

[54] **HYDRAULICALLY POWERED IMPACT DEVICE**

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[52] U.S. Cl. **173/15**, 91/165, 91/189,
 173/119, 173/127, 173/134, 299/70

[51] Int. Cl. **B25d 9/04**

[58] Field of Search 173/119, 16, 17, 134, 15;
 91/276, 300, 328, 173, 165, 423

[56] **References Cited**

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Primary Examiner—Ernest R. Purser

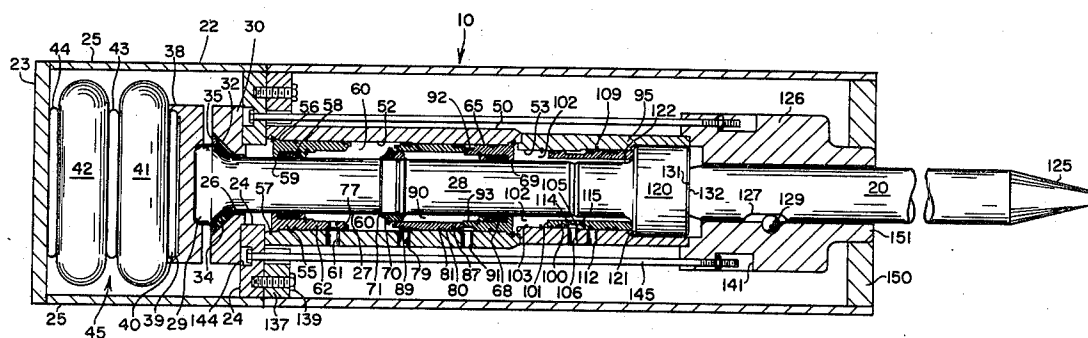
Assistant Examiner—William F. Pate, III

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 & Tucker

[57] **ABSTRACT**

A hydraulic impact device is disclosed which has a hammer member carrying a piston which is reciprocally disposed in a cylinder chamber to form an expansible fluid chamber. When the chamber is pressurized, the hammer is driven against an air spring or other energy storage device. The piston is formed in two parts, a piston member being connected to the hammer and a sleeve valve. When the hammer is fully retracted against the air spring, the valve sleeve is mechanically separated from the piston and pressure shifted in advance of the piston member while the piston member is momentarily held in the retracted position. When the sleeve valve reaches the lower position of its stroke, a port is opened to release the piston member so that the air spring can accelerate the hammer to deliver an impact blow to an anvil and thence a tool. Since the sleeve is separated from the piston member, the piston member moves substantially unretarded through the fluid in the cylinder and the fluid is not displaced from the cylinder. A safety shuttle valve may also be included which has a sleeve cooperable with a hammer member that bypasses pressure fluid to reservoir until moved to a flow blocking position by imposition of a predetermined load on the hammer.

17 Claims, 7 Drawing Figures



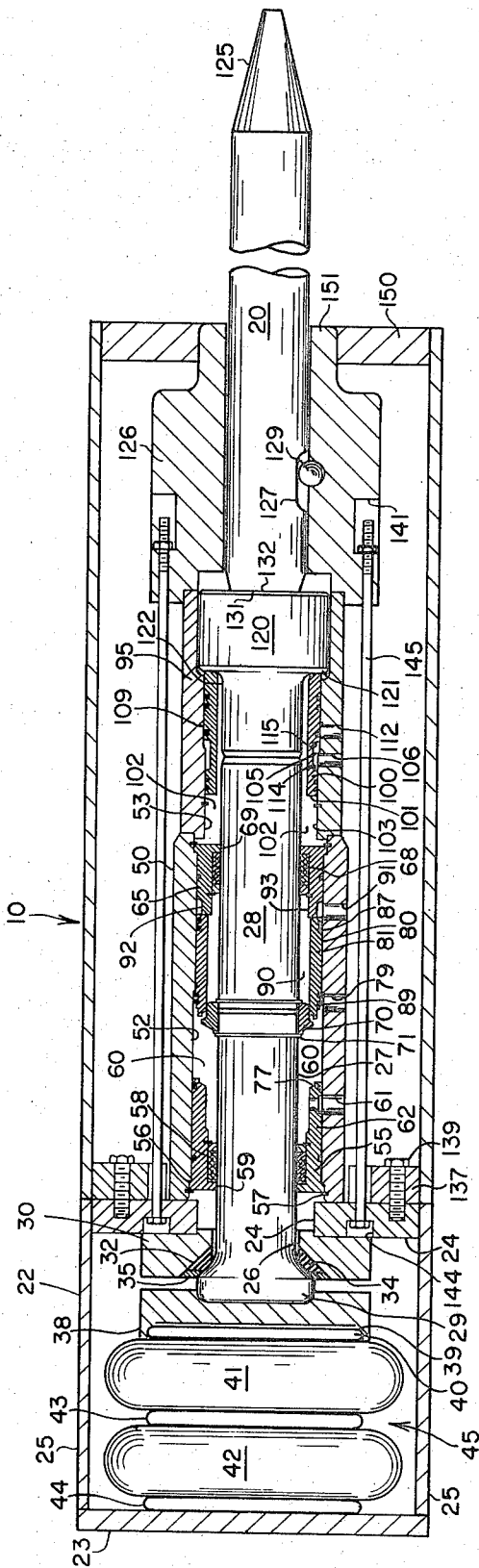


FIG. 2

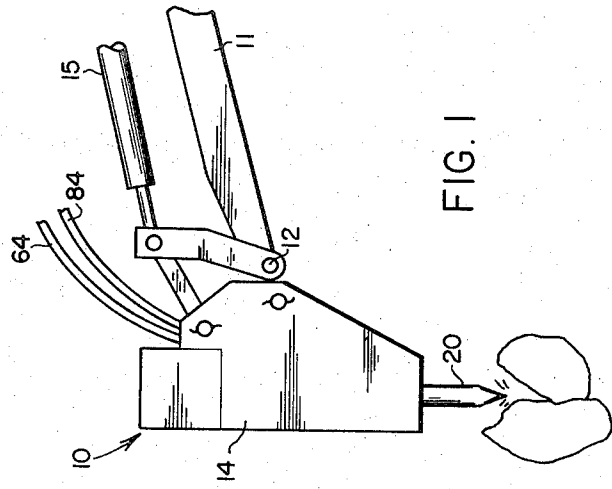
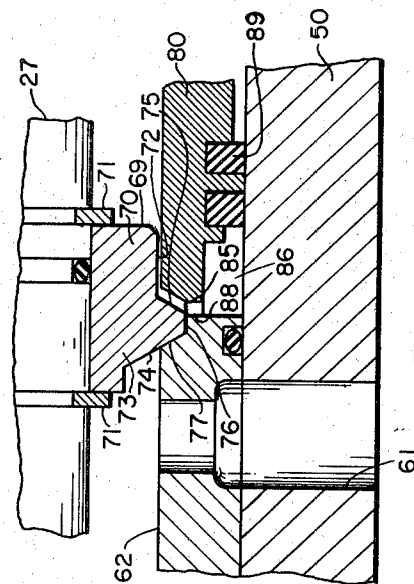


FIG. 1



ME

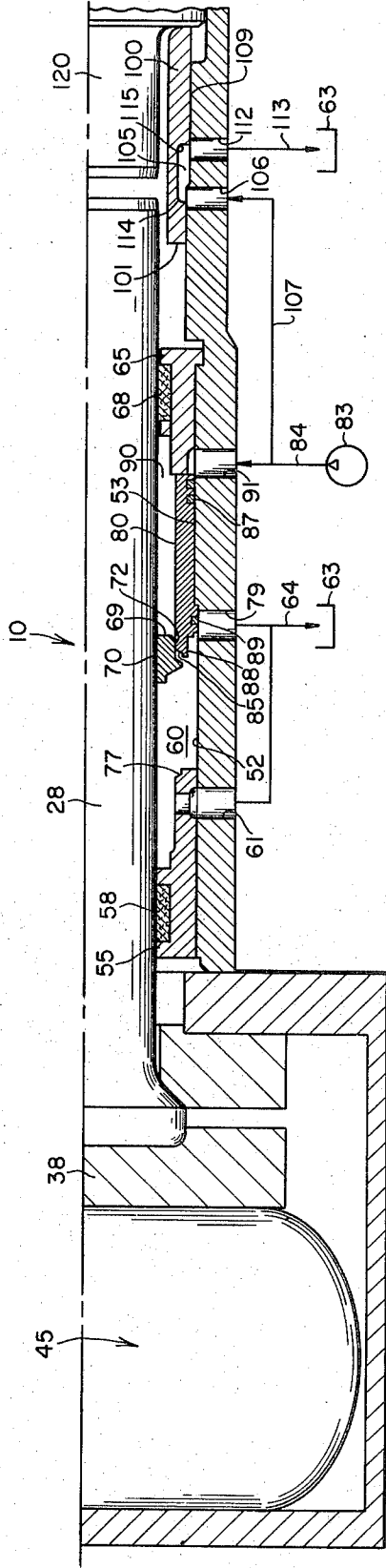


FIG. 4

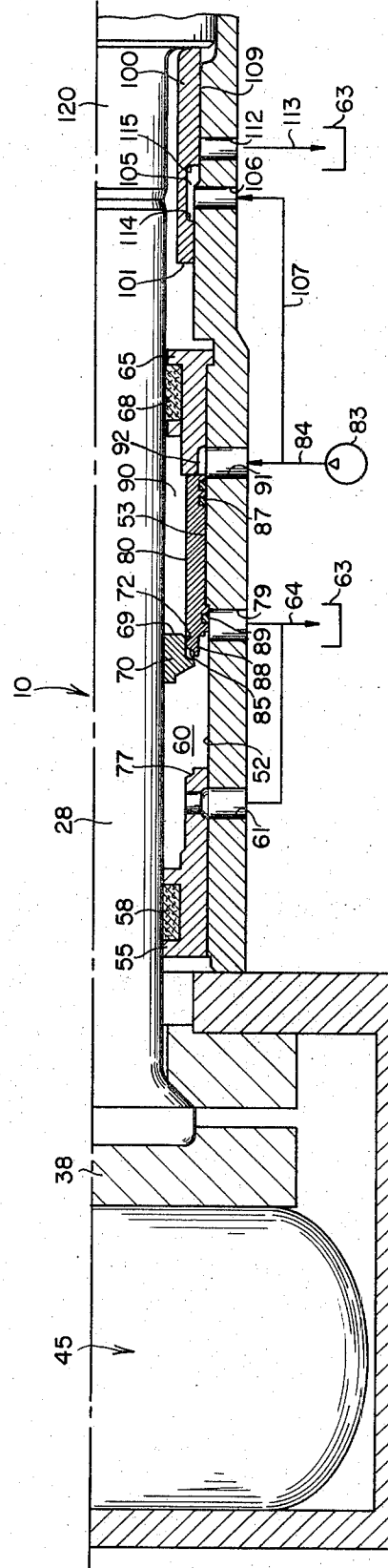


FIG. 5

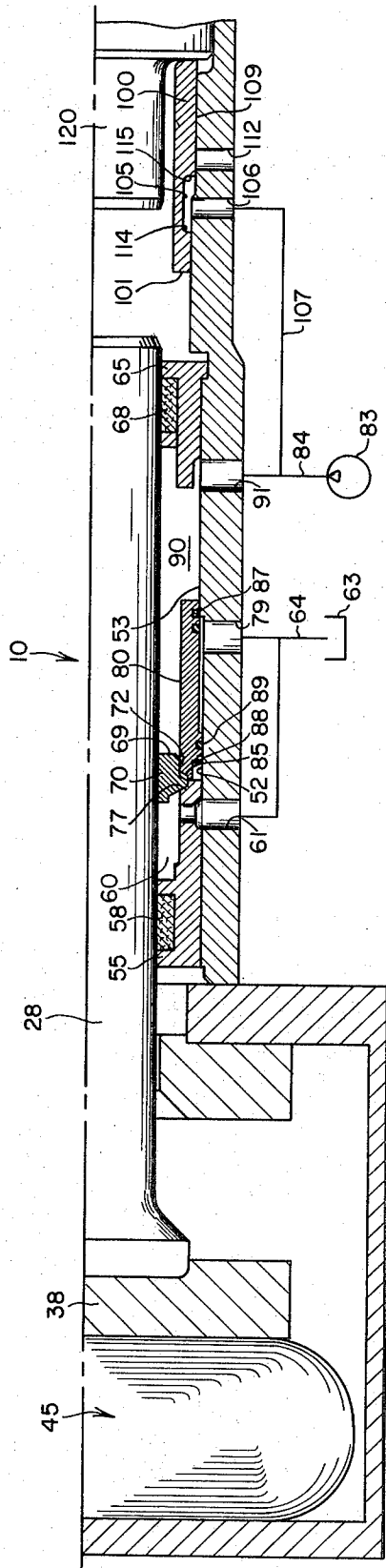


FIG. 6

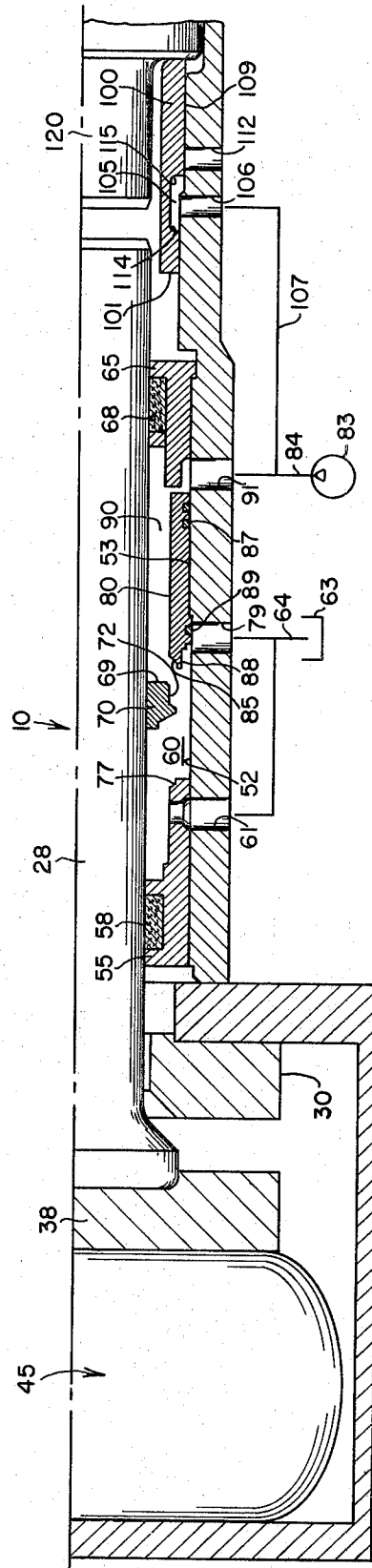


FIG. 7

HYDRAULICALLY POWERED IMPACT DEVICE

This invention relates to hydraulically actuated, repetitive impact devices and more specifically relates to an impact hammer of the type used for demolition work.

Reciprocating tools for delivering high impact blows to demolish pavement, rock, and the like are well known. These impact tools have heretofore been predominately driven by air pressure and are characterized by the well-known jackhammer. Large versions of the jackhammer have heretofore been mounted on the boom of a backhoe. These devices are characterized by being able to deliver relatively high frequency, but relatively low impact forces. As a result, even the larger of these devices tends to powder the harder materials due to the relatively low force. However, the high frequency to some extent compensates for this deficiency.

The present invention relates to a hydraulic hammer which represents a significant advance in the state of the art. The device delivers a highly efficient, high impact blow at a high rate when compared to prior art devices. The device comprises a hammer that is retractable against an air spring to store energy in the spring. The retraction of the hammer is by virtue of hydraulic pressure applied to one side of a piston carried on an elongated hammer member which acts as the rod of a linear actuator. A sleeve valve, axially slidable within the bore around the hammer, automatically shifts to control the cycling of the hammer. The annular cross-sectional area of the slide valve effectively becomes a part of the piston for driving the hammer upwardly on the retraction stroke. Once the hammer is fully retracted, compressing the air spring, the sleeve valve shifts away from the piston so that the hydraulic fluid in the cylinder bypasses the piston freely. This permits the potential energy stored in the air spring to be quickly released and to drive the hammer through a downward impacting stroke with minimum loss of energy due to pumping fluid. Upon completion of the extension or impact stroke, the valve sleeve again shifts to permit pressure fluid to build up behind the piston associated with the hammer so that the cycle is repeated. A substantial increase in operating efficiency and speed is attainable with the device of the present invention in that hydraulic fluid is utilized only to retract the hammer to store energy in the spring. It is not necessary to divert high pressure fluid to the opposite side of the piston to drive the hammer through the impact stroke. Therefore, with a preselected pump delivery, the hammer can theoretically cycle at a rate approximately twice that of hammers requiring pressurization on both the retraction and extension or impact strokes.

The increase in the effective area of the piston as a result of using the valve sleeve may be used to reduce the fluid operating pressure for a given impact force, or increase the impact force for a given fluid operating pressure. Alternatively, the overall size of the device can be reduced to deliver the same impact at twice the rate for a given pressure and flow volume of hydraulic fluid.

A better understanding of the present invention will become apparent from the following specification, claims, and drawings, in which:

FIG. 1 is a front elevational view showing the impact device of the present invention associated with the boom of a conventional backhoe;

FIG. 2 is a sectional front view of the impact device; FIG. 3 is a detail view of a part of the impact device; and

FIGS. 4-7 illustrate the operating sequence of the impact device of the present invention.

Referring now to the drawings, a device in accordance with the present invention is indicated generally by the numeral 10 in FIG. 1. The device 10 is mounted on the end of boom 11 of a typical construction machinery unit such as a backhoe, not shown, by bracket plate 14. As is conventional with such machinery, boom 11 may be swung horizontally or vertically to position the device 10 at the end of the boom. A hydraulic cylinder 15 is associated with the boom and is employed to pivot the hammer structure 10 about connection 12. Hydraulic lines 64 and 84 supply pressure fluid and return fluid to the hammer. Hard material such as pavement, roadbeds, rocks, etc., are broken by chisel tool 20.

FIG. 2, for convenience of illustration, depicts the device 10 in a horizontal position, it being realized that a normal operational position is as shown in FIG. 1. Therefore, the relative terms "upper" and "lower" refer to the device positioned vertically as in FIG. 1. The device 10 includes an upper frame 22 which houses an air spring or other similar energy storage device. The frame 22 is boxlike and includes an upper plate 23, side plates 25, and a base plate 24, which are all rigidly interconnected. Base plate 24 defines a circular opening 26 which receives the shaft 27 of hammer member 28. Hammer 28 diverges at the upper end to an enlarged head 29 which is within frame 22. A cushion plate 30 is interposed between tapered head 29 of the hammer and base plate 24. The cushion plate 30 has a blind bore 32 concentric with opening 26 which receives dampening member 34. A steel ring 35 having a generally frusto conical upper surface is provided at the upper surface of the dampening member 34 to abut against the tapered underside of head 29 when the hammer is in the extended position. Typically, cushion plate 30 would be formed of a high quality steel and cushion ring 34 is of a suitable resilient material such as an elastomer or rubber.

Bearing plate 38 is biased against the upper end of hammer head 29 by an air spring 45. The upper surface of bearing plate 38 is formed having a circular cavity 39 which receives metal bumper pad 40 which is an integral part of the air spring 45. The air spring has a pair of interconnected air chambers 41 and 42 which are defined by a constricting ring 43. The other bearing pad 44 of the air spring is disposed between the upper surface of air chamber 42 and cover plate 23 of the frame 22.

Air spring 45 is a pneumatic device and is formed of a compliant material such as fabric reinforced rubber and is inflated to a selected, but adjustable pressure, with a compressible medium such as air through a suitable valve, not shown. As hammer 28 is retracted, that is, moved upwardly, the air spring 45 will be compressed, storing energy which is utilized to drive the hammer downwardly on an impact stroke. The cushion ring 34 serves to absorb energy if for any reason chisel 20 does not stop the travel of the hammer before the head 29 reaches the plate 30. It is to be understood that energy storing devices other than the air spring device shown could be utilized, although the pneumatic air spring assembly 45 is preferred.

The shaft portion 27 of hammer member 28 extends through a cylindrical chamber formed by a stepped axial bore in a body 50. The diameter of an upper section 52 of the bore is greater than the diameter of a lower section 53 which defines annular chambers 60 and 90, respectively, around hammer section 27. The upper chamber 60 is closed by upper bearing member 55 which is in the form of a generally annular seal held in place by engagement at interior shoulder 56 in the bore and abutting exterior snap ring 57. Concentric bore 59 in member 55 receives hammer section 28 and retains appropriate sealing members 58 to prevent fluid leakage from annular chamber 60. Exhaust port 61 communicates with the upper end chamber 60 through inner extension 62 of bearing member 55. A second exhaust port 79 communicates with the cylinder chamber at an intermediate location in housing member 50.

The lower end of lower chamber 90 is closed by bearing member 65 which is held in place by snap ring 67. The bearing member 65 includes a sealing ring 68 to prevent leakage along the hammer shaft 27.

Referring now to FIG. 3, a piston 70 is secured on shaft 27 by snap rings 71. Piston 70 is formed having a lower annular sealing surface 72 and an upper adjacent generally trapezoidal portion 73, having angular surfaces 74 and 75 and an annular surface 76. The inner extension 62 of upper bearing member 55 is provided with a notch 77 having a shape conforming to surfaces 74 and 76 of the piston so that the piston will engage and seat in notch 77 at the upper end of the stroke and form a fluid seal to momentarily hold the piston in the retracted position as will presently be described.

The cycling operation of the hammer is automatically controlled by a sleeve valve 80 which has sealing rings 89 and 87 on a cylindrical sleeve 81 which are in sealing contact with bores 52 and 53, respectively. Because of the difference in diameter of bores 52 and 53, the sleeve valve 80 is shifted to the lower position illustrated in FIG. 2 when high pressure is applied to both ends of the valve. The upper end of the valve sleeve 81 is provided with a notch 85 which conforms to surfaces 75 and 76 of the piston and provides an annular fluid seal with surface 75. A lip 88 projects from the upper end of the valve sleeve 81 to bump the end of bearing 62 and separate the valve sleeve from the piston 70. The clearance between surface 72 and the valve sleeve 81 and the notches in the end of lip 88, as illustrated in FIG. 3, allow fluid pressure in chamber 90 to reach cavity 86 when the surface 75 of the piston is separated from the valve sleeve 81.

Inlet port 91 communicates with chamber 90 at undercut at the upper end of lower bearing member 65. The inner end 93 of the lower bearing member 65 serves as an abutment to engage the lower end of sleeve 81 when the sleeve assumes its lowermost operation.

An anvil 120 is reciprocable in sleeve 95 below the terminal end of the hammer. The anvil has an enlarged shoulder 121 which is slidably received in the lower end of sleeve 95. Stub shaft 122 extends upwardly and is impacted by the lower end of hammer 28 to transmit the force to the chisel tool 20.

The hammer of the present invention also incorporates a safety shuttle valve 100 which makes the hammer inoperative by diverting or bypassing high pressure fluid to a reservoir until at least a predetermined load has been placed on the unit chisel 20. By virtue of the

safety feature, the hammer cannot be inadvertently actuated until the hammer is positioned in an operative position. This is achieved by shuttle valve 100 which is in the form of a cylindrical sleeve 101 positioned in chamber portion 102 of sleeve 95 below lower bearing member 65. The interior diameter of sleeve 95 has two different diameters. A peripheral groove 105 is formed in sleeve 101 and sealing rings are disposed on opposite sides of the groove so that the cross-sectional area of the end 115 of the groove is greater than that of end 114. High pressure fluid introduced through port 106 will thus bias the sleeve 101 downwardly with a substantial force. An exhaust port 112 is positioned so as to be placed in communication with port 106 when the shuttle valve 100 is biased to its lowermost position.

When high pressure fluid is introduced into chamber 105, the differential area of ends 114 and 115 results in a net pressure force acting to urge valve 100 and the anvil and sleeve 101 downwardly. As sleeve 101 moves downwardly, chamber 105 is placed in communication with low pressure port 112, causing high pressure fluid to be directed to the reservoir. In this position, the unit is inoperative as high pressure fluid is bypassed directly to the reservoir and, accordingly, chamber 90 will not be pressurized to actuate the hammer. When sleeve 101 is moved upwardly by virtue of upward movement of anvil 120, chamber 105 will again be moved out of communication with outlet port 112 at land 109 and high pressure fluid will again be directed via port 91 into the chamber 90.

Chisel or other tool 20 is reciprocable within lower bearing member 126 and is provided with an appropriately shaped blade end 131. A flat area 127 is formed in one side of the tool 20 and a removable pin 129 is inserted through bearing 126 and through flat 127. In this way, the chisel is retained within bearing 126, but is permitted axial movement as determined by the length of groove 127. The upper end 132 of chisel 20 abuts the lower end 131 of anvil 120.

The device 10 is held together by tie rods 145 which extend longitudinally between recesses 144 in plate 24 at upper chamber 22 and recesses 141 in lower bearing member 126. It will be obvious that the unit can easily be disassembled by simply removing the tie rods to permit bearing 126 to be removed, thus releasing intermediate body section 50. Anvil 120 can be removed and removal of appropriate snap rings 57 and 67 will permit access to the valving and piston components.

Bracket plates 14, shown in FIG. 1 are provided with inwardly depending plates 137 which receive bolts 139 to secure the brackets to the underside of plate 24. Bottom plate 150 secured between the lower ends of brackets 14 defines a socket 151 which receives the lower end of bearing member 126. Removal of bolts 139 permits hammer 10 to be separated as a unit from bracket plates 14.

Ideally, the combined mass of hammer member 28 and plate 38 is approximately equal to the combined mass of anvil 120 and chisel 20. In this way, the unit is dynamically balanced and when the compacting blows are delivered by the hammer 28, rebound is minimized and maximum energy transfer is achieved.

The construction and operation of the hydraulic hammer of the present invention will be better understood from the following description of operation as shown in FIGS. 4 to 7. The fluid ports of the hammer are connected in a hydraulic system having an appro-

priate source of fluid pressure 83 such as a rotary gear pump and a reservoir 63. Inlet port 91 is connected to pump 83 by line 84. A bypass 107 connects line 84 to port 106. Port 112 is connected to reservoir 63 via line 113. Outlet ports 61 and 79 are similarly connected to reservoir 63 by line 64.

Referring to FIG. 4, the high pressure fluid introduced to chamber 105 continually exerts a net pressure force acting to urge valve 100 and anvil 120 downwardly as a result of the differential area between end walls 114 and 115. When the valve 100 is moved downwardly to a sufficient extent, chamber 105 is placed in communication with low pressure port 112, causing high pressure fluid from pump 83 to be directed to reservoir via line 107, and across chamber 105 to port 112, and the hammer is inoperable because chamber 90 cannot be pressurized. When valve 100 is moved upwardly by virtue of upward movement of anvil 120, due to the force exerted at chisel 20, chamber 105 will again be moved out of communication with outlet port 112 with land 109 blocking off port 112. Supply pressure fluid will again be directed through port 91. Thus it will be noted that the hammer cannot be inadvertently actuated until a sufficient load is placed on the hammer.

Fluid pressure entering at a groove 92 will act against valve 80 and will cause the valve to move upwardly into engagement with piston member 70 as is seen in FIG. 5 so that a peripheral fluid seal is formed with surface 75 of the piston as shown in FIG. 3. Fluid pressure in chamber 90 will exert a force against the piston exposed to chamber 90 and also against the lower end of the valve sleeve 81 to displace the hammer 28 upwardly. It will be noted that the cross-sectional area of the lower end of the valve sleeve 81 is thus added to the cross-sectional area 69 of the piston during compression of the air spring 45 as a result of the static seal at surface 75. In this way the net effective upward compression force is substantially increased when the unit is operated at the same pressure as a unit as described in the aforementioned co-pending application. Similarly, a substantially lower fluid pressure may be utilized to obtain essentially the same net force acting to compress the air spring 45 as compared with the aforementioned device. Or the total area of the effective piston formed by the piston 70 and sleeve valve 80 may be reduced and the rate of reciprocation increased for a given fluid flow rate.

As the hammer member 28 moves upwardly bearing plate 38 will compress the air spring 45, thus storing energy in the device. As valve 80 moves upwardly, outlet port 79 will remain sealed from communication with either chamber 60 or 90 by virtue of peripheral seal 89 in bore 52 and peripheral seal 87 in bore 53.

Referring to FIG. 6, piston 70 is shown in its maximum retracted position with the piston moved until surface 74, shown in FIG. 3, engages notch 77 of upper bearing member 55 and forms and annular fluid seal with the bearing member. Similarly, valve sleeve 100 has moved upwardly until sleeve lip 88 strikes the inner end of bearing member 55. During upward movement of the piston and hammer, cylinder chamber 90 has been expanding in volume, pressure fluid being admitted at port 91. Opposite cylinder chamber 60 has been contracting in volume with fluid being exhausted through port 61 to reservoir 63. As the piston assumes the position shown in FIG. 6, the valve 80 is separated

from the piston and high pressure fluid will pass between surfaces 75 and 85 and be admitted into groove 86, as shown in FIG. 3, to act against the upper end of the valve sleeve. Because the area of the upper end of the valve sleeve exceeds the area of the lower end, the sleeve will be very rapidly moved downwardly away from the piston. As seen in FIG. 7, when seal 89 passes the discharge port 79, chamber 90 is immediately placed in communication with exhaust port 79 and will be quickly depressurized. Once pressure in chamber 90 is reduced, the energy stored in the air spring 45 will force hammer 28 to leave sealing contact with bearing 55 and will rapidly accelerate the hammer downwardly to impact the anvil and, in turn, tool 20. Since valve 100 has moved out of the path of the piston prior to initiation of the power stroke, piston 70 is free to move unimpeded with little restriction to flow being afforded in the bore area vacated by the sleeve 101 as the fluid bypasses the piston. Little hammer energy is dissipated unproductively in pumping fluid as the relatively large open chamber area allows fluid to freely bypass the piston during rapid extension of the hammer. Valve 80 again assumes the lower position in contact with the inner surface of the upper end of lower bearing member 65.

Hammer 28 reaches the downward limit of the stroke with the hammer head engaged at cushion plate 30. Shuttle valve 100 will tend to move to the lower fluid bypassing position. The impact or rebound experienced at the chisel will be transmitted to anvil 120 to urge bypass valve 100 to the uppermost position. Thus, as long as sufficient force is sensed at chisel 20, to permit actuation of the unit, the hammer will cycle at the high rate due to the reciprocation of sequencing valve 80 within the bore.

The hydraulic hammer of the present invention provides a high impact device which cycles at a high rate. The static seal maintained between the piston and valve during retraction results in a unit having increased effective piston area and having higher operating capability. The simple valving is highly efficient and reliable. The safety feature prevents inadvertent actuation.

It will be obvious that the fluid actuated hammer device of the present invention has broad application to other types of impact tools. Also, modifications and changes will suggest themselves to those skilled in the art. It is intended that the scope of the present invention be limited only by a fair interpretation of the appended claims.

What is claimed is:

1. The hydraulic device comprising:

means forming a cylinder bore,

a reciprocable member carrying a piston reciprocally disposed in the bore, and

a valve member reciprocally disposed in the bore and adapted to sealingly engage the piston and divide the bore into first and second expansible fluid chambers such that when high pressure fluid is introduced to the first fluid chamber the combined fluid forces acting on the piston and the valve member will drive said reciprocable member against a load,

said valve member being positioned between said first chamber and said piston and having a first surface exposed to the high pressure fluid of said first chamber and a second surface abutting the piston to transfer the fluid force on the first surface to the

piston thereby supplementing the area of said piston to aid in moving said reciprocable member against the load, and

means for separating the valve member from the piston after the load has been driven a distance to bypass fluid in the first expansible fluid chamber around the piston as the load returns the piston.

2. The hydraulic device of claim 1 wherein:

the reciprocable member is an impact hammer, and further characterized by

an energy storage device acting as the load to drive the hammer through a return stroke upon separation of the valve member from the piston.

3. The hydraulic device of claim 1 further characterized by:

means for delaying the return of the piston by the load until the valve member has returned sufficiently to prevent the piston from catching the valve member.

4. The hydraulic device comprising:

a reciprocable member carrying a piston dividing a cylinder bore into first and second cylinder chambers, and

valve means reciprocable in said bore, said valve means adapted to statically engage said piston and seal said first chamber when said first chamber is pressurized permitting actuation of said piston in a second direction to drive a load, said valve means having a first surface area abutting said piston and including a second surface area in said first chamber for transmitting the pressure force in the first chamber to said piston by way of said abutting first surface area to supplement the pressure force against the piston to assist said piston in driving the load, and

means associated with said valve means adapted to shift said valve means away from said piston in a first direction upon said piston reaching a predetermined position to cause rapid depressurization of said first chamber thereby permitting relatively unrestricted return of said piston by said load.

5. A hydraulic device having a reciprocable member in a cylinder actuable against a load comprising:

a first piston means mounted on said reciprocable member dividing the cylinder into opposite first and second cylinder chambers, said first piston means having a piston surface exposed to said first cylinder chamber for moving said reciprocable member against the load when said first chamber is pressurized,

a second piston means having a first surface exposed to said first cylinder chamber and a second surface adapted to engage said first piston means when said first chamber is pressurized for transmitting the fluid force on said first surface to said first piston means, the pressure on said first surface thereby supplementing the pressure on said piston surface to assist in moving said reciprocable member against the load, and

means associated with said second piston means adapted to cause said second piston means to shift away from said first piston means upon said first piston means reaching a predetermined position.

6. The hydraulic comprising:

a hydraulic cylinder having a fluid inlet and a fluid outlet,

a piston carried on a rod reciprocable within said cylinder dividing said cylinder interior into first and second cylinder chambers,

an auxiliary outlet port in said cylinder intermediate the inlet and outlet,

valve means reciprocable in said cylinder having first and second opposite end surfaces, the second end surface having a greater effective area,

said valve means adapted to statically engage said piston when said first chamber is pressurized to seal said first chamber, said first surface being exposed to said first chamber and supplementing the effective area of said piston to aid in moving said piston rod against a load, and

means for admitting pressure fluid against said second end surface when said piston reaches a predetermined position thereby inducing a pressure differential across said valve to oppositely reciprocate said valve and place said first chamber in communication with said second chamber thereby allowing the load to return the piston relatively unimpeded.

7. A hydraulic device for applying impact forces to a body comprising:

a housing defining a bore,

an axially slidable hammer member in said housing bore defining with said bore an annular cylinder chamber having fluid inlet and outlet ports,

energy storage means adapted to transmit energy to said hammer to deliver an impacting blow,

piston means carried on said hammer in said bore defining first and second opposite expansible fluid chambers, said piston adapted to move said hammer to activate said energy storage device when said first cylinder is pressurized,

valving means engagable with said piston and presenting a first surface area to pressure fluid in said first chamber to supplement the piston area and assist in moving said hammer against the energy storage means to a predetermined position by transferring to the energy storage means through the hammer the fluid forces on the valving means, and means for shifting said valving from said piston upon said hammer reaching said predetermined position to permit fluid to bypass the piston as energy from the energy storage device returns the piston.

8. The device of claim 7 wherein said energy storage means comprises an air spring device.

9. The device of claim 7 further including second valve means for bypassing fluid from said first chamber until at least a predetermined load is applied to said hammer member.

10. The device of claim 9 wherein said hammer member is in abutting relationship with an anvil which abuts a tool member.

11. The device of claim 10 wherein said device is operatively mounted on a construction machine.

12. The device of claim 11 wherein said construction machine is a backhoe and said device is mounted on a boom member.

13. A hydraulic impact device for applying impact force to a body comprising:

a housing defining a bore having a first section of smaller diameter than a second section,

first and second bearing members closing the ends of said bore and carrying axially extending abutment members extending into said bore,

a hammer member reciprocable in said bearing members and defining therewith and with said housing bore an annular cylinder chamber,
 energy storage means adapted to transmit energy to said hammer to deliver an impacting blow with the hammer, said energy storage means including compressible air spring means mounted adjacent said upper bearing and in contact with one end of said hammer whereby retraction of said hammer will compress said air spring to store energy therein,
 piston means carried on said hammer in said bore dividing said cylinder chamber into first and second cylinder chambers, said piston extending radially having an annular sealing surface adapted to form an annular seal with the upper bearing at the end of a retraction stroke,
 inlet port means communicating high pressure fluid with said first chamber,
 first outlet port means communicating with said second chamber through the upper bearing above the annular seal between the upper bearing and the piston,
 second outlet port means intermediate said inlet port and said first outlet port,
 valve means having a generally annular body with an exterior surface in slidable contact with said bore, said sleeve having a first end exposed to said first chamber and a second end adapted to statically engage said piston when said first chamber is pressurized to move said hammer in said second direction, the effective cross-sectional area of said second end being greater than the cross-sectional area of the first end as a result of the difference in diameters of the first and second sections of the bore,
 said valve means adapted to abut said upper bearing when said piston seals with said upper bearing to permit pressure fluid to be admitted against said second end of the valve to shift said valve away from said piston and to uncover second outlet to depressurize said first chamber and release the piston from the upper bearing whereby the expansion of said air spring will accelerate said hammer, relatively unimpeded as the fluid bypasses the piston.

14. The device of claim 13 further including shuttle valve means having a first position bypassing fluid from said first chamber and a second flow blocking position, said shuttle valve being biased to said first position and adapted to be moved to said second position by a predetermined force being applied to move said hammer in a second direction.

15. The device of claim 14 wherein said hammer includes an axially slidable anvil member which is biased

downwardly by the shuttle valve.

16.. A hydraulic impact device for applying impact forces to a body comprising:

a housing defining a bore,

an axially slidable hammer member in said housing bore defining with said bore an annular cylinder chamber having fluid inlet and outlet ports,

energy storage means adapted to transmit energy to said hammer to deliver an impacting blow,

piston means carried on said hammer in said bore defining first and second opposite expansible fluid chambers, said piston adapted to move said hammer to activate said energy storage device when said first cylinder chamber is pressurized,

valving means engagable with said piston and presenting a first surface area to pressure fluid in said first chamber to supplement the piston area and assist in moving said hammer against the energy storage means to a predetermined position, and

means for shifting said valving from said piston upon said hammer reaching said predetermined position to permit fluid to bypass the piston as energy from the energy storage device returns the piston, comprising means for admitting pressure fluid against a second valve surface having an area greater than said first surface whereby a pressure differential is imposed on said valve causing it to shift.

17. The hydraulic device comprising:

a hydraulic cylinder having a fluid inlet and a fluid outlet,

a piston carried on a rod reciprocable within said cylinder dividing said cylinder interior into first and second cylinder chambers,

valve means reciprocable in said cylinder having first and second opposite end surfaces, the second end surface having a greater effective area,

said valve means adapted to statically engage said piston when said first chamber is pressurized to seal said first chamber, said first surface being exposed to said first chamber and supplementing the effective area of said piston to aid in moving said piston rod against a load, and

means for admitting pressure fluid against said second end surface when said piston reaches a predetermined position thereby inducing a pressure differential across said valve to oppositely reciprocate said valve and place said first chamber in communication with said second chamber thereby allowing the load to return the piston relatively unimpeded.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,866,690
DATED : February 18, 1975
INVENTOR(S) : Raymond E. Lance; Ronald N. James

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 44, delete "disassembled" and substitute therefor --disassembled--;

Column 5, line 33, delete "hammershaft" and substitute therefor --hammer shaft--;

line 58, delete "and" (second occurrence) and substitute therefor --an--;

Column 7, line 64, insert --device-- after "hydraulic";

Column 8, line 23, insert --impact-- after "hydraulic";

Column 9, line 38, delete "saif" and substitute therefor --said--.

Signed and sealed this 10th day of June 1975.

(SEAL)
Attest:

RUTH C. HASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks