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LaFlamme et al.

[11] **3,827,328**

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[54] **CONTROL SYSTEM FOR HYDRAULIC PRESSES**

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[73] Assignee: **Greenerd Press & Machine Company, Inc.,** Nashua, N.H.

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[21] Appl. No.: **318,545**

[52] **U.S. Cl.** **83/617,** 72/443, 83/639

[51] **Int. Cl.** **B26d 5/12**

[58] **Field of Search** 83/617, 639; 72/443, 444, 72/453; 100/256, 257, 269, 259

[56] **References Cited**

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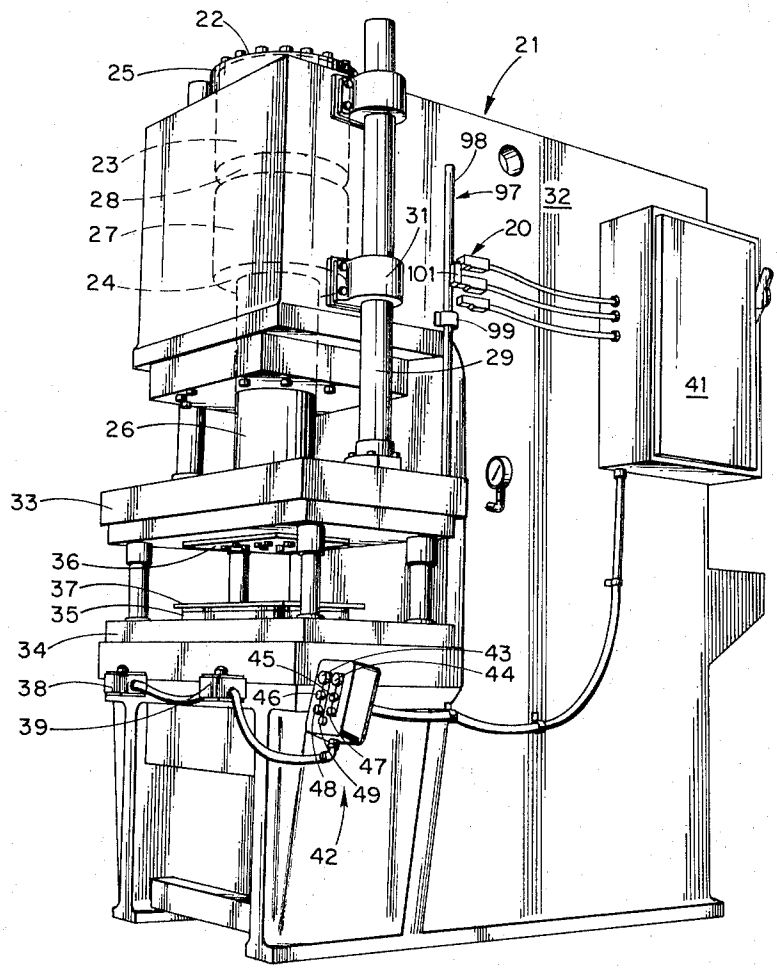
Primary Examiner—Frank T. Yost

Attorney, Agent, or Firm—Pearson & Pearson

[57] **ABSTRACT**

A hydraulic press is free of the conventional, four-way, drum-type, directional control valve and substitutes a plurality of relatively small, commercially-available, solenoid-actuated, pressure relief valves. High speed cycling is obtained with a large volume, low pressure pump paired with a small volume, high pressure pump, the latter valved out of the pressure line upon work-piece contact. The high pressure pump performs the work-piece penetration stroke, but is valved off to relieve pressure in the head end of the cylinder just before breakthrough of the work-piece to prevent shock to the press.

7 Claims, 5 Drawing Figures



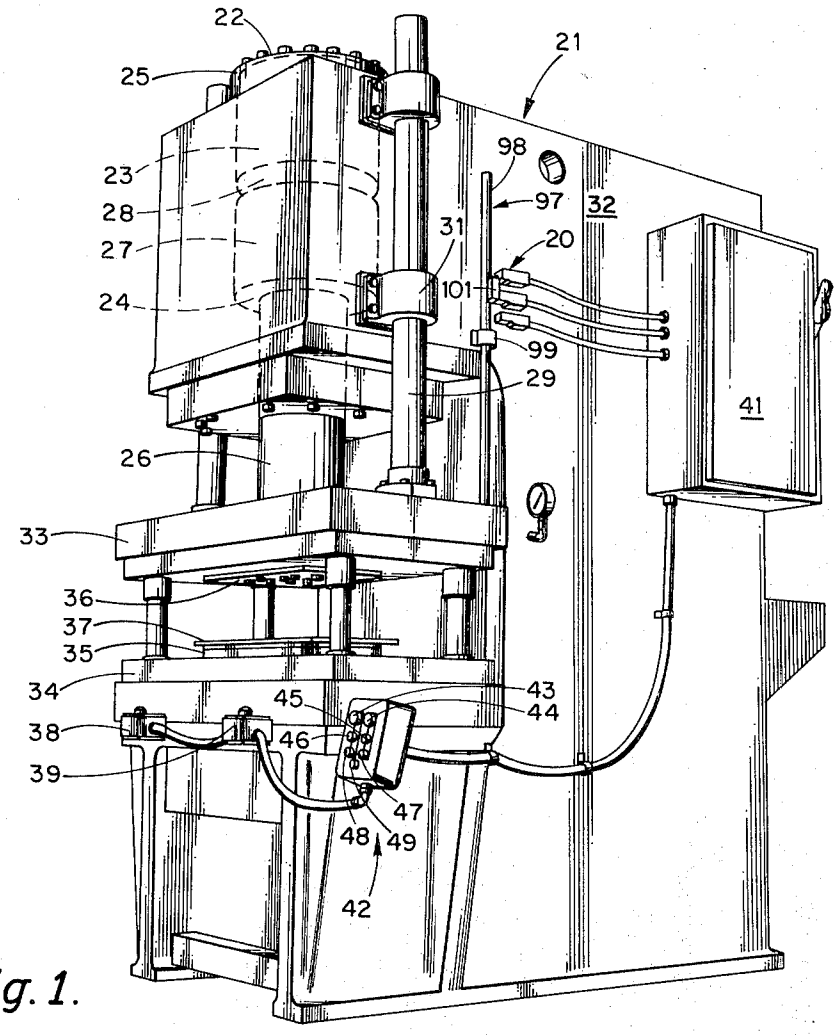

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Fig. 1.

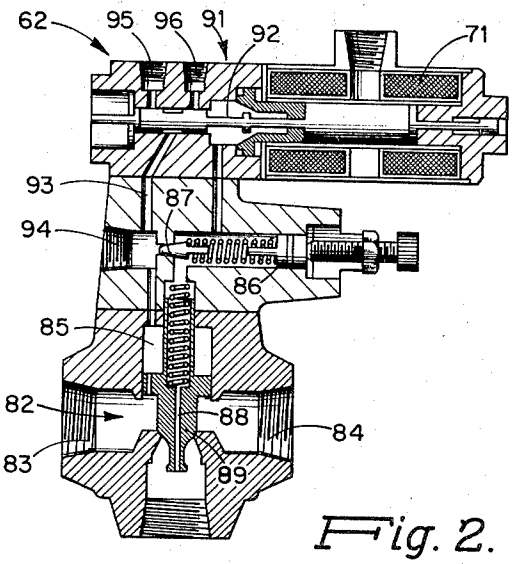

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Fig. 2.

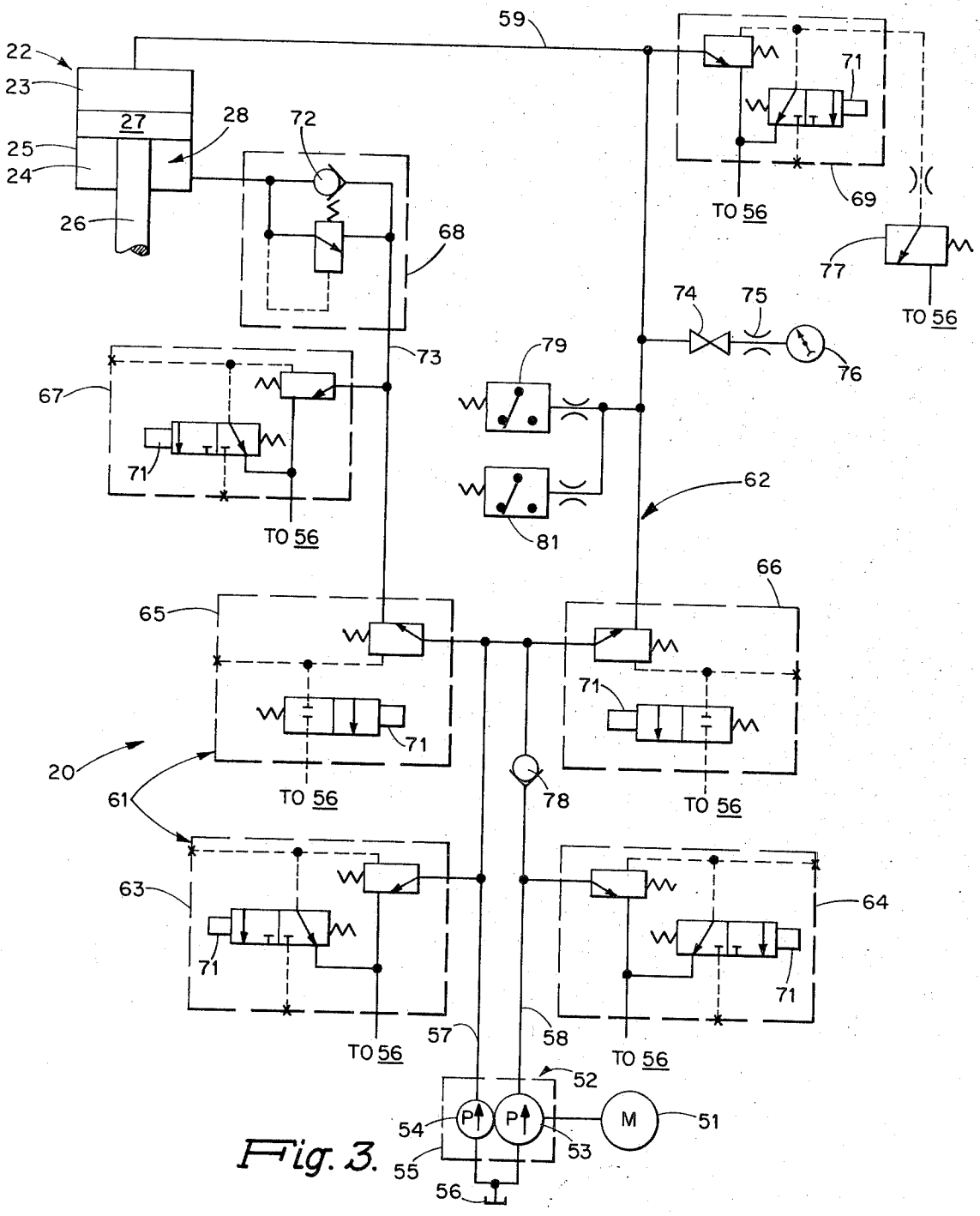


Fig. 3.

VALVE POSITIONS AT VARIOUS RAM FUNCTIONS						
FUNCTION	63	64	65	66	67	69
AT REST	0	0	X	X	0	0
RAM DOWN	X	X	X	0	0	X
SLOW DOWN	X	0	X	0	0	X
BREAK-THROUGH (DECOMPRESS)	0	0	X	0	0	X
RAM UP	X	X	0	X	X	0

Fig. 4.

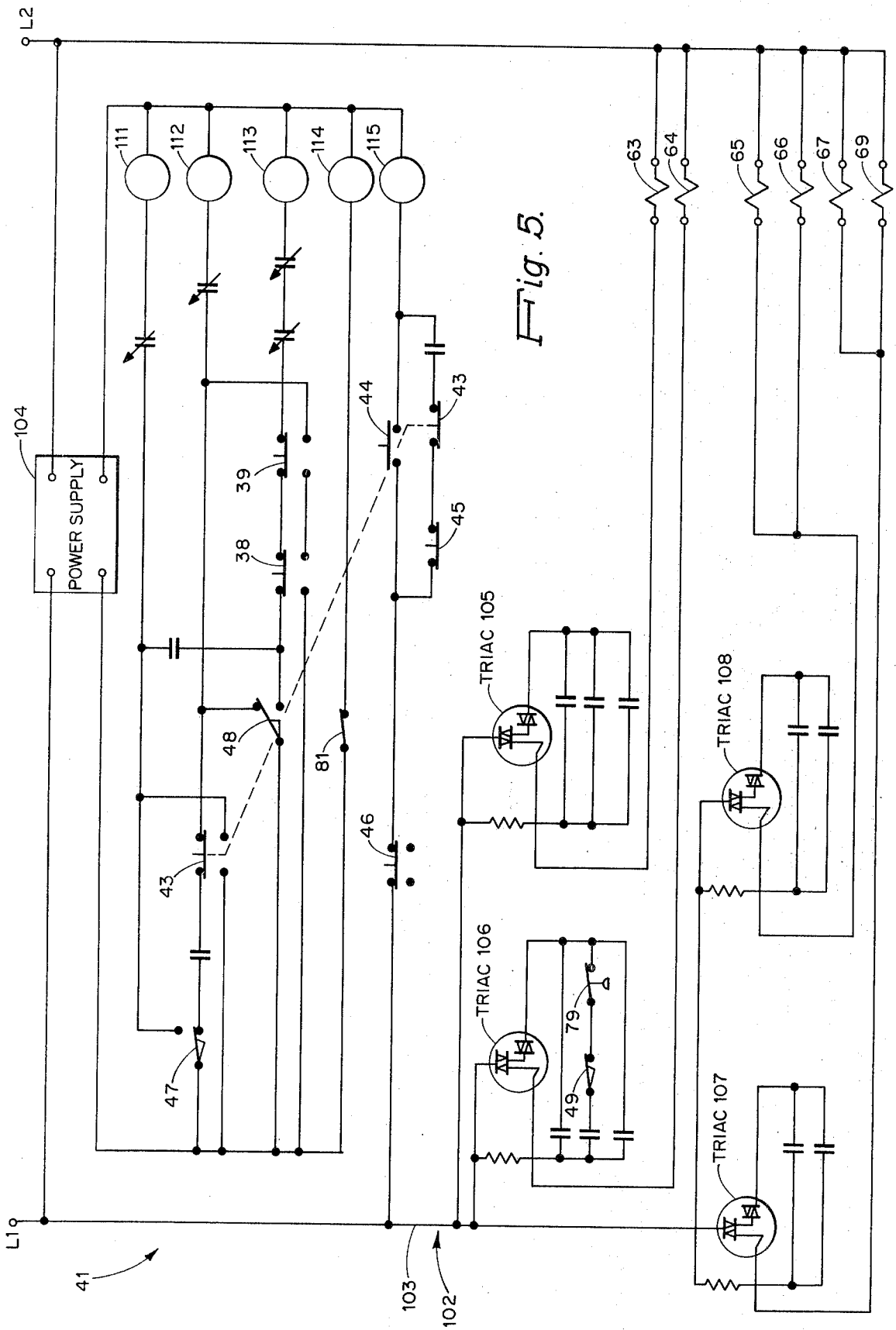

L2
L1
POWER SUPPLY
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111
112
113
114
115
63
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67
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48
43
47
44
43
45
81
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TRIAC 105
TRIAC 106
TRIAC 107
TRIAC 108
79
49
41
103
102

Fig. 5.

CONTROL SYSTEM FOR HYDRAULIC PRESSES

BACKGROUND OF THE INVENTION

This invention relates especially to hydraulic presses of the type having a stationary platen, or bed, and a movable platen on the end of a ram, the ram being movable by a hydraulic cylinder having a head end and a ram, or rod, end. The press illustrated herein is termed an "open gap" press, because the frame is heavy and of generally C-shape, the gap enabling the user to load and unload work pieces from the front or from either side. It will be understood that the invention can, however, be used in any other type hydraulic press, or machine, to which it may be adapted.

One of the disadvantageous features of conventional hydraulic presses is the use of a single, large, four-way, drum type, directional control valve for sequencing the press and shifting the direction of movement of the ram, the drum making a considerable impact when moved, taking considerable time to change direction and requiring a cylindrical housing which may leak if the casting is porous and may crack under undue stress. Such drums are usually about eight inches in diameter and the casting required to make such a control valve is complicated.

In U.S. Pat. No. 3,534,679 to Forichon of Oct. 20, 1970, a mechanical connection between the movable platen and the valve body is intended to prevent impact upon breakthrough. The Forichon device is intended to produce progressive relief of pressure in the pressure chamber of the cylinder, by mechanical hydraulic means, any electric switch means being used to reverse the valving after breakthrough of the work-piece for the return stroke of the ram.

Another disadvantage of conventional hydraulic presses is slow speed cycling, wherein constant volume pumps, such as disclosed in U.S. Pat. No. 3,290,919 to Malinak of Dec. 13, 1966, while comprising a pair of high pressure and low pressure pumps, tend to move the ram at slow speed on both the return stroke and the work stroke. Thus considerable time is lost by the user in waiting for the press to cycle.

As mentioned above, in many conventional hydraulic presses a shock occurs when the movable platen causes the male dies to penetrate a work-piece under high pressure and then suddenly break through the work-piece with a consequent impact and eventual damage to the press. There has long been needed a control system in which pressure in the head end of the cylinder is automatically and instantaneously relieved to the reservoir just before breakthrough, so that the terminal portion of the work stroke is smooth and free of shock.

SUMMARY OF THE INVENTION

In this invention the conventional, four-way, drum-type, directional control valve of the hydraulic press has been eliminated and replaced by a plurality of individual, relatively small, commercially-available, solenoid-actuated, pressure relief valves, all arranged in an electric circuit for instantaneous performance of their sequencing function upon actuation of electric switches by mechanical tripping mechanism.

The hydraulic pressure line to the head end of the cylinder is powered by a pair of pumps, one a large-volume, low pressure pump and the other a small volume, high pressure pump, the control circuit and valves accomplishing high speed cycling of the press by opening both pumps on the return stroke and on the work stroke of the ram until work-piece contact is made, thereby speeding up the cycle. Upon work-piece contact, the control circuit valves off the large volume pump to the reservoir, leaving the high pressure pump to perform the terminal portion of the work stroke from work-piece contact to work-piece penetration by male dies.

The control circuit and individual valves are also arranged to prevent shock caused by the breakthrough of the work piece, the release of the male dies and high pressure energy causing excessive impact and damage to the press. The tripping mechanism is set to sense when the male dies are about three quarters of the way through the work-piece on the work stroke of the ram and to respond by closing a switch to a pressure relief valve which instantaneously relieves pressure in the head end of the cylinder, diverting fluid to the reservoir and reducing the work pressure so that breakthrough is smooth and without substantial shock or damage.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a perspective view of a typical open gap hydraulic press with the invention applied thereto;

FIG. **2** is a diagrammatic side elevation in half section of a typical solenoid actuated, pressure relief valve used in the hydraulic control system of the invention;

FIG. **3** is a diagrammatic view of the hydraulic circuit of the invention; and

FIG. **4** illustrates the open versus closed positions of the various individual pressure relief valves of the improved hydraulic system at various ram functions of the press sequencing.

FIG. **5** is an electric circuit diagram.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. **1**, the improved hydraulic control system **20** of the invention is especially useful on a hydraulic machine such as the open gap hydraulic press **21** which may be from five to two hundred tons or more in capacity. The press **21** includes a heavy duty cylinder **22** with a head end **23**, a ram end **24**, and a cast, solid wall **25**. A large diameter ram **26** includes a ram head **27** having piston rings there around slidable in the fluid pressure chamber **28** of the cylinder. Guide rods **29** are slidable in rod brackets **31** fixed to the thick walled, rigid side plates **32** of the press, the movable platen **33** being carried by the guide rods and ram in a well known manner.

The stationary platen, or press bed, **34** is arranged to support the female dies **35** which receive the male dies **36** when a work-piece **37** therebetween is penetrated by the dies **36**. Dual palm buttons **38** and **39** are in the electric control circuit **41** so that the upper platen will not move down unless the operator has each palm on one of the palm buttons. The control station **42** includes an emergency open button **43**, a cycle start button **45**, an automatic manual jog switch **46**, a down switch **47**, an up switch **48**, a slow down switch **49**, and any other suitable switches desired.

As shown in FIG. **3**, the press **21** is provided with motorized pump means **51** consisting of a double pump **52** having two pump cartridges **53** and **54** in one common

pump body 55, one cartridge 53 being large volume, low pressure and the other cartridge 54 being small volume, high pressure. The pump means 51 supplies hydraulic fluid, such as oil, from the reservoir 56 through the pressure lines 57, 58 and 59 of the hydraulic fluid system 62 to the head end 23 of the cylinder 22.

To replace the conventional large diameter, drum-type control valve, the press of this invention includes valve means 61 comprising a plurality of individual, relatively small, commercially available, pressure relief valves, such as 63, 64, 65, 66, 67, and 69. Valves 63, 64, 67, and 69 are normally open, while valves 65 and 66 are normally closed, and each valve is actuated by a solenoid coil, such as 71, in a known manner. Valve means 61 also includes a check valve 72 which permits one way travel of hydraulic fluid from pressure line 73 into the ram end 24 of chamber 28 to lift the upper platen 33 on the return stroke of the ram 26, but does not permit fluid flow in the opposite direction. Also included in valve means 61 is the valve 74, snubber 75 and pressure gauge 76, and the remote relief valve 77 as well as a check valve 78 in pressure line 58. The hydraulic fluid system includes the unloading pressure switch 79 and the decompression pressure switch 81. Valve 68 is a counterbalance valve which operates to hold the ram in position as a counterbalance to its weight.

The pressure switches 79 and 81 are commercially available from Barksdale Company of Los Angeles, Calif., and the pressure relief switches are available as CT5 or CG5 valves from Vickers Machinery Hydraulics Division of Troy, Mich.

The pressure relief valves 63–67 and 69 are shown in FIG. 2 and each includes a main relief valve 82 normally permitting flow from inlet port 83 to outlet port 84 while hydraulic balance is maintained. When pressure in chamber 85 exceeds the setting determined by spring control 86, the pilot valve piston 87 is unseated, fluid escapes through central passage 88, thereby unbalancing the body piston 89 and causing it to lift and direct fluid to the reservoir or tank 56. The integral direction valve 91 has a piston 92 actuated by solenoid coil 71, and a passage 93 from the normal vent connection 94. The valve 91 can thus block control flow to cause the unit to act as a standard relief valve or it can vent the main valve 82 or it can direct fluid to either port 95 or 96, as desired.

As shown in FIG. 1, press 21 includes control means 97, including a control rod 98 fixed to the movable platen 33, or to the ram 26, or operable thereby to move therewith in a guide bracket 99, the rod carrying mechanical tripping mechanism 101, adjustably slidable thereon, for engaging and actuating limit switches for sequencing the press. Rod 98 controls the length of stroke of the ram in the usual manner.

As shown in FIG. 5, the electric means 102 includes the electric control circuit 103, with its power supply 104, triacs 105, 106, 107 and 108, and the control relays 111, 112, 113, 114 and 115.

HIGH SPEED CYCLING

The hydraulic circuit and electrical control circuit of this invention, together with the use of individual pressure relief valves, provide a new method and apparatus for making a rapid change in the direction of a hydraulic ram, which provides a faster shifting action than with a single large four-way valve.

Referring to FIG. 4, with the motorized pump means 51 running and the ram 26 retracted, the double pumps 53 and 54 feed oil from reservoir 56 through valves 63 and 64, both of which are in normally open position at this point in the cycle. Oil flows over these valves and back to the tank, or reservoir, 56. No oil can flow to the hydraulic cylinder 22 because valves 65 and 66 are normally closed and thereby blocked.

To bring the ram down, the cycle start button 44 is actuated. This action simultaneously closes valves 63 and 64 and opens valve 66. Valve 69 closes. Valve 67 remains open. Valve 65 remains blocked.

Valve 68, a counter balance valve, is a pressure actuated valve rather than an electrically operated valve. It opens on pressure and is used to hold the ram up when the press is at rest. With the system in this position, full volume from the double pump 52 is forcing the ram 26 down at full speed, and the oil exhausted from the rod end 24 at the cylinder 22 is flowing out through valve 67.

When the ram 26 contacts resistance in its downward stroke at the work-piece penetration portion of the work stroke, pressure is built up in the line 59 to the head end 23 of the cylinder 22. This starts a sequence of functions which follows in rapid succession. Pressure switch 79 causes valve 64 to open. This vents the large volume pump 53 and its volume is pumped back to the oil reservoir 56. The small volume, high pressure pump 54 continues to drive the ram down to cause the male dies 36 to penetrate the work-piece 37.

When the ram 26 reaches the desired lower limit of the work stroke, either a limit switch or a pressure switch opens valves 63. This immediately causes the pressure in the line 59 to the head end 23 of the cylinder to drop (decompress). Decompression switch 81 "reads" the pressure drop. When the pressure has fallen to a pre-set point it causes another cycle of simultaneous valve shifts. Valves 63 and 64 close. Valves 65 and 69 open. Valves 66 and 67 close. This allows the full flow of the double pump 52 to be directed to the rod end 24 of the cylinder 22. The ram 26 returns up.

When the ram 26 reaches the pre-set up position, a limit switch causes all the valves to be reset to the positions described above, ready for the cycle start button to be again actuated. The press cycles down again.

The cycle can be stopped by pressing "cycle stop" button 45. The valves go to the positions described above with the motor running and the ram retracted, but oil flow diverted to the tank, or reservoir, 56.

Valve 77 is a remote relief valve that controls the pressure setting of valve 69. This is a conventional valve and not significant as part of the new hydraulic circuit.

The entire circuit is thus capable of more rapid cycling on high production hydraulic presses without the shock and noise associated with rapid four-way valve-ram reversals on conventional hydraulic circuits.

BREAKDOWN SHOCK AVOIDANCE

As stated above, the double pump 52, consisting of the large volume, low pressure pump 53 and small volume, high pressure pump 54 will both power the ram on the return stroke and both power the ram on the work stroke for high speed travel, until the trip lever, or element, on the control rod, through adjustable mechanical linkage, trips the switch which de-energizes

and opens valve **64.** This allows oil from the large volume pump **53** to circulate back to the tank, or reservoir **56,** slowing the ram down to a slower speed with only the oil from the small volume, high pressure pump driving the ram down. Preferably, the trip mechanism is mounted at a predetermined point on the downward path of the platen **33** or ram **26** to open valve **64** just as the work-piece **37** is contacted by male dies.

The ram will continue downward, at the slower speed, in contact with the work and will build up pressure to punch out a part with a blanking die. Normally, when a blanking die is used in a hydraulic press, just as the blank breaks through the bottom of the die after a build-up of high pressure required to punch the blank from a metal strip, the sudden release of resistance on the blank will allow the ram to accelerate downward and this condition will create a loud noise and severe shock in the hydraulic system because the high pressure required to punch the blank through the die is instantly released as the blank breaks through the die.

This hydraulic circuit provides a method that will allow the high pressure in the cylinder to decompress just as the blank breaks through, therefore eliminating the noise and shock to the hydraulic system.

Just as the die breaks through the blank, or work-piece, an adjustable limit switch will de-energize and open valve **63,** valve **66** and valve **69** still energized, to instantaneously direct oil from small volume pump **54** to tank **56** and also release high pressure to the tank from the head end **23** of cylinder **22** and therefore eliminating the sudden downward surge of the ram as resistance on the blank has been overcome. As the high pressure in the system reduces, a pressure switch **79** (adjustable), deenergizes and opens valve **69,** de-energizes and blocks valve **66,** energizes and blocks valves **63** and **64** to stop the oil from the large volume and small volume pumps from circulating to tank **56,** energizes and opens valve **65** to direct oil to the rod end **24** of cylinder **22,** energizes and closes valve **67,** directing oil to the rod end **24** of cylinder through valve **68.**

When the ram **26** reaches its up position, a limit switch will de-energize and open valves **63** and **64** to circulate oil from large volume and small volume pumps to the tank, de-energize and block valve **65,** de-energize and open valve **67** and the press is now in a rest position.

We claim:

1. In a hydraulic press of the type having a lower platen, an upper platen movable by a ram slidable in a cylinder, the cylinder having a head end and a rod end, and the press having a hydraulic fluid system for driving the ram through a work stroke and a return stroke, the combination of:

motorized pump means in said fluid system for pumping hydraulic fluid under pressure from a reservoir into said cylinder;

valve means in said hydraulic fluid system comprising a plurality of relatively small, solenoid-actuated, pressure relief valves for sequencing said press by applying or relieving pressure in said cylinder;

electric means, including electric switches, in an electric circuit for actuating said valve means;

control means for actuating said switches in accordance with the movement of said upper platen,

said control means including tripping mechanism, operable to actuate one of said switches to electrically actuate one of said valves to instantaneously relieve pressure in the head end of said cylinder, at a predetermined point in said work stroke for preventing work-piece breakthrough shock and

high speed cycling means, actuated by the tripping mechanism of said control means, for sequencing said ram for a high speed return stroke, a high speed work stroke until work contact and a slow speed work-piece penetration stroke.

2. A hydraulic press as specified in claim **1** wherein:

said pump means forms part of said high speed cycling means and comprises a double pump consisting of two pump cartridges in one common pump body, one cartridge being large-volume, low-pressure, and the other cartridge being small-volume, high-pressure.

3. A hydraulic press as specified in claim **1,** wherein:

said pump means comprises a large-volume, low pressure pump and a small-volume, high-pressure pump, both feeding the head end of said cylinder on the work stroke; and

said control means includes a valve for diverting fluid from said large-volume pump from the head end of said cylinder to said reservoir to slow said ram, when a work-piece is contacted on said work stroke, thereby causing said small-volume pump to complete the work stroke through the work-piece.

4. A hydraulic press as specified in claim **1,** wherein:

said pump means includes a high-volume, low-pressure pump and a small-volume, high-pressure pump for driving said ram on the work stroke, said control means includes a valve for diverting said high-volume, low pressure pump from the head end of said cylinder to said reservoir to leave said small-volume, high-pressure pump driving said ram alone upon contact with a work-piece, and said mechanism for tripping said one switch to relieve pressure in the head end of said cylinder is operable to relieve the high pressure therein created by said small volume pump just before breakthrough of a work-piece.

5. In a hydraulic press of the type having a lower platen, an upper platen movable by a ram slidable in a cylinder, the cylinder having a head end and a rod end, and the press having a hydraulic fluid system with motorized pump means for driving the ram through a work stroke and a return stroke, the combination of:

valve means in said hydraulic system comprising a plurality of individual, solenoid-actuated, pressure relief valves for sequencing said press by applying and relieving pressure in said cylinder;

electric means, including an electric circuit, the solenoids of said valves and a plurality of electric switches for actuating said solenoids;

breakthrough shock avoidance means, including trip mechanism operable at a predetermined point on the path of said movable platen to actuate one of said switches to instantaneously close said electric circuit and energize one of said solenoid valves to relieve pressure in the head end of said cylinder; and

high speed cycling means, including a large-volume, low-pressure pump and a small-volume, high-

pressure pump in said pump means, and including trip mechanism operable by said movable platen to actuate said switches and energize said valves to sequence said ram for a high speed return stroke with both said pumps, a high speed work stroke with both said pumps until the work-piece is contacted and a slow speed work-piece penetration stroke with only said high-pressure, small-volume pump.

6. In a hydraulic press having a platen movable by a ram slidable in a cylinder, the cylinder having a head end and a ram end, the combination of:

high speed cycling means comprising a pair of pumps both connected to said cylinder, said pumps consisting of a small volume, high-pressure pump and a large-volume, low-pressure pump;

electric means, including a plurality of small, solenoid-actuated, pressure relief valves, each energized by a switch in an electric circuit, said means sequencing said press; and

control means for opening or closing the switches in said circuit to connect both said pumps to the rod end of said cylinder on the return stroke of said ram, to connect both said pumps to the head end of said cylinder on the work stroke of said ram until the work-piece is contacted, thereby moving said ram at high speed, and to connect only said high-pressure pump to said head end during the work-piece penetration portion of said work stroke, while diverting said large-volume pump to the reservoir of said press.

7. In a hydraulic press having a platen movable by a ram slidable in a cylinder, the cylinder having a head end and a ram end, the combination of:

breakthrough shock avoidance means, including trip mechanism operable at a predetermined point on the path of said movable platen to actuate an electric switch just before male dies break through a work-piece;

valve means, including a solenoid-actuated, pressure relief valve in the pressure line leading to the head end of said cylinder for normally feeding hydraulic fluid thereto when open, but for relieving pressure therein when closed;

electric control circuit means, including a source of current, said switch and the coil of said solenoid for instantaneously closing said valve means when said switch is actuated to relieve pressure in the head end of said cylinder just before said male dies break through a work-piece and

high speed cycling means, including a large-volume, low-pressure pump, a small-volume, high-pressure pump, said valve means and said circuit means for driving said ram at high speed on a return stroke, at high speed on a work stroke until contact with a work-piece and at slow speed on a work penetration stroke.

* * * * *