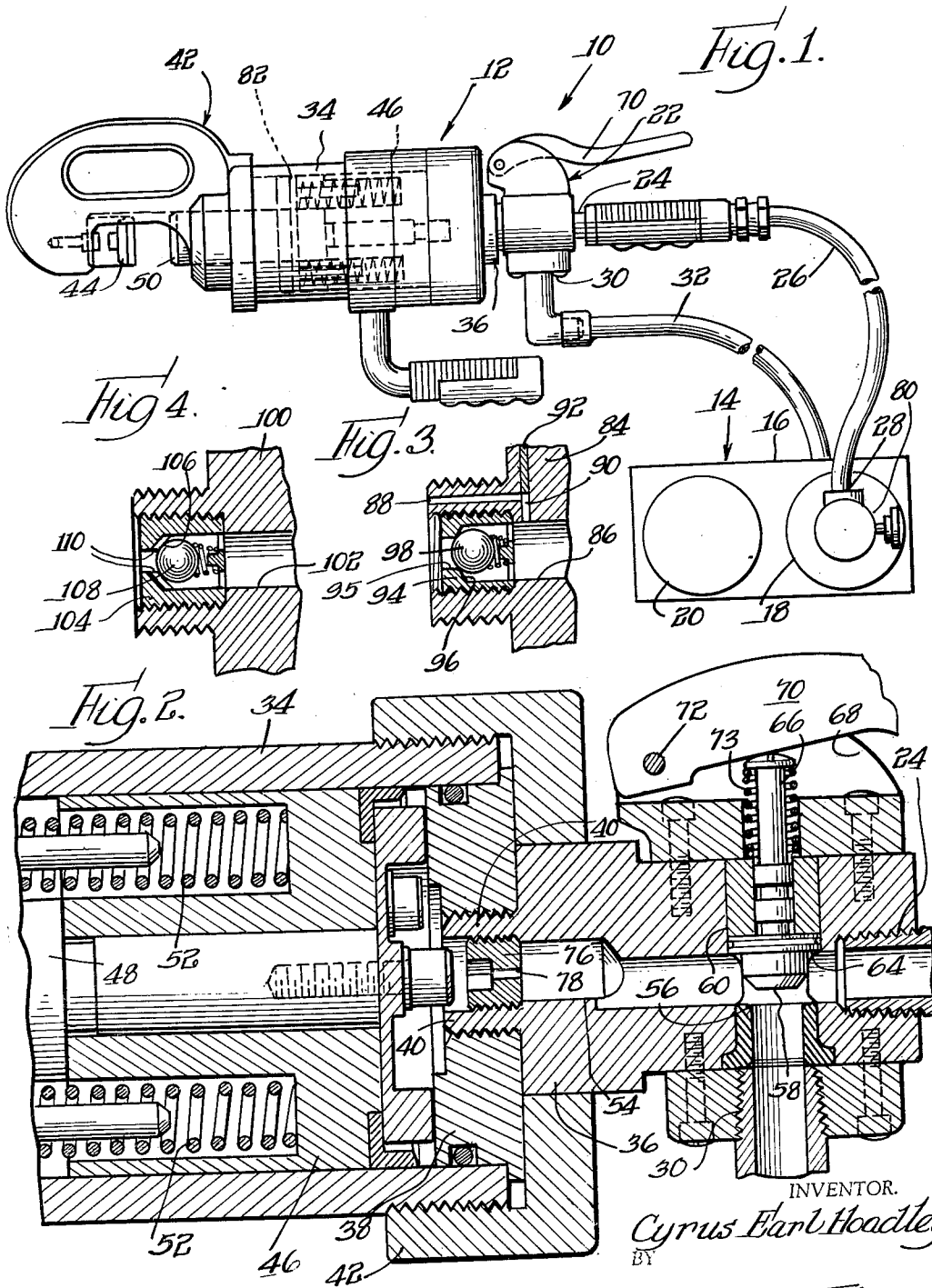


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HYDRAULICALLY ACTUATED TOOL

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HYDRAULICALLY ACTUATED TOOL

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The present invention relates to novel cutting or punching apparatus and the like, and more particularly to a novel apparatus for cutting, punching or similarly working of relatively hard material such as metal by means of a hydraulically actuated tool.

While apparatus utilizing various hydraulically actuated tools may be improved in accordance with the present invention, the disclosure will be directed particularly to cutting apparatus for the purpose of facilitating illustration of the invention.

The apparatus contemplated herein comprises a tool having a piston actuated blade, which tool is connected by a hose or pipe to a pump or other source of hydraulic fluid under high pressure. The pump is continuously driven and means is provided for recirculating the fluid between work cutting operations. During a work cutting operation, the tool is associated with a workpiece and then operated so that the blade is forced through the workpiece. It has been found that at the instant the blade breaks through the material of the workpiece the rate of travel of the blade or ram and piston connected thereto is sharply accelerated and the tool is subjected to a shock. As a result the useful working life of the tool is reduced and maintenance time and cost are substantially increased. It has been found that the sudden acceleration of the piston and blade is caused by a sudden inrush of hydraulic fluid into the piston chamber when the resistance of the workpiece is broken. This inrush of hydraulic fluid or oil when the system is operated under high fluid pressures may be at a rate far in excess of the normal delivery rate of the pump so that the piston is driven sharply against an internal stop in the tool. The high rate of oil flow results from the fact that the compressibility of the oil and the expansion of the hose or pipe under high pressures combine to act as an accumulator which is capable of delivering oil instantaneously at a high rate when the tool breaks through the workpiece so that the cutting pressure is instantaneously relieved.

It is an important object of the present invention to provide a novel apparatus of the above described type, which apparatus is constructed so as substantially to reduce or eliminate any undue shock to the tool when the resistance of the workpiece is broken.

A more specific object of the present invention is to provide a novel apparatus of the above described type including a hydraulically actuated tool, which tool is constructed so as to limit the rate of flow of hydraulic fluid under pressure thereto sufficiently to eliminate any undue shock to the tool when the resistance of the workpiece is broken.

Another more specific object of the present invention is to provide a novel apparatus of the type mentioned in the preceding paragraphs wherein means is provided for limiting inrush of hydraulic fluid to the piston of the tool while at the same time the apparatus is constructed so that at the end of a cutting operation or the like, the hydraulic fluid may be quickly discharged to facilitate rapid return of the tool piston.

Other objects and advantages of the present invention will become apparent from the following description and the accompanying drawings wherein:

FIG. 1 is an elevational view showing an apparatus incorporating the features of the present invention;

FIG. 2 is an enlarged fragmentary longitudinal partial

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sectional view taken in a vertical plane of the apparatus shown in FIG. 1;

FIG. 3 is a fragmentary partial sectional view taken along substantially the same plane as FIG. 2 but showing a modified form of the present invention; and

FIG. 4 is a fragmentary partial sectional view similar to FIG. 3 but showing a further slightly modified form of the present invention.

Referring now more specifically to the drawings wherein like parts are designated by the same numerals throughout the various figures, an apparatus 10 incorporating the features of the present invention is shown in FIGS. 1 and 2. The apparatus comprises a tool generally designated by the numeral 12, which tool is shown in the form of a rod cutter for the purpose of illustrating the present invention, but it is to be understood that the apparatus might also include various types of hydraulically actuated cutters, punches, and the like. A unit 14 is provided for supplying hydraulic fluid or oil under pressure to the tool 12, which unit includes a reservoir 16, a pump 18 and a motor 20 drivingly connected with the pump. The apparatus is provided with control valve means 22 which in this embodiment is a portion of the tool 12. The valve means or assembly 22 has an inlet port 24 connected by a hose or pipe 26 to an outlet 28 of the pump. An outlet 30 of the valve assembly is connected by a pipe or hose 32 to the reservoir.

The tool 12 includes a main body or cylinder 34 having a body member 36 of the valve assembly secured thereto by means of an adapter ring 38 into which a reduced diameter portion 40 of the valve body is threaded and a nut member 42 threaded onto the body 34 and overlying the adapter ring. A head assembly 42 is secured to the opposite end of the cylinder 34 and carries a fixed blade 44. A piston 46 is slidably disposed in the chamber within the cylinder 34 and is connected to a ram 48 which in turn is connected to or integral with a movable blade 50. Springs 52 are provided for urging the piston toward the position shown in FIGS. 1 and 2 so as to open the blade 50. A passageway 54 is provided through the valve body 36 so that when the control valve is actuated in the manner described below, hydraulic oil under pressure is introduced into the piston chamber so as to shift the piston against the action of the springs 52 and force the cutting blade 50 through a workpiece.

The valve assembly 22 is provided with a valve seat 56 in the outlet opening 30, and a valve member 58 is slidably disposed in a bushing 60 opposite the outlet opening for engaging the valve seat. A flange 64 on the valve member is engageable with the bushing for limiting outward movement of the valve member. A pin 66 formed integrally with the valve member 58 extends outwardly of the valve body through an aperture in the base of a bracket 68 to which bracket an actuating handle 70 is connected by pivot pin 72. The valve member is urged to its open position by a spring 73. With the valve member 58 opened, hydraulic fluid entering the port 24 will circulate back to the reservoir 16 without actuating the piston. When it is desired to actuate the piston 46 and the blade member 50, the handle 70 is depressed for shifting the valve member 58 to engage the valve seat 56 so that hydraulic fluid under pressure will be delivered through the passageway 54 to the piston.

It is important to note that in the passageway 54, preferably immediately adjacent the piston chamber, there is provided a member 76 which is threaded into an end portion of the passageway 54 and which is provided with a restricted orifice 78. The apparatus with the restricted orifice means therein is operated in the following manner. The motor 20 and pump driven thereby are operated continuously so that with the operating handle 70 in the raised position shown in FIGS. 1 and 2, hydraulic

fluid is continuously circulated through the hose or pipe 26 to the valve body 22 and back to the reservoir through the hose or pipe 32. Valve means 80 is provided in the pump assembly for controlling the pressure of the hydraulic fluid delivered through the pipe or hose 26 to the valve body 22. It will be understood that this fluid pressure may be varied as desired. By way of example, the apparatus is frequently operated with the fluid pressure set between 8000 p.s.i. and 9000 p.s.i. Then with a workpiece, not shown, located between the blades 44 and 50, the handle 70 is depressed so as to close the valve member 58 whereby fluid under pressure is directed through the passageway 54 and the restricted orifice 78 into the piston chamber. The workpiece provides substantial resistance to the movement of the blade 50 therethrough so that the fluid pressure builds up to the high pressures mentioned above and as a result, the hydraulic fluid or oil is slightly compressed and the high pressure fluid conduit means including the hose or pipe 26 is expanded. Then as the blade 50 breaks through the workpiece, the resistance or back pressure provided by the workpiece is sharply reduced so that there is a tendency for the hydraulic oil instantly to expand to its normal volume and for the conduit means including the hose or pipe 26 instantly to contract to its normal condition and thereby rapidly force a relatively large volume of hydraulic oil into the piston chamber which action would result in a sharp acceleration of the piston and forcing of the piston with considerable impact against an internal stop generally designated by the numeral 82 in FIG. 1. However, this surge of the hydraulic oil is prevented by the restricted orifice member 76 which is constructed so as to limit the rate of flow of oil therethrough to a rate which will be insufficient to force the piston against the stop 82 with an impact force great enough to cause material damage to the tool. It will be noted that the orifice member is located adjacent the piston chamber so that the volume of hydraulic fluid between the orifice member and the piston, even when such hydraulic fluid is slightly compressed, is insufficient by itself to cause undue acceleration of the piston. It will be appreciated that the size of the orifice 78 may be varied in different sizes of tools but it is understood that the size of the orifice will be such that the flow rate of hydraulic fluid therethrough will be limited in the manner described above. By way of example only, it has been found that for a tool of the size shown in full scale in FIG. 2, the orifice 78 will perform its function if it is formed with a diameter of about $\frac{1}{16}$ of an inch. In any event, the orifice 78 is considerably smaller in diameter than the internal diameter of the hoses or pipes or the diameters of the remaining fluid passageways so that the hydraulic fluid may flow freely through such hoses or pipes and passageways without undue pressure drops or power losses. When a cutting operation is completed, the actuating handle 70 is released to permit opening of the valve 58. This causes the pressure in the piston chamber to be relieved, and the piston is returned by the springs 52 back against the stop provided by the adapter ring 38. It will be appreciated that the rate of return of the piston will be limited by the rate of fluid flow back through the orifice 78. However, this rate of return will be rapid enough for most installations.

In FIG. 3 there is a fragmentary showing of a modified embodiment of the present invention. The structure of this embodiment is identical to the structure described above except for the portion of the structure shown in FIG. 3. More specifically, this embodiment comprises a valve body 84 corresponding to the valve body 36 described above and having a fluid passageway 86 therethrough corresponding to the above described passageway 54. Restricted orifice means providing communication between the piston chamber and the passageway 86 is formed by passageways 88 and 90 drilled in the valve body 84, the passageway 90 having its outer end closed by a plug

92. Another plug 94 is turned into an enlarged threaded portion of the passageway 86, and this plug has an opening 95 substantially larger than the restricted orifice and a valve seat 96. A ball valve 98 is disposed for engagement with the valve seat 96. The operation of this embodiment is similar to that of the structure described above in that during a work cutting operation, the check valve 93 is closed and fluid is directed into the piston chamber through the restricted orifice which bypasses the check valve. However, when the cutting operation is completed, more rapid return of the piston and blade connected thereto may be accomplished since the pressure provided by the springs returning the piston overcomes the pressure holding the check valve against the valve seat so that the valve is opened and the fluid may flow freely from the piston chamber.

FIG. 4 shows another modification of the present invention which is similar to the embodiment of FIG. 3 in that a check valve is provided for permitting rapid return of the piston and restricted orifice means is provided for bypassing the check valve to permit restricted fluid flow to the piston chamber. In this embodiment, a valve body 100 having a passageway 102 is provided, which valve body corresponds to the valve bodies 36 and 84 described above. A member 104 is threaded into the body 100 and provides a check valve seat 106 corresponding to the check valve seat 96 described above. A check valve member or ball 108 is disposed for engagement with the seat 106. In this embodiment, the restricted orifice means is provided by one or more shallow grooves 110 formed in the valve seat 106 so that when the valve member 108 engages the valve seat a restricted flow of hydraulic fluid may leak past the valve member.

While the preferred embodiments of the present invention have been shown and described herein, it is obvious that many structural details may be changed without departing from the spirit and scope of the appended claims.

The invention is claimed as follows:

1. A hydraulic apparatus of the type described comprising a tool including a member adapted to be forced through a workpiece, a hydraulically operated spring returned piston connected with said member for actuating said member and reciprocally disposed in a piston chamber, a remotely located hydraulic fluid reservoir, continuously operable pump means connected with said reservoir for continuously supplying hydraulic fluid under high pressure, valve body means located between said pump means and said piston chamber and substantially at said piston chamber, said valve body means including an inlet port, an outlet port and a third port communicating with said inlet and outlet ports, said outlet port being sufficiently large as compared with said inlet port for providing for substantially free fluid flow from said inlet port through said outlet port, a pair of conduit means respectively connecting said pump to said inlet port and said outlet port to said reservoir, the conduit means connecting said pump and said inlet being resiliently expandable under high fluid pressure produced by said pump during actuation of the piston, passageway means extending from said third port to adjacent said piston chamber, restricted orifice means immediately adjacent said piston chamber and connecting said passageway means to said piston chamber and being smaller than said outlet port for preventing sudden surges of hydraulic fluid into said piston chamber, and a normally opened valve member shiftable for closing said outlet port for directing hydraulic fluid under high pressure through said passageway means and said restricted orifice means to said piston chamber for actuating said piston.

2. An apparatus, as defined in claim 1, wherein said conduit means and said passageway means have predetermined relatively large diameters for facilitating flow of hydraulic fluid therethrough, and wherein said restricted orifice means has a diameter substantially smaller than

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the diameter of any of said conduit means and passageway means.

3. An apparatus, as defined in claim 1, which includes means providing a valve seat defining an opening between said passageway means and said piston chamber having an area substantially greater than a transverse cross sectional area of said restricted orifice means, and a check valve member engageable with said valve seat for directing hydraulic fluid from said passageway means through said restricted orifice means to the piston chamber and for permitting flow of hydraulic fluid from the piston chamber back through said opening to said passageway means to facilitate more rapid return of the piston.

4. A hydraulic tool of the type described comprising a member adapted to be forced through a workpiece, cylinder means providing a piston chamber, a piston connected with said member for actuating said member and reciprocally disposed in said piston chamber for operation by hydraulic fluid under pressure in one direction for advancing said member, spring means within said cylinder means and engaging said piston means for biasing the piston means in the opposite direction, valve body means assembled with said cylinder means and including hydraulic fluid passageway means having a relatively large predetermined diameter connected with said cylinder means and having an inlet and an outlet respectively connectable with a source of hydraulic fluid under high pressure and with a fluid reservoir, an open valve member shiftably mounted in said valve body means for closing said outlet for directing fluid to said piston chamber and means providing a restricted orifice substantially at said piston chamber and connecting said passageway means to said piston chamber, said restricted orifice having a transverse cross sectional area substantially smaller than the transverse cross sectional area of said passageway means for restraining sudden surges of hydraulic fluid

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under pressure from said passageway means into said piston chamber.

5. A tool, as defined in claim 4, which includes valve seat means defining an opening substantially at said chamber and connecting said piston chamber and said passageway means and having an area substantially greater than the transverse area of said orifice means, and a check valve member engageable with said valve seat for directing hydraulic fluid under pressure from said passageway means through said restricted orifice means into the piston chamber and for permitting relatively rapid return flow of hydraulic fluid from the piston chamber through said opening to said passageway means.

6. A tool, as defined in claim 5, wherein said restricted orifice means is provided by small diameter bore means extending between said passageway means and said piston chamber in bypassing relationship with respect to said valve seat.

7. A tool, as defined in claim 5, wherein said restricted orifice means is provided by groove means in said valve seat.

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