March 2, 1965 J. V. PERRONE 3,171,640

HYDRAULIC CUSHION AND RETURN DEVICE FOR DIES

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FIG. 1

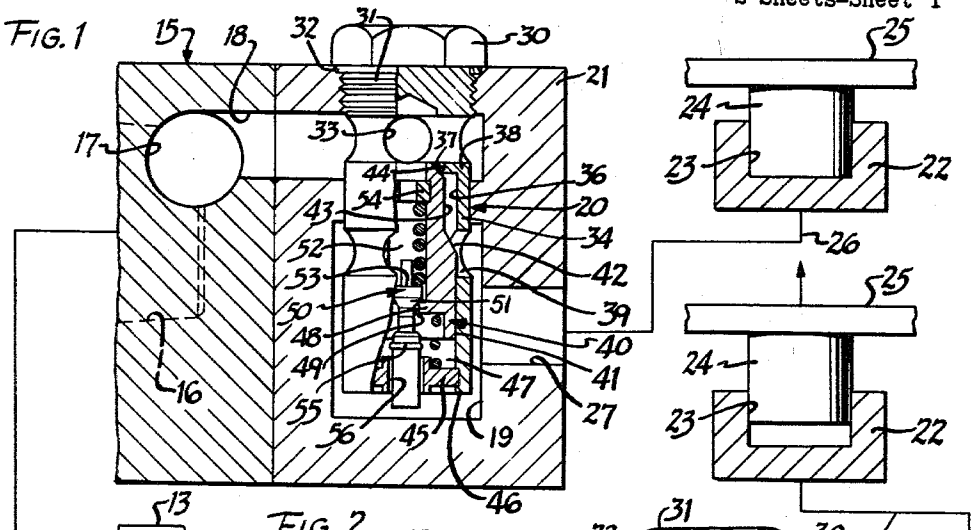


FIG. 2

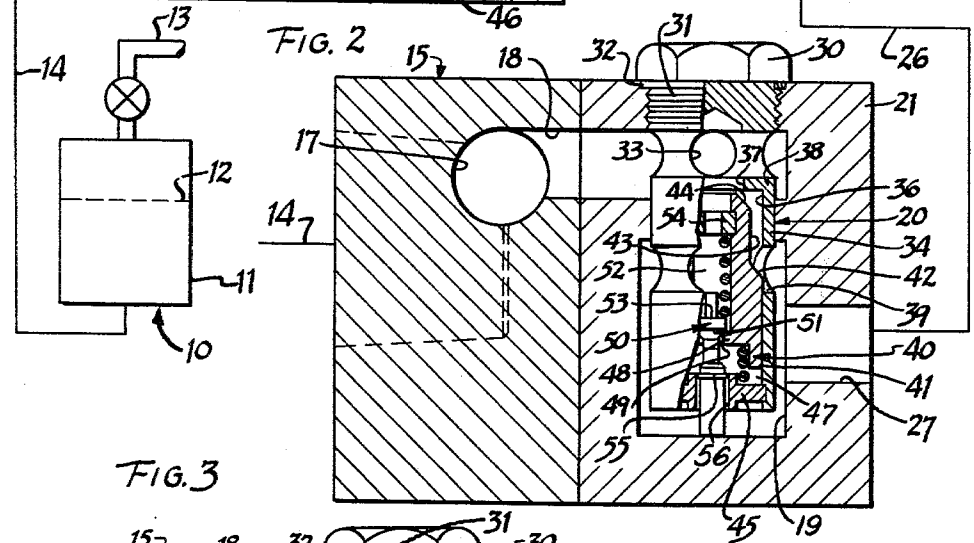
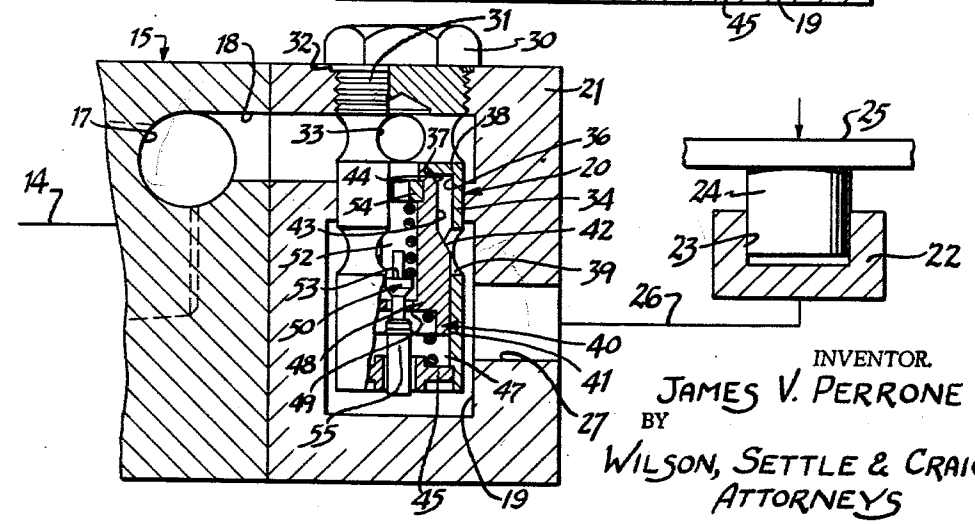


FIG. 3



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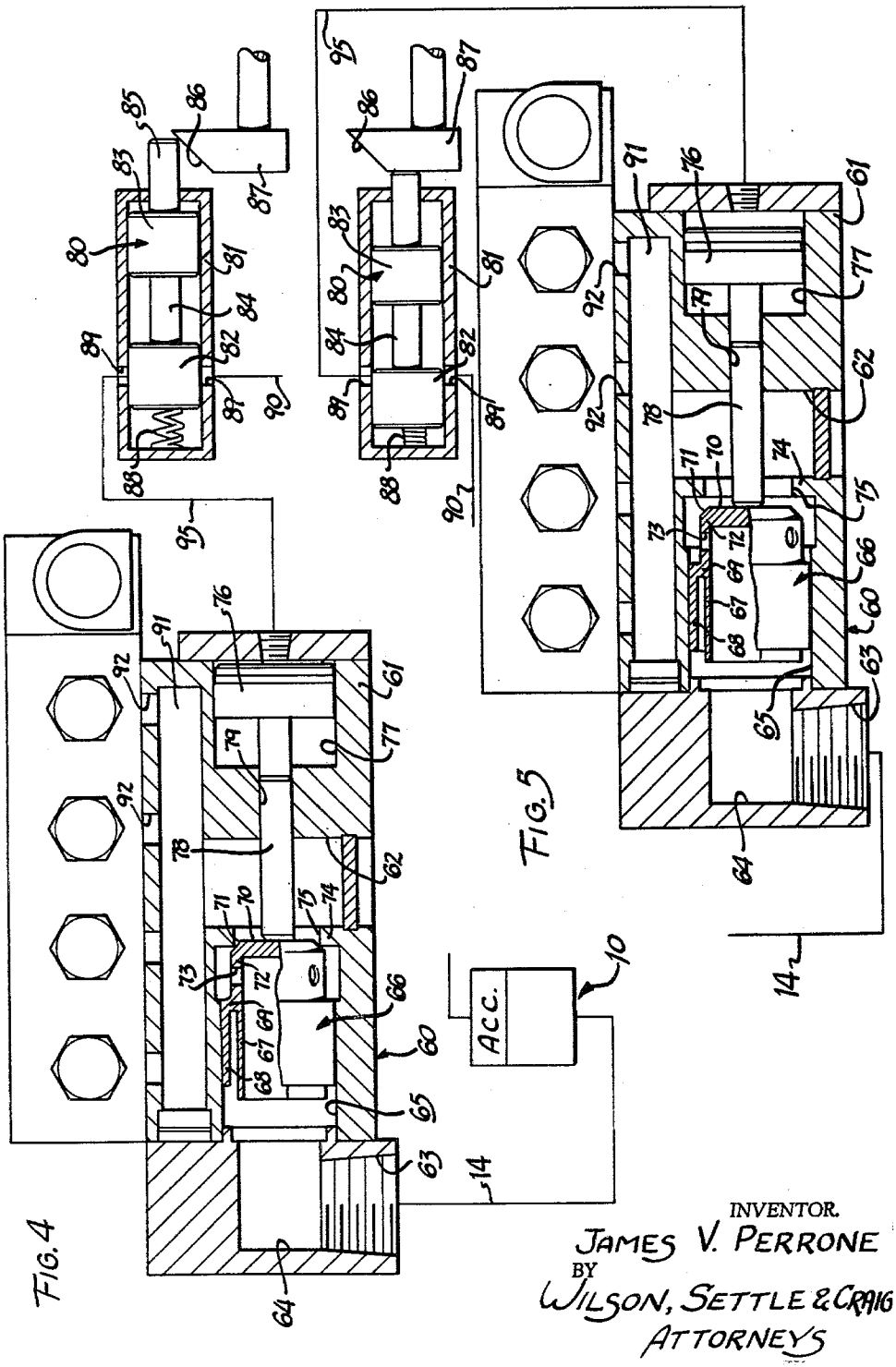


FIG. 4

FIG. 5

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HYDRAULIC CUSHION AND RETURN DEVICE FOR DIES

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2 Claims. (Cl. 267—1)

The present invention relates to a die pad control mechanism for a press and more particularly to a hydraulic control system for controlling the movement of a die pad to and from a working position in a press.

In modern, high speed presses commonly utilized for performing stamping, drawing or other operations upon sheet metal, it is necessary to provide for the accurately controlled movement of the die pad normally carrying the lower of the cooperating die elements of the press. It has been proposed that this die pad be mounted upon a plurality of individual hydraulically actuated cylinder and piston assemblies and that these assemblies be controlled from a common control valve or set of control valves. The die pad conventionally contacts the pistons of the assemblies and is movable with these pistons. Upon actuation of the press to its closed or "working" position, the pistons are forced downwardly within the cylinder block to subject hydraulic fluid trapped beneath the piston in the cylinder block to a pressure proportional to the working pressure of the press. Upon venting of this hydraulic pressure in a controlled manner, the consequent downward displacement of the die pad during the working stroke of the press is accommodated. Upon opening of the press, i.e. usually vertical retraction of the upper die member, the hydraulic fluid is fed back into the cylinder block beneath the pistons to elevate the die pad to its initial position prior to the next subsequent working stroke of the press. In some instances, e.g. to aid in stripping complex or deeply drawn parts from the press dies, it is desirable to delay elevation of the die pad to its initial position.

Several expensive and complicated valving assemblies have been proposed for controlling the movement of the die pad, both during the working stroke of the press and during return of the die pad to its initial or starting position. Such previously proposed valving systems as have been heretofore utilized are difficult to initially install, set up and maintain during use, are expensive and complicated in construction, arrangement and installation, and are inflexible in their adaption to the widely variant working conditions encountered in changes from one set of dies to another within a given press.

The present invention now proposes a new and novel valve structure for controlling the movement of a die pad to and from a working position in a press. Generally, the basic valve structure of the present invention includes a main valve body which may be used singly or in multiples to provide flexible valving arrangements capable of accommodating a wide variety of operating conditions at which the amount of fluid displaced and the fluid pressures encountered are widely variant. Each such main valve body is provided with an inlet element serving to control the flow of fluid into the cylinder block to displace the die pad pistons therein and a single outlet capable of controlling the operation of the inlet element so as to accommodate the flow of hydraulic fluid from a cylinder block during displacement of the die pad upon press actuation.

One fundamental advantage of the present invention resides in the utilization of the single inlet element of each valve body as the sole flow-controlling element for fluid flow both to and from the cylinder block and the utilization of the outlet element merely as a control device for the inlet element during flow of fluid in one direction only therethrough.

In those instances in which return of the die pad to its initial or starting position is desired, an inlet delay valve assembly is utilized in conjunction with the main valve assembly heretofore described. This inlet delay valve assembly is press-actuated and prevents the return flow of fluid to the cylinder block to displace the die pad to its initial starting position until such time as the proper stage of press actuation has been reached. The inlet delay valve assembly is preferably pneumatically actuated and is interposed between the source of fluid under pressure and the main valve assembly, so as to prevent any flow of fluid to the cylinder block to actuate the pistons and the die pad to their initial positions for the next subsequent press actuation, thus positively delaying the die pad return.

It is, therefore, an importnt object of the present invention to provide a new and novel control valve assembly for controlling movement of a die pad to and from a working position in a press.

Another important object of this invention is the provision of an improved and substantially simplified valve assembly for controlling actuation of a die pad for a press, the valve assembly including a single element through which the flow of hydraulic fluid occurs during complete cycling of the press.

Another important object of this invention is the provision of a hydraulic valve assembly particularly adapted for utilization in conjunction with a die pad control mechanism for a press and including a single valve element through which hydraulic fluid flow occurs upon actuation of the press die pad in either direction, operation of the single valve element in one such direction only being in response to actuation of a separate control valve element.

It is a further, and no less important, object of the present invention to provide an improved die pad actuation mechanism for a press including a main control valve element controlling the flow of hydraulic fluid between a source of fluid and a die pad cylinder block and a delay valve assembly interposed between the source of fluid under pressure and the valve element to prevent flow to the cylinder block until after the delay valve has been actuated in response to press actuation.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

On the drawings:

FIGURE 1 is a somewhat schematic representation of a die pad control mechanism for a press and illustrating in detail a hydraulic control valve of the present invention in a neutral or non-actuated position;

FIGURE 2 is a view similar to FIGURE 1, but illustrating the valve in an actuated position;

FIGURE 3 is a view similar to FIGURES 1 and 2 but illustrating the valve in another actuated position;

FIGURE 4 is a somewhat schematic representation of a die pad control mechanism similar to that of FIGURE 1 but provided with a press-actuated inlet delay valve illustrated in a non-actuated position;

FIGURE 5 is a view similar to FIGURE 4 but illustrating the inlet delay valve in its actuated position.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

As shown on the drawings:

In FIGURE 1, reference numeral **10** refers generally

to an accumulator providing a source of hydraulic fluid under pressure. The accumulator **10** may take any desired form but generally may be a cylindrical casing **11** containing a body of hydraulic fluid, e.g. to the indicated level **12**, the upper end of the casing **11** communicating with a conduit **13** connected to a source of air or similar fluid under pressure. The accumulator is connected, as through conduit **14**, to a main valve block **15** having an inlet opening **16** communicating with the conduit **14** and a transverse passage **17** communicating through one or more branch passages **18** with an open-topped valve body recess **19**.

Positioned within the valve body recess **19** is a main valve body **20**. It will be appreciated that a number of similar, parallel valve body recesses **19** may be provided in a single valve block **21**, each such recess **19** in the block **21** receiving therein a valve body **20**. The number of such main valve bodies **20** provided within any given block **21** is dependent upon the fluid flow required for a given installation, and the utilization of a plurality of such valve bodies **20** permits the utilization of valve bodies of standard size and capacity under a wide variety of operating conditions.

Each such valve body establishes and controls communication between the accumulator **10** and a cylinder block **22** having therein a plurality of recesses **23** snugly receiving pistons **24** contacting the undersides of a die pad **25**, in a manner well known in the art. The cylinder block recesses **23** communicate with the main valve block **21** by means of conduits **26**, valve block ports **27**, and valve body recesses **19** into which the main valve body **20** depends. One or more cylinder recesses **23** communicate with each main valve body port **27** so that each main valve body **20** controls the flow of hydraulic fluid between one or more cylinder recesses **23** and the accumulator **10**.

The main valve **20** comprises an upper, preferably hexagonal valve body head **30** overlying a threaded valve body boss **31** received by a threaded opening **32** defined in the main valve block **21**. Beneath the threaded portion **31**, the main valve body is provided with a plurality of ports **33** establishing communication between the inlet port **18** and the lower cylindrical valve body portion **34**. This main valve body portion **34** is provided with an enlarged body recess **36** communicating through an upper valve opening **37** with the valve ports **33**, the valve opening **37** being defined at the inner periphery of an annular end wall **38** defining a valve seat at the opening **37**. The main valve body portion **34** is provided with radial ports **39** establishing communication between the interior opening **36** thereof and the valve block recess **19**.

Disposed interiorly of the main valve body is a valve inlet element **40** having a lower cylindrical exterior surface **41** snugly mating with the inner surface **36** of the valve body **34** and merging through a frusto-conical inclined portion **42** with a reduced diameter nose portion **43** terminating at the free upper end in a frusto-conical peripheral seat **44** sealingly engageable with the valve body wall **38** to prevent the flow of fluid through the valve aperture **37**.

The lower extremity of the valve body portion **34** is recessed to receive interiorly thereof a radially extending orifice plate **45** retained in position by suitable means, as by a snap ring **46**. Bottomed against the upper surface of this orifice plate **45** and confined thereby against the undersurface of the inlet element **40** is a coiled compression spring **47** urging the valve inlet element **40** upwardly, so that the tapered seat **44** seats snugly against the wall **38** to prevent the flow of fluid from the inlet ports **33** through the valve port **37**.

The inlet element **40** is provided with an inwardly directed shoulder **48** circumscribing a circular valve port **49**. The flow of fluid through this valve port **49** is controlled by an outlet element **50**.

This valve element **50** is provided with a lower, downwardly facing frusto-conical valving surface **51** cooperable with the valve port **49** to prevent the flow of fluid therebetween. The valve element **50** is urged against the shoulder **48** into sealing relation with the port **49** by means of a coiled compression spring **52** acting upon the free upper surface **53** of the valve element and urged thereagainst by an annular snap ring or the like **54** carried by the inlet element **40**. The outlet element **50** is provided, beneath the frusto-conical surface **51** thereof with a depending extremity of reduced diameter axially projecting into a freely vertically displaceable, generally cylindrical orifice pin **55**. This orifice pin **55** depends freely through the central cylindrical orifice **56** of the orifice plate **45**, the pin serving to keep the orifice free of any dirt or other debris which might become lodged therein.

The operation of the device is well illustrated by a comparison of FIGURES 1, 2 and 3. In the neutral or non-actuated position of FIGURE 1, the die pad **25** is illustrated in its lowermost position, with the piston **24** being bottomed within the cylinder recess **23**. At this position, the inlet element **40** is displaced upwardly by the compression spring **47** to close the valve port **37** and to interrupt any communication between this valve port **37** and the radial valve ports **39**. At the same time, the outlet element **50** has its conical surface **51** in sealing engagement with the shoulder **48** to interrupt flow through the valve port **49**, by virtue of the coiled compression spring **52** urging the valve element **50** to its illustrated or lower position.

In the condition of FIGURE 2, fluid from the accumulator **10** under the pressure of air or other gas in the accumulator cylinder **11** displaces fluid under pressure through the line **14**, the passage **16**, the transverse passage **17** and each of the inlet passages **18** for flow through the radial inlet passages **33** of the main valve body **20**.

Assuming that the pressure within the accumulator and exerted upon the hydraulic fluid is on the order of 50 pounds per square inch, such pressure is sufficient to overcome the compression force of the spring **47**, and the inlet element **40** is displaced downwardly against the spring to open communication between the upper or axial valve port **37** and the lower, radial valve ports **39**. The resultant flow of fluid from the accumulator through the valve block recess **28** and the port **37** enters the conduit **26** and displaces the piston **24** upwardly to thereby elevate the die pad **25** to its operating position for the next subsequent press stroke. External stops are conventionally provided for the die pad to position the die pad in its proper relation to the press and the movable die element carried thereby.

Upon actuation of the press, the die pad **25** is depressed and the piston **24** is similarly depressed to generate within the cylinder space **23** substantial hydraulic pressure. This pressure is exerted through line **26**, port **27** and valve block recess **19** upon the main valve assembly. This inlet element **40** is balanced against such pressure, the pressure being vented through the orifice **56** of the plate **45** against the entire undersurface of the inlet element **40**, and the pressure being exerted in the reverse direction upon the inlet element **40** against the inclined surfaces **44** and **42** thereof by flow through ports **39**. However, the pressures upon the undersurface of the inlet element **40** act against the outlet element **50** only in opposition to the compression spring **52**.

When the pressure against the chamfered or inclined face **51** of the outlet element becomes sufficient to overcome the compression force of the spring **52**, the outlet element **50** is displaced upwardly, thereby opening the valve port **49**. The opening of the port **49** relieves the pressure on the undersurface of the inlet element **40**. As a result, the inlet element is no longer subject to balanced pressures, but to an unbalanced pressure acting on the

chamfered surfaces 42 and 44 to displace the inlet element downwardly against compression spring 47. That fluid under pressure passing through the lower inlet element port 49 will, of course, flow upwardly through the hollow inlet element and through the upper radial ports 33. Upon downward displacement of the inlet element 40, the pressure will be vented through the lower radial ports 39, between the concentric spaced surfaces 36 and 43 of the valve body 34 and the inlet element 40, respectively through the upper valve port 37 and finally through the upper radial ports 33 into the passage 18. Fluid thus displaced by the piston 24 can now flow freely through the main valve body, by virtue of opening of the inlet element through the passages 17 and 16 and the conduit 14 into the accumulator, thereby accommodating movement of the die pad 25 downwardly under the displacement force of the press. The pressure of fluid so flowing to the accumulator will be modulated by the combination of the outlet element 50 and the inlet element 40.

After the die pad 25 has reached its lowermost position because of actuation of the press, pressure will be maintained in the piston space 23 until such time as the die pad begins its upward stroke when press actuation completes its full cycle. At this time, the cycle heretofore described will be repeated.

In the event that return of the die pad to its upper position by fluid under pressure from the accumulator is to be delayed in order to facilitate stripping of a formed part or the like, that embodiment of the invention illustrated in FIGURES 1 through 3 is supplemented by the structure illustrated in FIGURES 4 and 5. In effect, the structure of FIGURES 4 and 5 includes an externally actuated return valve structure 60 which is interposed between the main valve casing 21 and the accumulator 10.

More particularly, the structure 60 includes an inlet delay valve casing 61 having an interior flow passage 62 communicating with the accumulator 10 through casing port 63 and inlet port 64. Interposed between the flow chamber 62 and the inlet port 64 is a valve chamber 65 within which is disposed a fluid pressure displaceable inlet delay valve body 66. This inlet delay valve body 66 comprises a generally cylindrical inner body element 67 surrounded by a cylindrical sleeve 68 joined to the body 67 at its leading end, as at shoulder 69. The forward end of the inlet delay valve body is provided with a circular end face 70 circumscribed by a chamfered sealing surface 71 merging into a cylindrical portion 72 which is provided with a plurality of radial flow passages 73. Interposed between the valve body portion 65 and the flow passage 62 of the inlet delay valve casing 61 is a radial valve seat 74 having an annular sealing edge 75 cooperating with the chamfered sealing face 71 of the piston 66.

A pneumatically actuated piston 76 is disposed in a pneumatic cylinder chamber 77 axially aligned with the inlet delay valve body 66 and provided with an elongated cylindrical piston rod 78 contacting the flat forward face 70 of the valve body or piston 66. The piston rod 78 projects through a cylindrical aperture 79 formed in the inlet delay valve casing 61. A press-actuated valve 80 is provided to actuate the pneumatic piston 76 by means of an air supply line 95 joining the chamber 77 to the valve 80. The valve 80 includes a generally cylindrical valve casing 81 within which is disposed a valve spool having first and second enlarged cylindrical portions 82 and 83, respectively, joined by a central reduced cylindrical portion 84. Carried by the valve spool and projecting beyond the casing 81 is an actuating rod 85 contacting a chamfered cam face 86 of a press-actuated cam 87. The cam 87 is displaceable vertically with the press during each stroke of the press, in a manner well known in the art, and contact between the cam face 86 and the actuating rod 85 will displace the valve spool to the left against compression of return spring 88 to control the flow of fluid pressure through ports 89 in the press valve casing 81, thereby controlling the flow of air under pressure from supply line 90 into the line 95 for the piston 76.

The fluid flow passage 62 communicates with an elongated distribution passage 91 which, in turn, establishes communication through ports 92 with each of the main valve bodies heretofore described.

The operation of the structure illustrated in FIGURES 4 and 5 will be readily appreciated by those skilled in the art. Upon the downward displacement of the die pad 25, as illustrated in FIGURE 3 of the drawings, hydraulic fluid under pressure flowing through the main valve body and through the ports 18 will flow through the registering ports 92 into the elongated passage 91 and the flow passage 62 of the inlet delay valve casing 61. Such hydraulic pressure, acting on the full diameter of the valve body 66, will displace the inlet delay valve body 66 to the left against the pressure exerted through line 14 from the accumulator 10. As a result, the fluid under pressure will flow between the chamfered valve body surface 71 and the sealing edge 75 of the casing wall 74, through the ports 73 and through the interior of the body portion 67 of the inlet delay valve body and finally through the ports 64 and 63 and the line 14 back to the accumulator 10.

Upon the release of the force of the press exerted downwardly on the die pad 25, the accumulator will attempt to displace hydraulic fluid through the inlet delay valve 60 and the main valve body into the piston chamber 23. However, such fluid cannot pass the inlet delay valve body 66, since the entire diameter (the left end of the valve body 66, as viewed in FIGURES 4 and 5) of the inlet delay valve body is subjected to such pressure to urge the valve body to the right, while there is no substantial pressure in the cylinder recesses 23 and attempting to displace the valve body to the left. As a result, no flow between the accumulator and the flow passage 62 can occur. After vertical retraction of the press actuation parts, i.e. to an extent such that the cam face 86 contacts the actuating rod 85 to displace the press valve 80 to the left against the compression of spring 88, the valve spool 82 is displaced from its position of FIGURE 4 to its actuated position of FIGURE 5.

At this time, air pressure from the line 90 passes in through the line 95 and acts upon the right hand face of the piston 76 to displace this piston to the left. The net force from the accumulator acting to displace the inlet delay valve body to the right is less than the total force exerted to the left by the piston 76, even though the pressure in the accumulator and the pressure in the line 95 acting upon the piston 76 may be the same.

Thus, the inlet delay valve body 66 is displaced to the left and hydraulic fluid under pressure from the accumulator 10 flows through the line 14, the ports 63 and 64 into the inlet delay valve body 66, through the ports 73 and intermediate the chamfered face 71 of the valve body and the sealing edge 75 of the wall 74 into the flow passage 62. From this flow passage 62 flow occurs through the passage 91 and the individual passages 92 and finally through the main valve body to displace the inlet element 40 to its position of FIGURE 2, so that the flow of hydraulic fluid to the cylinder space can occur. The length of the cam face 86 determines the time during which the valve 80 is actuated.

Thus, it is evident that the structure of FIGURES 4 and 5 is effective to prevent the flow of fluid under pressure to the cylinder space to elevate the die pad until such time as the press has been actuated to an extent sufficient to actuate the press valve 80 by the press cam 87.

Having thus described my invention, I claim:

1. In a fluid flow control valve,

a valve body having first and second coaxial bores separated by an annular radial wall,

a hollow piston slidable in said first bore,

a valve seat on said annular wall sealingly engageable by said piston,

a port in said piston providing flow between said first bore and said seat,

a second piston in said second bore having a piston rod extending into engagement with said hollow piston to move said hollow piston away from said port,

and fluid means for moving said second piston in a direction to force said hollow piston away from said port.

2. In a cyclically operable hydraulic press having an accumulator and a press actuated die pad cushion cylinder; means for controlling the flow of hydraulic fluid between said accumulator and said cushion cylinder comprising a conduit defining the sole path of fluid communication between the accumulator and the cylinder, a pressure responsive valve in said conduit operable to block the flow of fluid in either direction through said conduit when the pressure in said accumulator exceeds the pressure in said cylinder and operable to permit the flow of fluid from said cylinder to said accumulator when the pressure in said cylinder exceeds the pressure in said accumulator, said pressure responsive valve including means defining an enlarged diameter piston chamber in said conduit having a reduced diameter valve seat at the end of said chamber connected to said cylinder, and a hollow piston slidable in said chamber and having a valve head thereon sealingly engageable with said seat, said valve

head being of a diameter greater than that of said seat and less than that of said chamber, means defining ports through said piston opening radially through said head into said piston chamber, and press actuated means operable at a predetermined point in the cycle of operation of the press when the pressure in said accumulator normally exceeds the pressure in said cylinder for opening said pressure responsive valve to permit fluid to flow from said accumulator to said cylinder.

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