Aug. 5, 1941. W. ERNST 2,251,275

PRESSURE RELIEF VALVE

Original Filed Sept. 16, 1936

FIG. 3

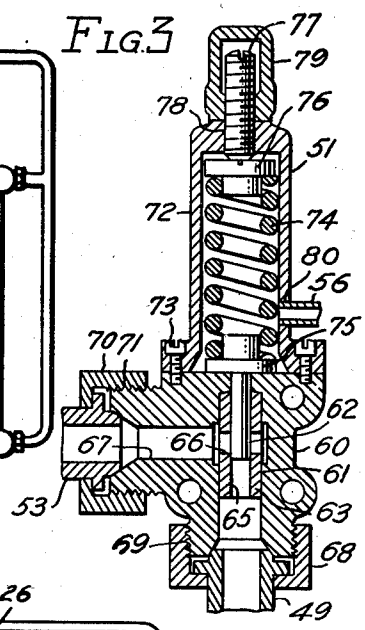


FIG. 2

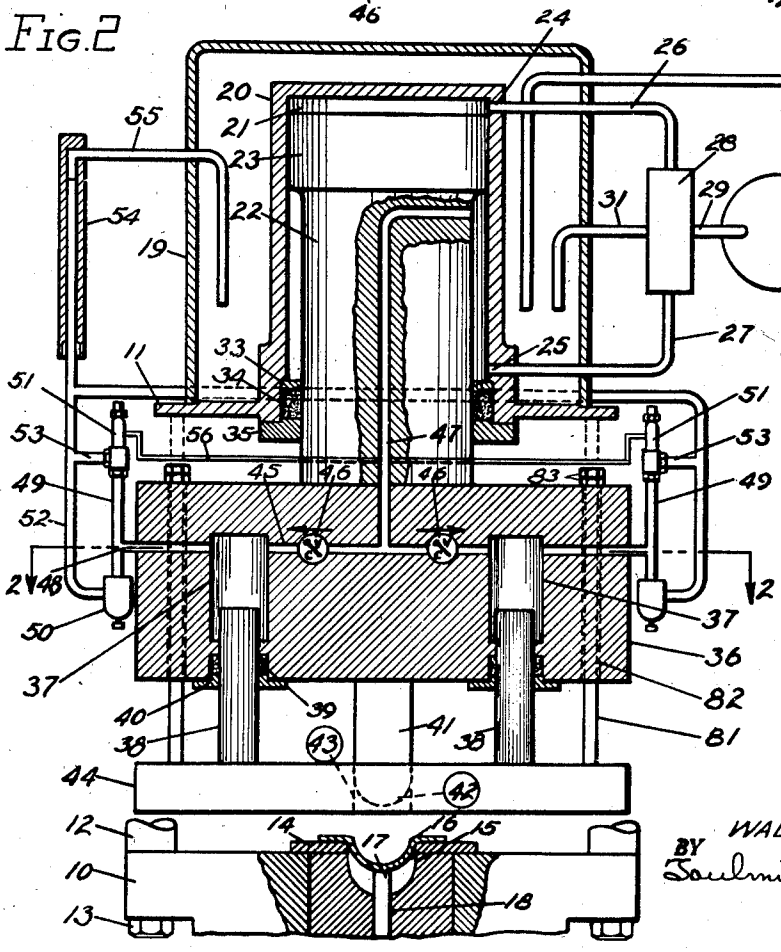


FIG. 1

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PRESSURE RELIEF VALVE

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Original application September 16, 1936, Serial No. 101,110, now Patent No. 2,167,941, dated August 1, 1939. Divided and this application July 12, 1937, Serial No. 153,156

1 Claim. (Cl. 137—53)

This invention relates to hydraulic valves, and in particular to pressure relief valves.

One object of this invention is to provide a pressure relief valve having means associated therewith for preventing the opening of the valve under conditions which would normally open the valve were not such a counterforce applied.

Another object is to provide a pressure relief valve having hydraulic means for counteracting the opening of the valve when the counteracting means is hydraulically connected to one portion of a hydraulic circuit.

Another object is to provide a pressure relief valve having a valve member which normally opens in response to the attainment of a predetermined pressure, but which is provided with a hydraulic counteracting arrangement receiving pressure fluid from another part of the circuit, and adapted to forcibly maintain the valve member temporarily in its closed position.

This is a division of my copending application, Ser. No. 101,110, filed September 16, 1936, and issued August 1, 1939, as Patent No. 2,167,941.

In the drawing:

Figure 1 is a diagrammatic view, mainly in section, showing the relief valve of this invention connected to a hydraulic press circuit.

Figure 2 is a horizontal section along the line 2—2 in Figure 1.

Figure 3 is a vertical section through the hydraulic pressure relief valve of this invention, shown connected in the circuit of Figure 1.

Referring to the drawing in detail, Figure 1 shows the pressure relief valve of this invention in a typical circuit with which it may be used. It will be understood that this relief valve may be used with various circuits, but for convenience and clearness of disclosure a typical circuit will be described by way of an example.

Figure 1 shows diagrammatically such a circuit containing a hydraulic metal drawing press having a base member 10 connected to a top member 11 (reduced in size for clearness of showing) by means of tie rods 12, the latter being secured in position by means of the nuts 13 upon the ends thereof. Mounted in the base member 10 is a drawing die 14 having a die cavity 15 for receiving the blank 16. Associated with the die cavity 15 is a plunger 17 adapted to support the tip of the blank as it is being drawn, and passing through a bore 18 to its operating cylinder (not shown). The details of the supporting plunger 17 form no part of the present invention, and are shown in my copending application, Ser. No. 74,742, filed April 16, 1936, and issued November 8, 1938, as Patent No. 2,136,240.

The present invention may be employed either with flat blanks or with blanks which have already been subjected to one or more drawing operations. For convenience of disclosure, blank 16 is shown as having been subjected to one drawing operation, and in position for another drawing operation which will elongate it and cause it to be drawn downwardly into the die cavity 15.

Associated with the top member 11 of the press is a surge tank 19 for containing the fluid by which the press is actuated. Also associated with the top member 11 is the drawing or main cylinder 20, having a bore 21 within which reciprocates the double-acting drawing plunger 22 having a piston head 23 thereon. The cylinder 20 is provided with upper and lower ports 24 and 25 on opposite sides of the piston head 23, and adapted by means of pipes 26 and 27 to supply pressure fluid to advance or retract the drawing plunger 22, according to the manner in which the four-way valve 28 is manipulated. This valve 28 is of any suitable type known to those skilled in the art, and its details form no part of the present invention.

Leading from the four-way valve 28 is the pressure line 29 connected at its opposite end to the pump 30. A discharge line 31, also connected to the four-way valve 28, leads into the interior of the surge tank 19. The pump 30 is also provided with a suction line 32, likewise leading into the interior of the surge tank 19. The drawing cylinder 20 is supplied near the mouth of its bore 21 with a packing ring 33, beyond which is a packing 34 adapted to be compressed by a gland 35 so as to prevent leakage around the drawing plunger 22. Connected to the drawing plunger 22 is the platen 36, within which are arranged the clamping cylinders 37 having clamping plungers 38 operating therein. Each clamping plunger 38 is provided with a packing 39 and gland 40 for the prevention of leakage. Secured to the platen 36 is a drawing plunger or punch 41 having a nose portion 42 corresponding to the die cavity 15, and adapted to pass through an aperture 43 in the clamping member 44 secured to the outer ends of the clamping plungers 38.

Each of the clamping plungers 38 is provided with a fluid passageway 45 leading by way of an outwardly opening check valve 46 to a common passageway 47, which extends upwardly through the drawing plunger 42 and opens into the drawing cylinder bore 21 immediately be-

neath the drawing plunger head 23. Consequently, fluid is free to pass from the pull-back or return side of the drawing plunger 23 into the clamping cylinders 37, but is prevented from passing in the opposite direction by the action of the check valves 46. Also passing outwardly from each clamping cylinder 37 is a fluid conduit 48 leading to an intermediate portion of a pipe 49, having on one end a safety valve 50 and on the other end a pressure relief valve 51. Leading from the discharge side of the safety valve 50 is a discharge line 52 connected to the discharge side of the relief valve 51 by the line 53.

The discharge line 52 passes upwardly into the telescoping cylinder 54, thereby forming a slip connection, enabling the telescoping cylinder 54 and the pipe 52 to move vertically relatively to each other, an action which necessarily occurs when the platen 36 moves downwardly in response to the action of the drawing plunger 22. A discharge line 55 leads from the telescoping cylinder 54 into the interior of the surge tank 19 and serves to discharge fluid expelled from the pressure relief valve 51 of the safety valve 50. The safety valve 50 is provided merely as an additional safety feature in the event of a jamming or other failure of the pressure relief valve 51, and is set at a higher pressure than the relief valve 51 so as to operate in case of the accumulation of a dangerous pressure within the corresponding clamping cylinder 37 and a failure of the corresponding pressure relief valve 51 to act. It will be seen from Figures 1 and 2 that each clamping cylinder is provided with its own pressure relief valve 51 and safety valve 50 so that a different pressure release point may be given to each clamping cylinder. The pressure relief valves 51 are connected to the drawing plunger passageway 47 by conduits 56 for the purpose of counteracting the action of the relief valves 51 during the return stroke of the drawing plunger 22, as is discussed below in connection with the description of the details of the relief valve 51.

The relief valve 51 is shown in vertical section in Figure 3, and consists of a casing 60 having a bore 61 within which reciprocates a valve plunger 62. Arranged between the valve plunger 62 and the bore 61 is a tubular member 63 having a longitudinal bore 65 and a cross bore 66, communicating therewith and opening into a transverse bore 67 in the casing 60. The end connection of the pipe 49 is held in communication with the bore 61 by means of the collar 68 engaging the threaded portion 69 of the casing 60, whereas the end of the pipe 53 is similarly held in communication with the transverse bore 67 by means of the threaded collar 70 engaging the threaded portion 71 of the casing (Figure 3).

Mounted on the upper portion of the casing 60 is a tubular cap 72 secured thereto by screws 73. Within the cap 72 is a coil spring 74, one end of which engages an enlargement 75 upon the upper end of the valve plunger 62, whereas the opposite end engages a button 76 in contact with an adjusting screw 77 threaded through a bore 78 in the upper end of the cap 72. Surrounding and covering the adjusting screw 77 is a hollow nut 79, which serves to protect the adjusting screw 77 and also to lock it in its adjusted position. The cap 72 is provided with a port 80 receiving and communicating with the pipe 56 leading to the pull-back side of the drawing plunger 22, as shown in Figure 1.

Thus, when the same pressure fluid is admitted simultaneously to the valve 51, by way of the pipes 49 and 56 during the pull-back stroke of the press, the valve plunger 62 will be prevented from opening by means of this counteracting arrangement, as is more fully described under the operation thereof. The pipe 56 also serves during the return stroke of the press to receive and transmit the fluid which leaks into the interior of the cap 72 past the valve plunger 62. Thus, each safety valve 51 may be adjusted to discharge pressure fluid at a different predetermined pressure by differently adjusting the adjusting screw 77 to compress the spring 74 by different amounts. The clamping member 44 is provided with rods 81 passing through the vertical bores 82 in the platen 36, and having the nuts 83 on the upper ends thereof. The rods 81 limit the extent to which the clamping member 44 can move relatively to the platen 36.

In the operation of the form of press shown in Figures 1 and 2, the pump 30 is started and delivers pressure fluid to the four-way valve 28, which in turn, is set to deliver pressure fluid through the line 26 and port 24 into the space above the drawing plunger head 23. This pressure forces the drawing plunger 22 and platen 36 downwardly, carrying with them the clamping member 44. When the latter engages the periphery of the blank 15 and clamps it tightly against the die member 14, the clamping member 44 halts, but the platen 36 continues to move downwardly, forcing its drawing die or punch 41 into engagement with the blank 16. As the punch 41 moves downwardly it forces the central portion of the blank 16 into the die cavity 15 and overcomes the resistance of the supporting plunger 17, which protects the tip of the workpiece or blank 16.

Meanwhile, pressure has been built up in the clamping cylinders 37 by reason of the relative motion between the platen 36 and the clamping member 44 to which the clamping plungers 38 are attached, and the fluid in the clamping cylinders 37 has been prevented from escaping by the closing of the outwardly opening check valves 46. When the pressure within each clamping cylinder 37 reaches the amount for which its corresponding relief valve 51 is set, the latter opens and discharges fluid through the line 53, into the discharge line 52 leading to the telescoping cylinder 54, and thence by the line 55 to the surge tank 19. In this manner each clamping plunger 38 may be caused to exert a different force upon the portion of the blank periphery which is engaged by the clamping member 44 in its vicinity.

When the drawing stroke of the press has been completed the setting of the four-way valve 28 is reversed so that pressure fluid flows through the line 27 and port 25, into the space beneath the drawing plunger head 23, causing the drawing plunger 22 to move upwardly. A portion of this pressure fluid, however, passes downwardly through the plunger passageway 47, the outwardly opening check valves 46, to the passageways 45, into the clamping cylinders 37, causing their plungers 38 and the clamping member 44 to remain in clamping engagement with the blank 16 while the punch or drawing die 41 is withdrawn from the cavity 15 of the die 14. If the relief valves 51 have been set for a low clamping pressure it would, at first glance, seem that pressure fluid during the pull-back stroke would pass

from the clamping cylinders 37, through the relief valve 51 and lines 52, 53 and 55, back into the surge tank 19, thus preventing the return of the moving parts. This, however, is prevented by the operation of the pipe line 56 leading from the valve cap 72 of the valve 51 to the passageway 47 within the drawing plunger 22. Consequently, during the pull-back stroke pressure fluid is applied simultaneously upon opposite sides of the valve plunger 62 within the relief valve 51, and prevents its opening regardless of how long a clamping pressure is provided by the setting of each relief valve 51. When the platen 36 has moved upwardly along the rods 81 it will engage the nuts 83 and lift the clamping member 42 free from engagement with the work-piece 16, thereby enabling the operator to remove the work-piece and also lifting the entire platen and blank holder assembly as a unit.

It will be understood that I desire to comprehend within this invention such modifications as come within the scope of the claim and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

A pressure relief valve comprising a casing having a valve chamber with a valve inlet port and a valve outlet port at an angle to the valve inlet port, a valve rod with a plunger valve thereon arranged to slide across the valve outlet port and to open and close said port, a cylinder adjacent said valve chamber, a partition between said cylinder and said valve chamber having an aperture therethrough for the passage of said valve rod, an enlarged piston portion in said cylinder connected to said valve rod on the opposite side of said partition from said valve chamber, a spring in said cylinder confined between said enlarged piston portion and an adjustable abutment in said cylinder, said spring normally urging said valve portion to slide across and close said outlet port, said piston being responsive to pressure fluid entering into said cylinder through an opening therein for counteracting the yielding of said spring means to hold said valve portion in a closed position.

WALTER ERNST.