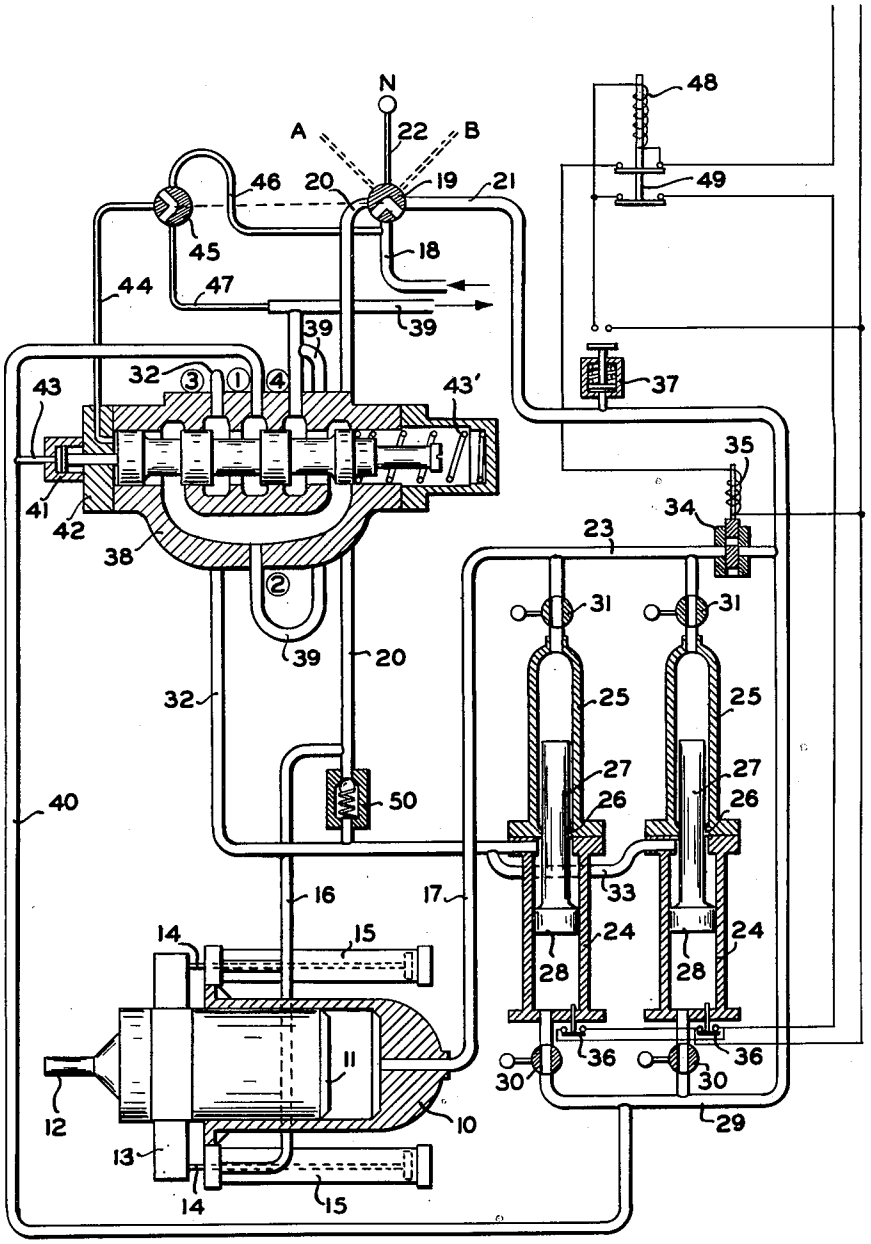
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HYDRAULIC PRESS FLUID SUPPLY WITH PRESSURE INTENSIFIER

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HYDRAULIC PRESS FLUID SUPPLY WITH PRESSURE INTENSIFIER

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This invention relates to hydraulic actuation of metal extruding presses and the like and more particularly to improved apparatus for supplying hydraulic fluid pressure to presses generally and to improved control systems for such apparatus. In certain press operations, as in the metal extrusion field, for example, it is essential that extremely high hydraulic fluid pressures be developed for proper operation of the press and as extremely high pressures can not be readily developed in a practical manner by the use of pumps it has heretofore been proposed to employ pressure intensifiers of the differential piston area type in conjunction with the press. These prior systems, however, are very complicated and expensive and limit the speed of operation of the press to such an extent that their use is largely avoided whenever possible.

It is the primary object of the present invention to provide a hydraulic fluid supply and associated control system for a hydraulic press which is economical to construct, flexible in operation, capable of precise control, and which does not mitigate against the cyclic speed of operation of the press.

A more specific object of the invention is the provision of a hydraulic fluid pressure intensifying system and an associated control system for a hydraulic press in which the various operative control valves are located in the relatively low pressure side of the system while yet capable of effecting complete and simplified control over the operation of the press.

Another object of the invention is the provision of an improved system for supplying intensified hydraulic fluid pressure to a metal working press and the like in which provision is made for limiting the application of the intensified pressure only to the extent required in a particular cycle of operation at hand and in which provision is made for enabling the pressure intensifying installation to be adequately serviced and maintained without materially decreasing the output or capacity of the installation. The above and other objects and advantages of the invention will become apparent upon consideration of the following detailed specification and the accompanying drawing wherein there is disclosed a preferred embodiment of the invention.

The single figure of the drawing is a schematic representation of a hydraulic press actuator and control system therefor constructed in accordance with the principles of the invention.

Referring to the drawing in detail, reference numeral 10 indicates the main cylinder of a

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press in which is slideably mounted a piston or ram 11. A punch or metal extruding ram 12 is shown as being carried by the outer end of ram 11 and also mounted on the ram 11 is a cross head 13 to which is attached piston rods 14 of a pair of pull-back cylinders 15. As shown, the cylinders 15 may be conveniently mounted on the cylinder 10 and suitable means as a conduit 16 may be employed to conduct fluid pressure into the ends of cylinders 15 adjacent the cross head 13 to retract the ram 11 in the cylinder 10. A conduit 17 conducts fluid pressure into the closed end of cylinder 10 to advance the ram 11 through its working stroke.

A source of hydraulic fluid pressure comprising a conduit 18 is provided and, in actual practice, this source may comprise the outlet of a pump but more preferably the outlet of a series of ganged pumps connected in parallel. Associated with the source 18 is a three-way valve 19 having ports also connected with conduits 20 and 21, respectively. Any suitable control may be provided for the valve 19 as, for example, the lever 22 and, as shown, when this lever is in neutral or "N" position the conduits 18, 20, 21 are all blocked but when the lever is moved to position "A" conduit 18 is connected with conduit 21 and when the control lever is moved to position "B" conduit 18 is connected with conduit 20. Hydraulic fluid supplied the conduits 18 and 21 is utilized to actuate the main cylinder 10 of the press and through apparatus now to be described this source of fluid is also utilized to develop a much higher or intensified pressure to raise materially the load capacity of the press. It should be observed, however, as the description proceeds that the increased pressure is not applied to any of the controlled valves, particularly during the times that any of such control valves are actuated. Conduit 21 is interconnected with conduit 17 by means of a conduit 23.

The hydraulic pressure intensifier utilized in the system of the invention comprises a pair of cylinders 24 and 25 having closed outer ends and communicating inner ends rigidly connected end to end. The inner end wall of cylinder 25 is provided with a bore 26 in which is closely but slideably received a ram 27 made integral with or rigidly connected to a piston 28 which is slideably received in cylinder 24. A conduit 29 having a manual valve 30 interposed therein connects the supply conduit 21 with the lower end of cylinder 24 and the upper end of the pressure chamber or cylinder 25 is connected with the conduit 23 by means of a manual valve 31. As shown, the up-

per end of cylinder 24 above the piston 28 is provided with a port which is connected to a conduit 32. For purposes to be hereinafter more fully described two or more of the pressure intensifiers thus described are preferably utilized in each installation and such intensifiers are connected in parallel, the valves 30 and 31 being employed to select the number of units in use at any particular time as will be understood. An interconnecting conduit 33 is employed to connect the upper ends of the cylinders 24 in parallel and with the conduit 32.

Positioned in the conduit 23 between the valves 31 and the conduit 21 is a normally open solenoid valve 34, the energizing coil 35 of which is in a series circuit including a suitable current source and a normally open solenoid switch 49. The switch 49 is actuated by a solenoid 48 which may be held energized by normally closed limit switches 36 positioned in the bottom of cylinder 25 or initially energized by a pressure responsive switch 37 which is actuated by the pressure in conduit 21, said actuation occurring upon the pressure in conduit 21 reaching a predetermined value. It should therefore be understood that the valve 34 will be open when the pistons 28 are in their lowermost position, provided that the pressure in conduit 21 has not exceeded the aforementioned predetermined value at which the pressure responsive switch 37 is actuated.

I provide a four-way control valve 38 having ports 1, 2, 3 and 4, as shown, and it will be observed that ports 2 and 4 are connected to an exhaust conduit 39 while port 1 is connected with conduit 29 by means of conduit 40 while port 3 is connected with conduit 32 leading from the upper ends of cylinders 24. Valve 38 is provided with two fluid pressure operated actuators 41 and 42, respectively, and an opposing spring 43'. The construction of valve 38 (which is a conventional type of relay valve readily procurable in the market) is such that so long as fluid pressure is supplied to neither of the actuators 41 and 42 port 1 is connected only with port 3 and vice versa while upon the application of predetermined fluid pressure to actuator 41 port 1 is blocked and port 3 interconnected with port 2. Upon the application of fluid pressure to actuator 42 port 1 is connected with exhaust port 4 and port 3 is connected to port 2. To control valve 38 in the manner to be hereinafter more fully described actuator 41 is interconnected with conduit 40 by means of a conduit 43 while actuator 42 is connected by means of a conduit 44 to one of the ports of a three-way pilot valve 45. The second port of valve 45 is connected to the source conduit 18 by means of conduit 46 while the third port is connected to exhaust by means of a conduit 47. Valve 45 may be coupled with the valve 19 so that when control lever 22 is in position "A" conduit 44 is connected to exhaust conduit 47 when control lever is moved into position "B" to retract the main ram 11 the conduit 44 is connected with the supply conduit 46. The mechanical interconnection between the valves 19 and 45 may be made adjustable so that ports 1 and 4 of valve 38 are interconnected just ahead of the supplying of fluid pressure to conduit 20 when lever 22 is moved to retracting or "B" position.

Considering now the operation of the above described system as a whole, the pistons 28 will normally be at their lowermost positions at the start of a cycle of operation and the ram 11 will be fully retracted and the space in cylinder 10 as well as the spaces in the pressure heads 25 and in the cylinders 24 above pistons 28 will be fully filled with liquid. Operators 41 and 42 of valve 38 are at this time deenergized so that only ports 1 and 3 of valve 38 are interconnected. Valve 34 is open. To initiate a cycle of operation the control lever 22 is moved to position "A" and fluid pressure is admitted to conduit 21 through valve 19 and thence into the cylinder 10 by means of conduits 23 and 17. Ram 11 moves rapidly forward through the idle portion of its working stroke and, of course, the same pressure which is at this time applied against the ram 11 appears in the lower ends of cylinders 24 by means of conduit 29 but since conduits 29 and 32 (leading to the upper ends of cylinders 24) are interconnected by way of conduit 40 and ports 1 and 3 of valve 38 and since the fluid in the pressure chambers 25 is in open communication with the conduit 23 through open valves 31 the pistons 28 will be in equilibrium and will have no upward motion, thus insuring that the intensifiers are held inactive until their higher output pressure is required at the ram.

Upon the punch or ram 12 engaging the work and the press meeting its full resistance to further operations, the fluid pressure will build up in conduit 21 and upon a predetermined pressure valve being obtained, the pressure responsive switch 37 will close thereby energizing solenoid 48 and closing the switch 49, thus completing the circuit through solenoid 35, thereby energizing said solenoid to quickly and positively close valve 34. This higher pressure acting on valve actuator 41 through conduits 29, 40 and 43 shifts valve 38 to connect ports 3 and 2, providing an exhaust outlet for the liquid contained in the annular spaces in cylinders 24 above the pistons 28. With the pump pressure then acting only upon the lower surfaces of pistons 28, rams 27 rise in cylinders 25, forcing the liquid contained therein out through conduits 23 and 17 and into the press cylinder 10. It should be observed that this arrangement of maintaining a back pressure on the pistons 28 during the time that hydraulic fluid is flowing directly into the main press cylinder 10 from the source 18 to the valve 34 insures the continuance of the retraction of the intensifier rams until such time as increased pressure is actually required by the main press cylinder 10. There is thus made available for high pressure actuation of the press cylinder the full fluid capacity of the intensifiers.

The liquid displaced by the rams 27 will of course be a function of their area and length of stroke. Actual practice therefore will determine the size and number of intensifiers to be used in any particular system. It is usually advantageous, however, to use several small units connected in parallel, the principal advantage being that if in any particular installation the work at hand requires but slight high resistance movement of the press ram 11, all but one or two intensifiers may be isolated from the system by means of valves 30 and 31. Another advantage of the use of a multiplicity of intensifiers is that some of them may be out of service at all times for maintenance or other purposes without affecting the continuity of operation of the plant.

Outward movement of the main ram 11 of the press is ultimately arrested either by a stop on the press or by the cessation of fluid flow due to the rams 27 having reached their uppermost positions. If it is desired now to retract the press the control lever 22 is moved to position "B"

thereby connecting supply conduit 18 with the head ends of pull-back cylinders 15 through conduits 20 and 16 and to relieve the pressure in the cylinder 10 to allow the ram to retract the actuator 42 is energized by means of valve 45 in the manner described above to interconnect port 1 to port 4 and port 3 to port 2 of valves 38 thus relieving pressure in conduit 40 and providing a fluid intake passage into the annular spaces immediately above the pistons 28 of the intensifiers. Immediately upon pressure decrease in conduits 40 and 29 valve actuator 41 and pressure responsive switch 37 are de-energized. The system remains unaffected, however, since valve 38 is being actuated by the actuator 42 and the valve 34 is being held closed by the limit switches 36 which are in the holding circuit shown for the relay 48, 49. It should be understood that a portion of the fluid which issues from the cylinder 10 upon retraction of the ram 11 goes into the chambers 25 to keep these chambers filled and to force the rams 27 downwardly. The excess fluid is exhausted through conduits 29, 40 and 39.

Upon the pistons 28 of the intensifiers reaching their lowermost positions switches 36 are opened. These switches are preferably connected in parallel so that both of them must be opened to de-energize the relay coil 48, thereby de-energizing solenoid 35, allowing valve 34 to open in re-cycling the system preparatory to the next succeeding cycle of operation. It should be observed that this arrangement insures that the intensifier rams will be fully retracted at the end of each cycle of operation so that during the next succeeding cycle of operation the intensifiers may deliver their maximum volumetric capacity of high pressure fluid, as explained above.

The relief valve 50 is provided for the purpose of providing an outlet for the hydraulic fluid contained in the pull-back cylinders 15 during forward movement of the press. During the initial or high speed movement of the press the fluid discharged from cylinders 15 through the valve 50 is added to the conduits 40, 29, 23 and 17 due to the interconnection of ports 1 and 3, as explained above, so that there is, in effect, a reduction in the effective area of the main press cylinder thereby increasing the speed of initial movement of the press. However, upon the press meeting its higher resistance to movement and the consequent interconnecting of port 3 of valve 38 (conduit 32) with the exhaust port 4 of valve 38 the remaining fluid in the cylinders 15 is discharged to exhaust, thereby allowing the main press cylinder to exert its maximum driving force.

It should now be apparent that I have provided improved apparatus for hydraulic press actuation and an improved control system for such apparatus. Through the adoption of the principles of the invention it is possible, while using a minimum number of simply constructed parts, to actuate and control a hydraulic press at greater cyclic speeds and with maximum force which is automatically applied when required and which may be made effective only to the extent required in the particular work at hand. Further, and of more importance, is the fact that the system provides extremely high pressures for actuating the press but none of the control valves are in any of the high pressure lines. Rather, all these valves are in the low pressure lines and this contributes materially to the economy and durability of the system. The apparatus is further simplified in that the operation of the press is always under the precise and instantaneous control provided by the valves 19 and 45 which, in turn, are actuated by the lever 22.

The above specifically described embodiment of the invention should be considered as illustrative only as obviously many changes may be made therein without departing from the spirit or scope of the invention. Reference should therefore be had to the appended claims in determining the scope of the invention.

What I claim is:

1. In hydraulic fluid supplying apparatus for a press cylinder the combination of a primary source of hydraulic fluid under pressure, a control valve and conduit means interconnecting said source and said press cylinder, a pressure intensifier comprising a first cylinder having a piston therein and a second cylinder communicating with said press cylinder and having a ram therein coupled with said piston, means to simultaneously connect both ends of said first cylinder with said source, means to close said valve upon the fluid in said conduit means attaining a predetermined pressure, and means to thereafter relieve the fluid pressure on the ram side of said piston.

2. Apparatus according to claim 1 further characterized in that said means to relieve comprises means responsive to the attainment of a predetermined maximum pressure in said conduit means.

3. Hydraulic fluid supplying apparatus for a press cylinder comprising in combination a source of hydraulic fluid under pressure, a conduit interconnecting said source and said cylinder, a pressure intensifier having a high pressure cylinder interconnected with said press cylinder and an operating cylinder associated therewith, a ram in said high pressure cylinder, a piston in said operating cylinder rigidly connected with said ram, conduit means interconnecting said source with both ends of said operating cylinder, means responsive to the attainment of a predetermined back pressure in said source to block said conduit interconnecting said source and said press cylinder, and means responsive to the attainment of a predetermined back pressure in said source to relieve the fluid pressure in the ram end of said operating cylinder.

4. Hydraulic apparatus comprising a press cylinder, a source of hydraulic fluid under pressure, a conduit interconnecting said source and said cylinder, a normally open solenoid-operated valve in said conduit, a fluid pressure intensifier having its high pressure cylinder connected with said press cylinder and its low pressure cylinder connected to said source, a ram in said high pressure cylinder coupled with a piston in said low pressure cylinder, a switch responsive to the pressure in said source to establish an energizing circuit for said solenoid operated valve whereby said valve is closed upon a predetermined back pressure being reached in said source, and a switch arranged to be operated upon said ram reaching its fully retracted position to de-energize said solenoid operated valve, the arrangement being such that during retraction movement of the press and said intensifier said ram must reach a fully retracted position before said valve is opened.

5. In hydraulic apparatus having a press cylinder, a source of fluid pressure, and a pressure intensifier having a high pressure cylinder with a ram therein and a low pressure cylinder having a piston therein connected with said ram; the combination of a first conduit interconnecting

said high pressure cylinder and said press cylinder, a second conduit interconnecting said source and the outer end of said low pressure cylinder, a third conduit including a normally open valve interconnecting said source and said first conduit, a fourth conduit and a three-way valve to normally maintain fluid from said source in the inner end of said low pressure cylinder, said three-way valve having an exhaust port, the arrangement being such that at the start of a cycle of operation fluid from said source is furnished directly to said press cylinder through said third conduit while said ram is held in retracted position by the back pressure in said high pressure cylinder and by the back pressure in the inner end of said low pressure cylinder, means responsive to the attainment of a predetermined back pressure in said source to close said valve in said third conduit, and means responsive to the attainment of a predetermined back pressure in said source to shift said three-way valve whereby the fluid in the inner end of said low pressure cylinder is exhausted to allow forward movement of said ram.

6. Apparatus according to claim 5 further including a single-acting press pull-back cylinder, valve means and a fifth conduit to connect said source to said pull-back cylinder, a pressure relief valve interconnecting said pull-back cylinder and said fourth conduit whereby during the initial low-pressure actuation of said press cylinder

the fluid contained in said pull-back cylinder is added to the fluid of the source to increase the speed of movement of said press cylinder while after actuation of said three-way valve the remaining fluid contained in said pull-back cylinder is exhausted to thereby allow said press cylinder to exert its maximum force.

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