation of the ram. When depressed, air is directed to the pulse former element 122 which transmits only a pulse of air via the NOT input of the AND element 124 to the 5/2 valve 125. This valve consequently changes its state and air is removed from the line to inlet/outlet 64 and now passes to the low pressure chamber via inlet/outlet 62 causing the piston rod 34 to start its downstroke in a first stage of a sequence of operation of the ram. The air in this line to inlet/outlet 62 is reduced in pressure by the regulator 126. The exhausting air from inlet/outlet 64 is also controlled by the bleed valve 130. These adjustments allow the downstroke of the press to be set for a given speed of closure and a given low force for operator safety.

Should an obstruction be sensed by the switch P6, the latter is changed to its open condition. Consequent leakage to atmosphere causes the leak sensor relay element 134 to pass a mains air signal via the AND element 136 and the OR element 132 to change the state of the 5/2 valve 125. This causes the low pressure piston 20 to rise and retract the piston rod 34. Exhausting air from inlet/outlet 62 is discharged rapidly to atmosphere by the quick exhaust valve 128 and adds to the speed of retraction.

If the state of the selector valve 142 is changed, the circuit is put into a PRESS mode. Actuation of the foot pedal 118 now repeats the sequence as for the SET mode, but high pressure stages of the circuit are now primed to operate. When the hydraulic piston 22 enters the narrowed end 44 of the chamber 16 it engages the hydraulic seal 60. Any hydraulic fluid now trapped below the piston 22 can be by-passed to the oil reservoir 54. During the downstroke, air is bled to atmosphere via the normally open limit switch P5 and the leak sensor relay element 146 from the line which is connected between the AND element 160 and the pulse element 122. As can be seen from the circuit, mains air pressure is directed from the foot valve 118 to the OR element 120, and also to the OR element 132 and thence to the 5/2 valve 125. The press cannot be made to close until these air feeds are removed, that is to say until the foot pedal is depressed.

To ensure the correct sequence of the three stages, the switch P5 must be operated before the switch P6. If by incorrect adjustment this does not happen it follows that the "flyback" switch P6 will signal the return of the press to its UP position and no power stroke will take place.

Whenever the switch P5 is closed a signal is generated by the leak sensor relay element 146 and is diverted three ways. A signal to the AND element 136 via its negated input inhibits any further signals from the "flyback" switch P6 thus preventing a return stroke. Secondly, a signal to the negated input of the AND 124 inhibits further signals in the foot pedal circuit. This is purely a safety feature to ensure that, should the switch P5 remain mechanically closed, then a further operation of the press is prevented. Thirdly, a signal is directed to the second input of the AND element 138.

Now that the AND element 136 is inhibited, a signal is also received at the second input of the AND element 138. When there are signals at both inputs of the AND element 138, the air feed passes through the open selector valve 142 and the AND element 162 and changes the state of the 5/2 valve 144. This results in high pressure air being directed to the inlet/outlet 66 and air is exhausted rapidly from the inlet/outlet 70 to atmosphere via the quick exhaust valve 148. This helps to ensure a very fast downstroke of the high pressure air piston 24. During downward travel of the piston 24, its sleeve 26 passes through the seal 52 and effectively cuts off the hydraulic fluid feed from the reservoir 54.

The hydraulic chamber 16 is now sealed and the continued downward movement of the piston 24 begins to generate a rise in hydraulic fluid pressure owing to penetration of the sleeve 26 into the chamber 16. This increase in pressure acts on the upper main surface of the hydraulic piston 22 which by this time has almost reached the full extent of its travel. With the press correctly set for rivet fasteners, for example, the amount of movement left is just sufficient to close a fastener into sheet metal before it reaches bottom. This concludes the third stage.

The formula for calculating the full force exerted by the ram is given by the product of the maximum air pressure in the pneumatic chamber 14, the ratio of the pneumatic piston 24 cross-sectional area to that of the sleeve 26, and the cross-sectional area of the hydraulic piston 22. Control of the force developed is by means of the pressure sensing element 163. By sensing the hydraulic oil pressure developed by the pneumatic piston 24 the pressure valve 163 opens the microvalve of the sensor element 163 at its preset setting. A mains pressure air signal is directed via the OR element 120 and also via the OR element 132 to the 5/2 valve 125. The changeover of this valve passes air to the port P2 and at the same time a signal from this line is directed to the input port of the 5/2 valve 144 and also to the negated input of the AND element 162 thereby removing the signal feed to the other input port of the 5/2 valve 144. This valve can now change over and air passes to the 3/2 valve 164 which is now open and via line 70 to the cylinder port P4. Both cylinders now return to the up position, and the press opens. The 3/2 valve 164 is caused to open because of the mains signal originating from the junction between elements 160 and 122 when the foot pedal 118 is depressed. This line also feeds the leak relay 146. It follows that when the press has completed its sequence this signal will disappear when the foot pedal is released and allows the 3/2 valve 164 to return to its normal state, consequently exhausting the air in the cylinder 14 to atmosphere.

This feature ensures that no pressurised air can penetrate the seals and seep into the oil chamber when the machine is at rest for long periods of time. The circuit now assumes its "at rest" state and the food pedal must be actuated to effect a further sequence.

As stated previously the circuit is drawn in the SET condition, and the conditions arising when PRESS is selected have also been described. A three-position selector switch 180 enables DAYLIGHT SET to be selected and in this mode a 3/2 valve 165 is opened. This valve obtains its air supply from the incoming air at 110 and is passed two ways: one to the negated input of the AND element 160 thus preventing further signals from the foot pedal 118 and one to the signal input of the 3/2 valve 161. This valve now changes over to exhaust the air from the cylinder 12 to atmosphere. This feature allows the daylight adjustment of the press to be made without the disadvantage of air pressure acting on the piston 20. On switching back to SET or PRESS air is immediately redirected to the cylinder 12 and the circuit to its normal state.

It is possible for the two feed lines to the switches P5 and P6 to be damaged, especially if they are external. However, it is a safety feature of the ram that if the line to the switch P6 is cut or disconnected, air is released which is the same condition as when the "flyback" switch P6 is opened. The piston rod 34 therefore retracts and will not descend until the connection is made good.

If the line to the switch P5 is cut or disconnected, no power stroke can be generated because it needs to be blocked to satisfy the AND condition in the element 138. The ram would then only operate in the SET mode.

The fact that the hydraulic piston only engages at the end of its stroke ensures that high pressure is only generated over a short distance.

A complete list of safety features of the illustrated ram now follows.

1. No power stroke can be generated with the machine "at rest".
Reason: The foot pedal maintains a continuous signal to both 5/2 valves.

2. No power stroke can be generated by a 5/2 valve.
Reason: As for 1 immediately above. Also, the initiating signal is only a pulse and has to "reset" after being operated once.

3. No power stroke can be generated until the machine is downstroking.
Reason: The feed signal is taken from the air line from the foot pedal 118. This ensures that the switch P5 is only primed when needed.

4. No power stroke is generated until both switches P5 and P6 are operated.
Reason: The AND element 138 provides a single signal from those two sources.

5. No power stroke is generated if the switch P5 is disconnected.
Reason: The conditions of the AND element 138 are not satisfied.

6. No power stroke or downstroke is possible if the switch P6 is disconnected.
Reason: The leak relay 134 immediately passes a signal to the 5/2 valve 144 thereby inhibiting a downstroke. The conditions of the AND element also apply.

7. No power stroke is generated if the machine is in its SET mode.
Reason: The selector valve 142 isolates the power stroke signal to the 5/2 valve 144.

8. No repeat power stroke is generated if the switch P5 stays blocked after the machine has been operated.
Reason: should this happen a signal is also directed to the negated input of the AND element 136 in the foot pedal circuit. This inhibits the signal to the 5/2 valve.

9. No repeat power stroke is generated if the foot pedal remains depressed.
Reason: The pulse element 122 cannot be recharged until the pedal is released.

10. The flyback switch P6 is failsafe.
Reason: The valve must remain blocked until after the switch P5 is operated. If it should leak then the effect is the same as though the switch P6 had been disconnected, as set out in feature 6 above. In operation the valve is forced to "open" to achieve a signal for a quick reversal of the downstroke. The speed of the return is assisted by the quick exhaust valve 128 in the circuit.

Claims

1. A ram for a press, comprising an hydraulic piston and cylinder arrangement (10,22) which is operated by the application of pressure to hydraulic fluid in a region of the hydraulic chamber (16) within the cylinder (10) which is on one side of the piston (22), characterised in that hydraulic fluid is free to flow into and out of the said region until the hydraulic piston (22) nears the end of its stroke, means (44) being provided to cut off such flow at that point, so that subsequent application of pressure to the hydraulic fluid in the said region effects a movement of the hydraulic piston (22) under the full operating force of the arrangement (10,22).

2. A press according to claim 1, characterised in that the said means (44) are so constructed as to bring about such cut off when the hydraulic piston and cylinder arrangement (10,22) is about to bottom out, with the distance of available travel remaining being less than the width of an operator's finger.

3. A press according to any preceding claim, characterised in that the said means (44) comprise a narrowed end (44) of the hydraulic chamber (16), with the cross-section of the hydraulic piston (22) corresponding precisely with the cross-section of the chamber (16) at that narrowed end (44).

4. A press according to claim 1 or claim 2, characterised in that the said means comprise a

passageway which communicates with the said region of the hydraulic chamber (16), the communication therewith being cut off when the pneumatic piston 22 is near the end of its stroke.

5. A press according to claim 3 and claim 4, both means for cutting off such flow being present.

6. A press according to any preceding claim, characterised in that the hydraulic piston and cylinder arrangement (10,22) is part of a pneumatic/hydraulic intensifier in which operation of the pneumatic piston and cylinder arrangement (14,24,26) is used to apply pressure to the said region of the hydraulic chamber (16).

7. A press according to claim 6, characterised in that a pneumatic piston rod or sleeve (26) which is urged into the said region to apply such pressure covers an hydraulic fluid inlet/outlet (56) of the said region when the pneumatic piston and cylinder arrangement (14,24,26) is operated.

8. A press according to claim 7, characterised in that pneumatic switching is provided to ensure that the pneumatic piston (24) does not commence its stroke until the hydraulic piston (22) is near the end of its stroke.

9. A press according to any one of claims 6 to 8, characterised in that the pneumatic piston and cylinder arrangement (14,24,26) is juxtaposed with the hydraulic piston and cylinder arrangement (10,22), with the piston rod or sleeve (26) of the pneumatic piston and cylinder arrangement (14,24,26) extendable into the said region of the hydraulic piston and cylinder arrangement (10,22).

10. A press according to claim 9, characterised in that an auxiliary pneumatic piston and cylinder arrangement (12,18,20) is juxtaposed to the main one, (14,24,26) with the piston rod (18) of the auxiliary arrangement (12,18,20) extending through that (26) of the main one (14,24,26) to the piston (22) of the hydraulic arrangement (10,22).

Fig.1.

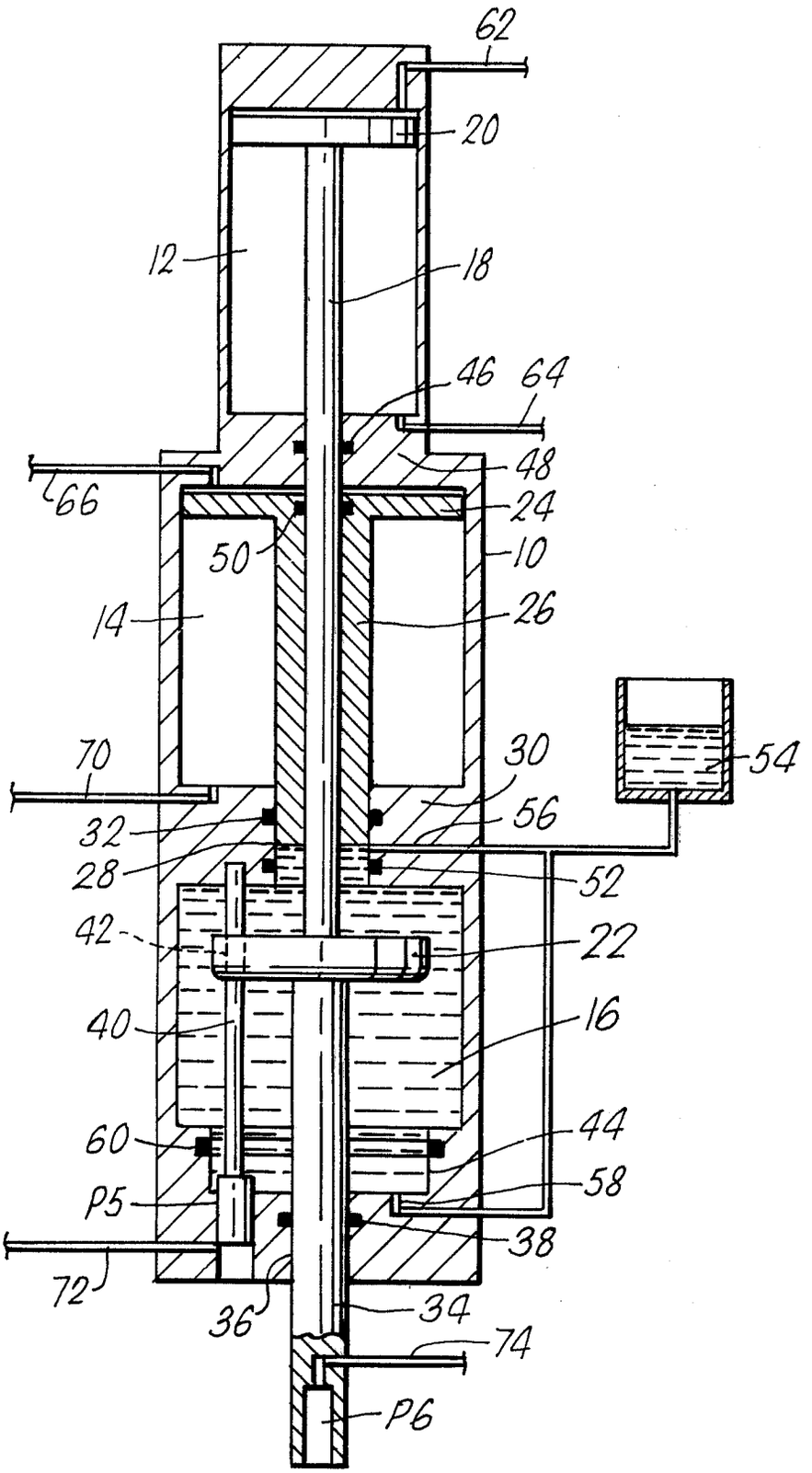

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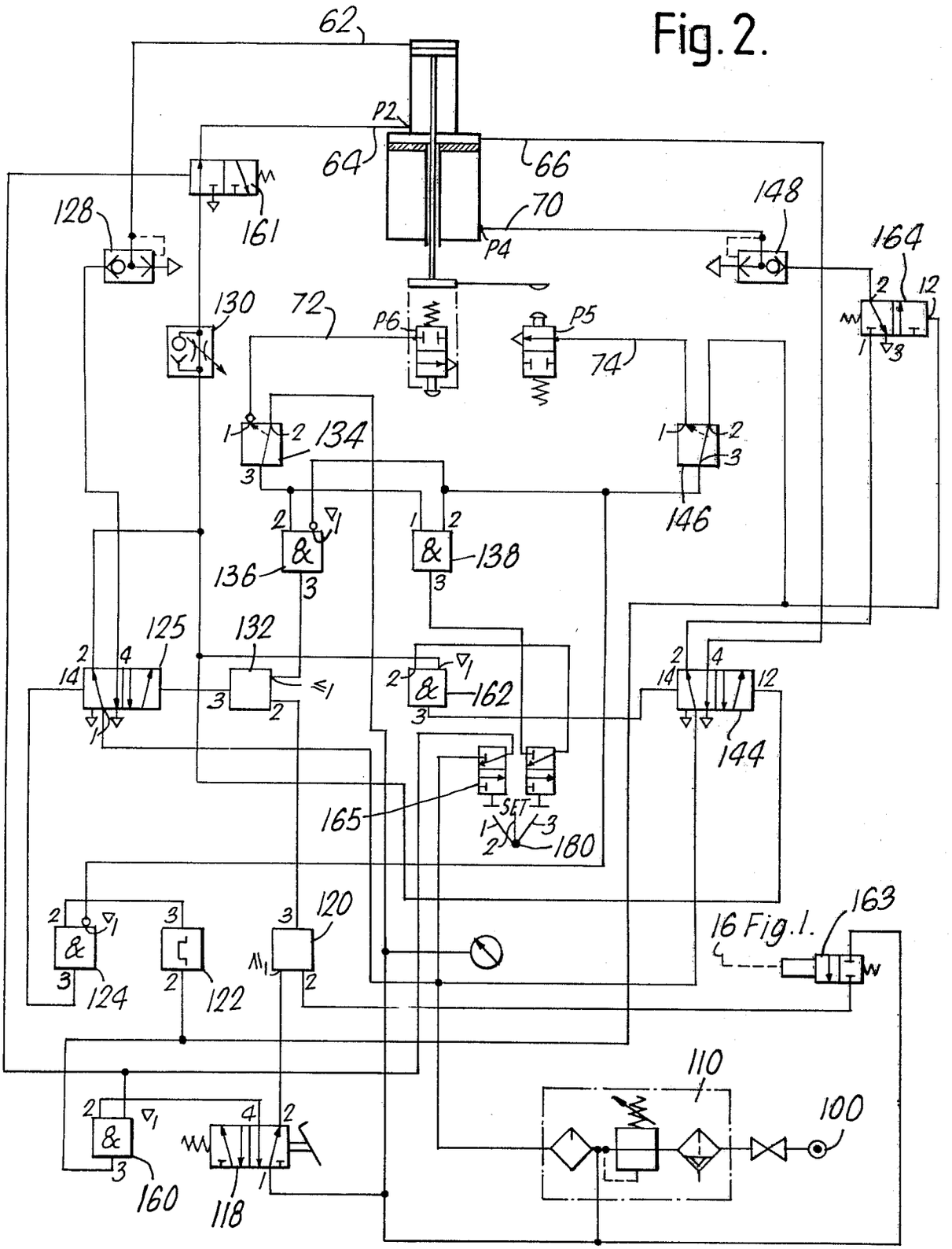
Fig. 2.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SET
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16 Fig. 1.
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