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This invention relates to hydraulic cushions for die pads of ram type presses.

In ram type presses having conventional hydraulic cushions, the pressure relief valve tends to bounce or vibrate on closing of the press due to the sudden rise in pressure and velocity of the hydraulic fluid on the high pressure side of the system and this causes frothing of the hydraulic fluid and generates excessive heat, both of which are objectionable.

The present invention substantially eliminates such bounce or vibration of the pressure relief valve upon closing of the press and thus minimizes, if not entirely eliminates, frothing and generation of excessive heat due to such valve action.

A principal object of the invention is to provide a new and improved hydraulic cushion for die pads of ram type presses.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawings which by way of illustration shows a preferred embodiment of the invention and what I now consider to be the best mode of applying the principles thereof.

In the drawings:

Fig. 1 is a schematic view of part of a hydraulic cushion embodying my invention; and

Fig. 2 is a schematic view illustrating the remainder of the cushion and showing a section of the pressure relief valve taken along the line 2—2 of Fig. 1.

This application is a continuation-in-part of my prior copending application Serial No. 455,270, filed September 10, 1954, for “Mechanisms for Hydraulically Controlling Movement of Pads in Dies,” now Patent No. 2,890,669.

A hydraulic cushion embodying my invention comprises in general one or more hydraulic cylinders 12, each provided with a reciprocating plunger or piston 14 therein arranged to rest on the die pad 10 of a ram type press, a tank 16 of hydraulic fluid under pressure, a pressure relief valve indicated generally at 18, a hydraulic fluid connection 20 between the tank 16 and the valve 18, a hydraulic fluid connection 22 between the valve 18 and each hydraulic cylinder 12 whereby hydraulic fluid under the pressure to which it is subjected in the tank 16 (say 80 to 100 pounds per square inch) is supplied to the hydraulic cylinders 12 and plungers 14 for biasing the die pad 10 to its extended position.

The hydraulic fluid connection 20 is connected at one end to the bottom of the tank 16 and at its other end to the cross passage 26 of the manifold 24. The bores 28 are interconnected by passages 32 which form part of a one-way by-pass around the pilot valve indicated generally at 34 and the unloading valve indicated generally at 36. Each of the hydraulic fluid connections 22 is connected to a manifold 38 having a manifold passage 40 therein. A passage 42 extends between the manifold passage 40 and one end of each of the bores 28. The by-pass just referred to includes a cross passage 44 intersecting and interconnecting the passages 42 and a plurality of passages 46 extending between the cross passage 44 and the passages 32.

A one-way check valve 48 associated with each passage 46 permits flow of hydraulic fluid from the passage 32 through the passage 46 into the cross passage 44 and the passages 42 under the pressure to which the hydraulic fluid in the tank 16 is subjected, but prevents return flow of such fluid from the passage 44 to the passage 32 through the passages 46. The valves 34, 36 and 48 normally separate the low pressure side of the system from the high pressure side thereof where the pressure may rise during the closing of the press to 1000 pounds per square inch or whatever pressure the valve 18 is set for. Thus hydraulic fluid under pressure to which it is subjected in the tank 16 reacts on the plungers 14 for biasing the die pad to its extended position.

Displacement of the hydraulic fluid in the cylinders 12 by movement of the plunger 14 due to movement of the die pad 10 upon closing of the press is controlled by the unloading valve 36 and the pilot valve 34 which together form the pressure relief valve 18 whereby suitable resistance to displacement of hydraulic fluid from the cylinders 12 and the high pressure side of the system may be obtained so as to provide a hydraulic cushion for the die pad.

The pilot valve 34 includes a piston valve member 50 which is normally seated on an annular seat 52 provided on a valve member 54, the seat 52 surrounding one end of a passage 56 in the valve member 54. The piston valve member 50 is reciprocable in a bore 58 provided in the body or block 60 of the valve 18, and a spring 62 disposed in the bore 58 is arranged to react on the piston valve member 50 and on one end of a pin 64 for seating the piston valve member 50 on its seat 52. The pin 64 is axially movable in a guide 66 secured in place by cap 68 suitably secured to the body 60, and an adjusting screw 70 is provided for reacting on the head of the pin 64 whereby the pressure at which the pilot valve 34 opens may be adjusted.

The unloading valve 36 comprises a cup-shaped valve member 72 and a plurality of circular valve ports 74 provided in the side wall of a sleeve 76 disposed within the bore 28 below the valve member 54. The ports 74 on the upstream side thereof are provided with V-shaped notches in the edges thereof first exposed on opening movement of valve member 72 so as to minimize frothing of the high pressure fluid as it escapes through ports 74. The sleeve 76 is of such a shape as to form an annular passage 78 between the outside of the sleeve and the inside of the bore or recess 28, with which the passages 30 and 32 and the ports 74 communicate. A spring 80 confined between the sliding valve member 72 and the valve member 54 biases the valve member 72 to its lowest possible position and so as to close the ports 74. The interior of the sleeve 76 forms a valve bore, one end of which communicates with one end of the passage 56 while the other end which communicates with one end of the passage 42 which forms a part of the hydraulic fluid connection 22 of the hydraulic clinders 12. The valve member 72 is provided with a passage 82 therethrough, such passage being of smaller effective cross section than that of the passage 56.

A plurality of unloading valves 36 are illustrated, the same being arranged in parallel in a by-pass around the valve 34 and being of the same construction, with the
possible exception that only one of them need be provided with a passage 82. The number of valves 36 used de-
pends upon the hydraulic fluid capacity of the high pres-
sure side of the system. The bores internally provided by the sleeves 76 of the other of the valves 36 are each connected by a passage 84 to a cross passage 86 which communicates with a cross passage 90 in the valve mem-
ber 54 which intersects the passage 56. A conduit 92 around the valve 34 interconnects the bore 58 adjacent the valve seat 52 with the annular passage 78 whereby fluid which passes the valve 34 when the same is open may react through the conduit 92, the annular passage 78, and the passage 30 to the hydraulic connection 20.

Assuming that the system is charged with a suitable hydraulic liquid and a pressure of the order of 100 pounds per square inch is imposed on the hydraulic fluid in the tank 16 through the air pressure line 94, such pressure will react on the fluid in the system to cause the plungers 14 of the hydraulic cylinders to bias the die pad 10 to its extended position. At this time the pressure throughout the system is equalized. The springs of the check valves 45 exert only sufficient pressure on the valves to seat the same and hence offer little resistance to flow of fluid from the passages 46 into the passages 44 and 42. Upon closing of the press the die pad 10 will be moved downwardly and react on the plungers 14 so as to displace hydraulic fluid from the cylinders 12. The displacement of such fluid from the cylinders 12 and the high pressure side of the system will be resisted by the pilot valve 36 and unloading valve 30. However, the pilot valve 34 will open when the pressure on the high side of the system exceeds the resistance for which the pilot valve 34 is set. The variable speed of the ram during the closing of the press so reacts on the die pad 10 and the plungers 14 as to cause a very rapid and sharp increase in pressure and velocity on the fluid in the high pressure side of the system which creates a sudden impact upon the valve member 50 of the pilot valve 34, thereby suddenly opening the same in such a way that the valve 50 would bounce or vibrate except for the cushioning effect obtained by the unloading valve 36 which upon opening by-passes high pressure fluid from the high pressure side of the system around the pressure relief valve 34. The result is pressure drop on the spring side of the unloading valve member 72 attending the initial opening of valve 34 coupled with the resistance to flow of oil through passage 82 will cause valve member 72 to travel and uncover passage 74 a short time interval after the opening of valve 34, thereby discharging oil from the high pressure side of the system through ports 74. This dissipates the effects of the sudden increase in pressure and velocity of the hydraulic fluid and the resulting reaction on valve 50, and positions the valves 50 and 72 for the steady relief of oil from the high pressure side of the system. I have found that this arrangement minimizes, if not entirely eliminates, frothing and generation of excessive heat due to the bounding action of the pressure relief valve experienced in conventional hydraulic cushions and eliminates the necessity of water cooling such valves, as is sometimes necessary. While I have illustrated and described a preferred embod-
iment of my invention, it is understood that this is capable of modification, and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

1. In a ram type press having a die pad, a hydraulic cushion for said die pad providing at least one hydraulic cylinder provided with a reciprocating plunger therein arranged to react on said die pad, a tank of hydraulic fluid and a hydraulic circuit whereby hydraulic fluid under pressure is sup-
pplied from said tank to said hydraulic cylinder and plunger for biasing said die pad to its extended position, said unloading valve member being normally disposed between said hydraulic connection to said second bore and the valve port in the side thereof so as to be movable in response to the flow of hydraulic fluid in said second fluid connection produced by movement of said plunger by said die pad upon closing of the press, and an open passage having a portion thereof of smaller effective cross section than that of said passage in said valve member between said second hydraulic fluid con-
nection and said passage in said valve member, a part of said by-pass including a fluid flow path around and in heat exchange relation with a part of said bore whereby heat generated therein is absorbed by hydraulic fluid as it flows through said path toward said hydraulic cylinder.

2. Apparatus according to claim 1 wherein said second bore is provided by a sleeve in and spaced from the wall of a recess in said valve body, the space between said sleeve and recess being filled with hydraulic fluid.
cylinder provided with a reciprocating plunger therein arranged to react on said die pad; a tank of hydraulic fluid under pressure, a fluid connection between said tank and said cylinder having a check valve therein whereby hydraulic fluid under pressure is supplied from said tank to said cylinder and plunger for biasing said die pad to its extended position but return flow through such connection is prevented, a second fluid connection between said tank and cylinder having a pressure relief valve therein whereby resistance to displacement of hydraulic fluid from the cylinder is provided so as to form a hydraulic cushion for said die pad, and a by-pass around said pressure relief valve and including a plurality of normally closed unloading valves disposed in parallel in said second fluid connection between said pressure relief valve and said cylinder, said unloading valves opening in response to a predetermined pressure differential across said valve following the opening of said pressure relief valve.

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