Oct. 17, 1961 S. L. CHRISTENSEN 3,004,523

HYDRAULIC IMPACT TOOL

Filed Nov. 4, 1959 2 Sheets-Sheet 1

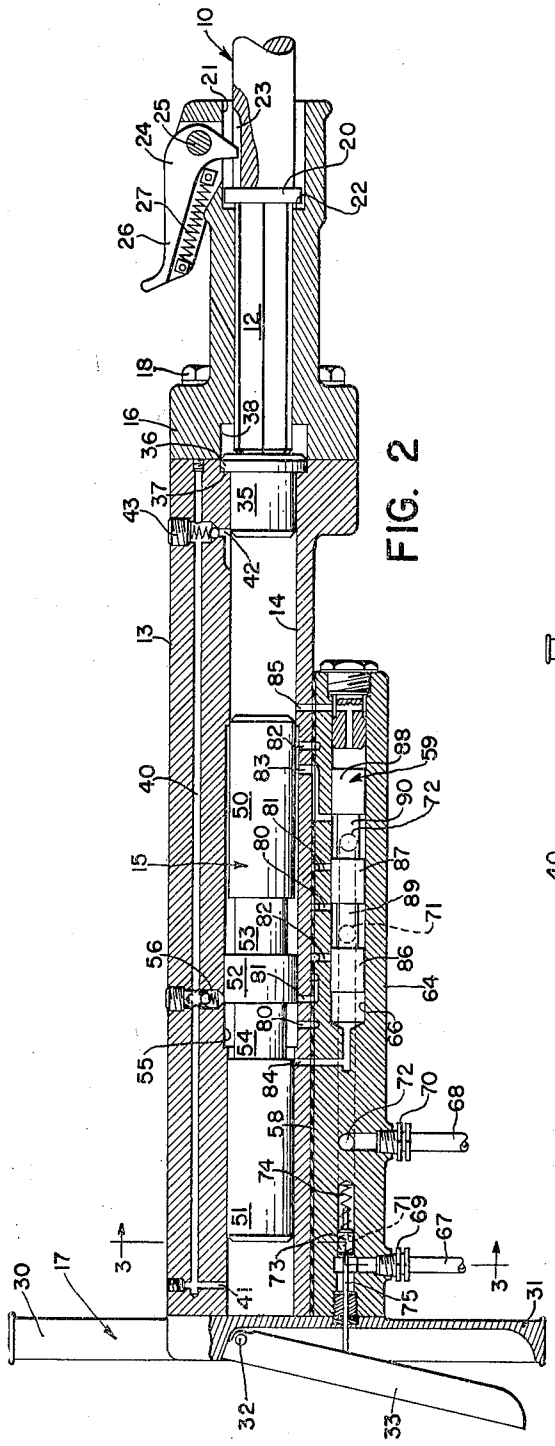


FIG. 2

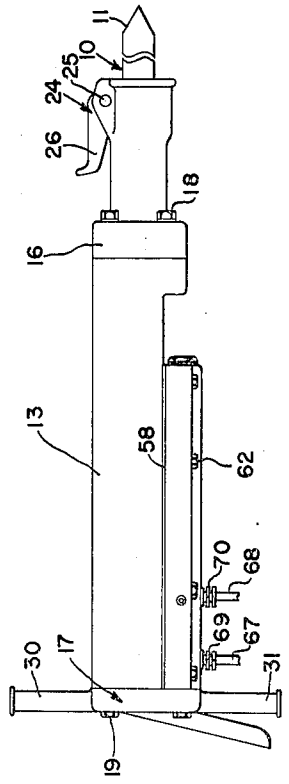


FIG. 1

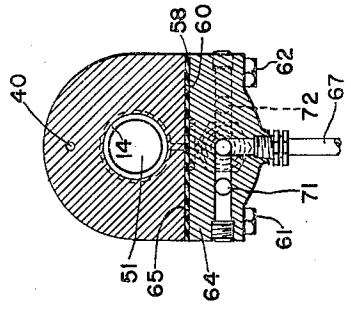


FIG. 3

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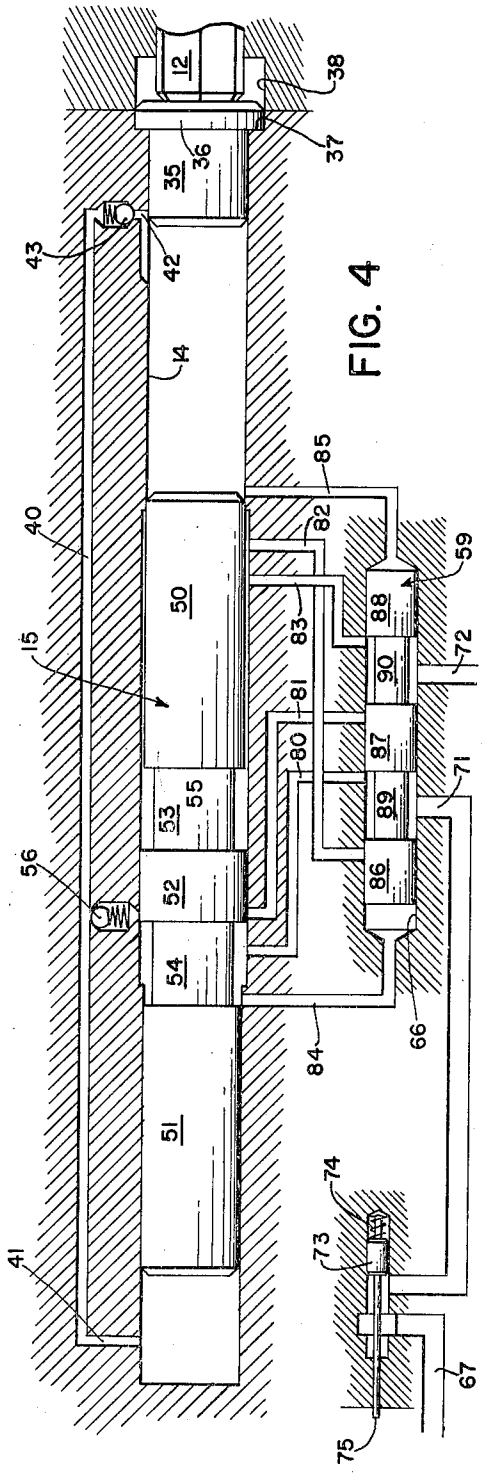


FIG. 4

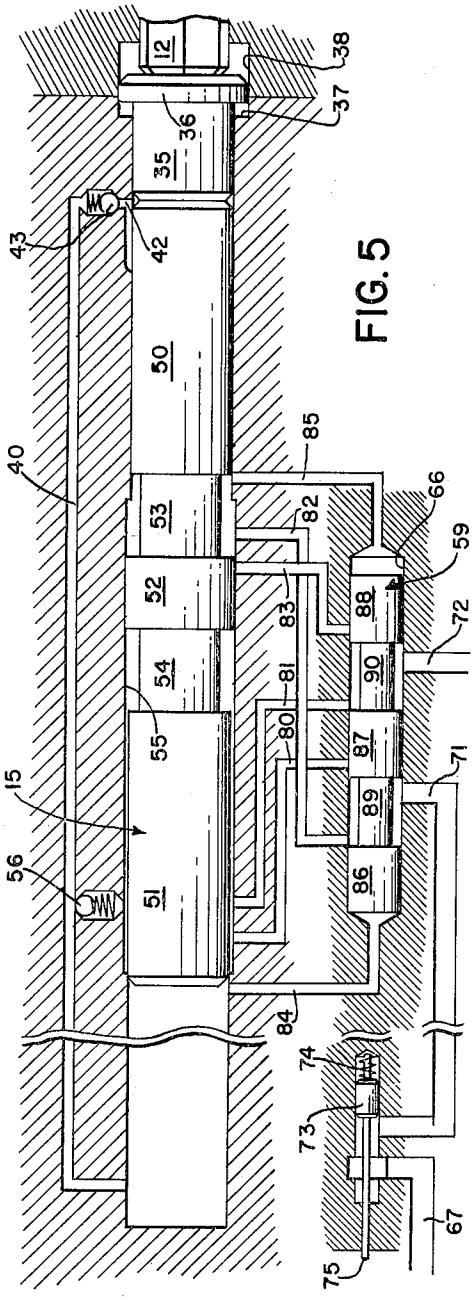


FIG. 5

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HYDRAULIC IMPACT TOOL

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6 Claims. (Cl. 121—28)

This invention relates to an impact tool of the type which may be used as a jack hammer, dirt tamper, post driver and similar operations in which a reciprocating pounding or driving action is required. Still more particularly this invention relates to an impact tool which is hydraulically operated and which may conveniently be operated, for example, by the hydraulic system of conventional type tractors or other motive vehicles.

The main object of the present invention is to provide a hydraulic impact tool, which for convenience of description will be described in relation to a hydraulically operated jack hammer, of a new and relatively simple construction. The hydraulic impact tool will be a self contained unit which may operate from any type of hydraulic system having a pressure line and a return line. Consequently, it may be presumed that the impact tool will find its greatest use in combination with a tractor having a hydraulic system as a part of its structure.

A further object of the present invention is to provide a hydraulic impact tool featuring a cylinder having an anvil at one end which strikes the shank of the working tool. The anvil is struck by the hammer end of a piston contained in the cylinder. It is proposed to provide a communicating line between opposite ends of the cylinder and a check valve within the line which relieves pressure in advance of the piston during its power stroke and permits a relatively large pressure build up in advance of the piston during its return stroke to thereby effect a cushioning action of the piston during the latter stroke.

Other objects and advantages of the present invention will become apparent to those skilled in the art as the nature of the present invention is better understood from the following description and as shown in the accompanying drawings.

FIG. 1 is a side view of an hydraulically operated jack hammer.

FIG. 2 is an enlarged vertical sectional view extending through the axis of the hydraulic jack hammer.

FIG. 3 is a sectional view taken substantially along the line 3—3 of FIG. 2.

FIG. 4 is a schematic view of the hydraulic system in the jack hammer showing one position of the control valve and piston.

FIG. 5 is a view similar to FIG. 4 showing a different position of the control valve and piston.

The impact instrument herein to be described is for convenience shown in conjunction with a jack hammer type tool 10 having a pointed end 11 which normally strikes the pavement or other hard surface, and a shank portion 12. The main body or housing 13 has therein a relatively centrally located longitudinal cylindrical opening 14 which receives a reciprocating piston 15 one end of which operates as a hammer. The housing or cylinder 13 is closed at one end by a shank supporting portion 16 and a head portion 17 at the opposite end, the portions 16 and 17 being bolted as at 18, 19 to the housing 13. The shank 12 of the tool 10 has a hexagonal cross section which slides in a hexagonal bore in portion 16 of the housing. Consequently the tool 10 is permitted relatively free axial movement and is restricted against angular or rotative movement in the supporting portion 16. The tool 10 is further provided with an integral annular collar 20 which fits into and

may move axially in an enlarged annular opening 21 at the outer end of the support portion 16. A shoulder 22 limits inward axial movement of the tool 10. Extending outwardly from the collar 20 is an axial groove or slot 23 which receives a lug 24 pivotally mounted on the shank supporting portion 16 by means of a pivot pin 25. The lug 24 has an integral outwardly extending and hand operated portion 26 which is utilized to raise or lower the lug 24 into and out of the slot 23. As may be easily visualized from viewing FIG. 2, the lug 24 may be raised clear of the annular opening 21 so as to permit the collar 22 to pass under the lug 24 for purposes of removing or placing the tool 10 in or out of its operating position in the supporting portion 16. A spring 27 is provided to hold the lug 24 in its down position. The head portion 17 of the housing has radially projecting hand supports 30, 31 by which the operator may carry or direct the jack hammer. Pivoted at 32 on the head end 17 is a control lever 33 which will, as later will become apparent, control the flow of hydraulic fluid into the jack hammer.

Provided adjacent the shank supporting end 16 of the main housing or body is an anvil 35 which has its main portion seated in the cylinder opening 14 and has an enlarged head or striking end 36 extending outwardly of the main body or support 13, the opening 14 of the main body 13 being there enlarged, as at 37, to receive the enlarged end 36. In registry with the enlarged opening 37 is an end opening 38 in the shank support 16. The openings 37, 38 combine to permit a limited amount of axial movement of the anvil 35.

As may be seen from viewing FIG. 2, the shank portion 12 of the tool extends into the opening formed by the recessed ends 37, 38 and is obviously positioned to receive the striking force of the anvil 35.

A bypass or communication duct 40 opens into the piston opening 14 at opposite ends of the cylinder 13, such being shown by the passages 41, 42 which extend radially from the main duct 40. A check valve 43 is provided in the duct system for the purpose of permitting flow of fluid from the anvil end to the head end of the cylinder and to prevent the flow of fluid in the opposite direction.

The piston 15 is elongated axially and has an enlarged anvil-striking or hammer end 50, an opposite enlarged head end 51 and an enlarged central section 52 which is axially spaced from the ends 50, 51 to form with the respective ends first and second fluid receiving reduced portions 53, 54 respectively. The cylinder opening 14 is enlarged at 55 to accommodate axial movement of the enlarged section 52. Opening into the enlarged opening 55 is a second check valve 56 which permits fluid to flow from the passage 40 into the cylinder opening 14.

The main body of housing 13 has an outer surface which in cross section is inverted U-shaped with a horizontal flat surface 60 on its lower side. Bolted at 61, 62 to the lower or under side 60 of the cylinder body 13 is a valve mechanism composed of a main valve casing 64 having an upper surface 65 lying adjacent to the under surface 60 of the body 13, the two surfaces being separated by a sealing gasket 66. The casing 64 is provided with a bore 66 having contained therein an axially shiftable spool valve 59. A pair of hydraulic hoses including a pressure line 67 and a return line 68 is coupled at 69, 70 to the under side of the casing 64 and open into an inlet line 71 and a discharge or return line 72 respectively. Provided in the inlet line 71 is a valve 73 which is biased by springs 74, to block off the passage 71. The valve 73 is provided with a stem 75 which extends axially outwardly of the head 17 and is connected to the control lever 33. Therefore, it becomes obvious by depressing the

lever 33, the valve 73 will be moved axially to open the line 71 to the fluid passing through the inlet line 67.

The valve structure as well as the associated passages between the valve and cylinder 14 is for the purpose of providing a constant reciprocating action of the piston 15. Consequently, it is necessary that the valve be actuated so as to provide relatively fast shifting action of the valve for purposes of obtaining a high rate of reciprocation of the piston 15. Generally, therefore, it will be the object of the present valve system, now to be explained, to create the shifting action of the valve 59 in response to the reciprocating motion of the piston 15. In this manner each stroke of the piston will shift the valve and consequently each shifting action of the valve will cause reciprocation of the piston.

A first pair of axially off-set fluid passages extends from the casing to the cylinder 14 and opens into the cylinder in axial off-set relation. The pair of passages comprises a first supply line or passage 80 and a first return passage 81 which opens into the cylinder 14 for purposes of supplying and returning fluid from the reduced section 54 of the piston. A second pair of axially offset passage leads from the casing to the cylinder 14 and opens into the cylinder in axial off-set relation. The second pair of axially off-set passages includes a second supply line or passage 82 and a second return passage 83 for supplying and returning fluid from the second reduced section 53 of the piston. A third pair of fluid passages 84, 85 leads from opposite ends of the casing 64 into opposite ends of the cylinder 14. The lines or passages 84, 85 open into the cylinder 14 adjacent the respective opposite piston ends 51, 50 and normally are closed by the respective piston ends 51, 50 except at the extreme terminal ends of the piston strokes.

The shiftable valve spool 59 is composed of three large spool knobs 86, 87, 88 separated by a pair of recessed portions 89, 90. The fluid inlet 71 opens into the opening in the casing formed by the recessed portion 89 and the fluid return line 72 opens into the opening formed by the recessed portion 90 of the valve spool 59. It will be noted that the inlet passage 71 opens into the casing cylinder adjacent the reduced portion 89 of the spool valve 59 and also the first and second supply passages 80, 82 open into an area of the casing adjacent the recessed portion 89. The discharge outlet 72 opens into an area of the casing cylinder adjacent the recessed portion 90 of the spool 59 and the return line 81, 83 also opens into the casing cylinder adjacent to or approximate the recessed portion 90 of the spool 59.

Referring specifically to FIGS. 4 and 5 for explanation of the operation of the mechanism, FIG. 4 shows the mechanism in a position in which the piston has just reversed its stroke and is moving in the initial stages of its power stroke. The spool 59 is positioned so that the second fluid passage 82 is blocked off by the enlarged spool section 86 and fluid from the inlet 71 is passed adjacent the reduced section 89 of the spool into the first fluid supply passage 80 to be passed into the area adjacent the reduced piston section 54. The first return passage 81 is blocked by the enlarged spool section 87 and the second return passage 83 opens into the spool cavity formed by the reduced section 90 and consequently fluid may pass from a position in advance of the spindle section 52 through the return passage 83 and into the outlet line 72. Therefore, the fluid passing through the pressure lines 71 and into the first supply passage 80 to be passed behind the enlarged piston section 52 will cause the piston 15 to move in its power stroke to the right at a high rate of speed until the striking end 50 of the piston contacts the anvil 35 which in turn strikes the tool 10. It will be noted in FIG. 4 that the passages 84, 85 are open, but upon slight movement of the piston 15 to the rigth both passages will be closed. Consequently the valve 59 at the initial stages of the movement of the piston 15 to the right is locked against movement.

Referring now to FIG. 5, it will be noted that the anvil striking end 50 of the piston passes beyond the passage 85 thereby opening the passage 85 to the fluid contained in the recessed portion 53 of the piston. At the same time the discharge or return passage 83 is closed by the enlarged central section 52 of the piston. Likewise, the head end of the piston will move in advance of the control passage 84 at the opposite end of the cylinder. When the latter three stages occur, further advance of the piston 15 will cause the fluid trapped in the area adjacent the reduced portion 53 to pass through the control passage 85 and to drive the spool 59 to the left or from a position shown in FIG. 4 to a position shown in FIG. 5. Movement of the spool valve 59 to a second position, as shown in FIG. 5, and as compared to its first position as shown in FIG. 4, will permit communication between the third inlet 71 and the second supply passage 82 while blocking communication between the pressure inlet 71 and the first supply passage 80. Likewise, the return passage 81 will be open to communicate with the discharge or return outlet 72 and the second discharge passage 83 will be blocked by the spool valve 59. Consequently there will be a pressure build up in the area to the right of the enlarged central section 52 of the piston which will drive the piston in its return stroke to the left or to the head of the cylinder. This movement to the left will continue until the opposite piston ends 51, 50 uncovers their respective control passages 84, 85 and the large central portion 52, of the piston covers the return passage 81, or to a position shown in FIG. 4 at which time the fluid will be forced into the passage 84 by advance of the piston which will cause the spool valve 59 to move from the postion shown in FIG. 5 to that shown in FIG. 4. Therefore, it becomes apparent that there is continuous reciprocating action of the piston 15 so long as the valve 73 is retained open.

It becomes apparent that there will be some fluid retained in the casing at opposite ends of the spool valve 59 and in the passages 84, 85 and may leak or be discharged into opposite ends of the cylinder opening 14 in advance of the piston ends 50, 51. Due to the pressure created by the movement of the piston 15 the oil will become generally vaporized and will enter into the passage or duct 40 from one end through the check valve 43 and at the other end through the opening 41. Upon the piston head 50 moving to the right the oil in advance of the piston head 50 will move into the passage 40 and into the area of the cylinder opening 14 adjacent the piston head 51. Consequently there will be no appreciatable pressure build up in advance of the piston in the anvil-striking stroke. Upon the piston 15 moving to the left the fluid or vapor in advance of the piston head 51 will move into the passage 40 and since it is blocked by the check valve 43 from entering the opposite end of the cylinder opening 14 will pass through the check valve 56 and into the cylinder 13 adjacent the piston head 51 where it will be discharged into the return passage 81. Viewing FIG. 4 it becomes apparent that the opening in which the check valve 56 is disposed is blocked from entering into the cylinder opening 14 by the enlarged central portion of the piston 52 as the piston moves to its extreme terminal end in its movement to the left. At this point it becomes obvious that all outlets in advance of the piston head 51 have been blocked and consequently the pressure created in the cylinder opening 14 in advance of the piston head 51 acts as a cushion to the piston 15 in its return stroke.

While only one form of the invention has been shown it should be recognized that other forms and variations will occur to those skilled in the art without departing from the basic principles of the invention. Therefore while the invention was shown and described in detail for the purpose of clearly and concisely illustrating the principles, there is no intention to limit or narrow the invention beyond the broad concepts set forth in the appended claims.

What is claimed is:

1. A hydraulic impact tool comprising a main body having a shank support, a tool having a shank carried by said shank support, said body having a cylinder, an anvil alined with said support to strike the shank, a hammer in said cylinder for striking said anvil, a piston movable with said hammer, a spool valve casing having hydraulic pressure inlet and return ports, pressure and return passageways extending between the casing and cylinder adapted to be connected to said inlet and return ports respectively during the actuation of said piston; spool-control fluid passageways communicating between opposite ends of the cylinder and opposite ends of the casing, a spool valve carried in said casing for directing liquid under pressure into one of said pressure passageways when said piston is in a raised position so that liquid under pressure may enter said cylinder and drive said piston in a power stroke during which the return port is open to a return passageway to exhaust and return most of the liquid in advance of said hammer, said piston closing said return passageway near the end of the power stroke of said hammer to form a pressure build-up in advance of said piston and opening a spool control passageway in advance of the piston to effect shifting of the spool valve to effect opening of the return port to the other of the return passageways and the pressure port to the other of the pressure passageways while closing the pressure passageway and the return passageway effecting the power stroke of the piston, the shifting of the spool valve thereby effecting reversal of movement of the piston to its non-power stroke, said piston advancing in its non-power stroke to close said other of the return passageways to effect a pressure build-up in advance of the piston while opening the other of the spool-control fluid passageways to reverse shift the spool valve to the position effecting the power stroke of the piston, and a fluid duct communicating between opposite ends of the cylinder and containing check valves therein for relieving pressure within the cylinder and in advance of the hammer during the latter's power stroke and retaining pressure within the cylinder in advance of the piston during the latter's non-power stroke.

2. A hydraulic impact tool comprising a main body having a shank support, a tool having a shank carried by said shank support, said body having a cylinder, an anvil alined with said support to strike the shank, a hammer in said cylinder for striking said anvil, a piston movable with said hammer, a spool valve casing having hydraulic pressure inlet and return ports, pressure and return passageways extending between the casing and cylinder adapted to be connected to said inlet and return ports respectively during the actuation of said piston; including a first combination of pressure and return passageways effective to move the piston in its power stroke toward the anvil and a second combination of pressure and return passageways effective to move the piston in its opposite non-power stroke; a pair of valve-control fluid passageways communicating between opposite ends of the cylinder and opposite ends of the casing, a spool valve carried in said casing for directing liquid under pressure into and movable to one position to effect communication between the inlet and return ports and the first combination of pressure and return passageways so that liquid under pressure may enter said cylinder and drive said piston in a power stroke, said piston closing the return passageway near the end of the power stroke of said hammer to form a pressure build-up in advance of said piston and opening a spool control passageway in advance of the piston to effect shifting of the spool valve to a second position to effect communication between the second combination of pressure and return passageways and the inlet and return ports, the shifting of the spool valve thereby effecting reversal of movement of the piston to its non-power stroke, said piston advancing in its non-power stroke to close said other of the return passageways to effect a pressure build-up in advance of the piston while opening the other of the spool-control fluid passageways to reverse shift the spool valve to said one position, and a fluid duct communicating between opposite ends of the cylinder and containing check valve means therein for relieving pressure within the cylinder and in advance of the hammer during the latter's power stroke and retaining pressure within the cylinder in advance of the piston during the latter's non-power stroke.

3. A hydraulic tool comprising: an impact tool having a shank portion; a main body defining a hydraulic cylinder and having one end thereof supporting the shank of the impact tool for axial movement; an anvil supported at the one end and alined with the shank for striking the latter; a piston having an anvil-striking end, an opposite end, and a central portion, said ends and central portion being separated by first and second fluid-receiving reduced sections; a valve including a valve casing connected to the main body and having a valve bore and an axially shiftable spool valve member contained therein, said casing having a pressure inlet and outlet, a first pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation comprising a first supply passage and a first return passage for supplying and returning fluid from said first reduced section of the piston, a second pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation including a second supply passage and a second return passage for supplying and returning fluid from said second reduced section of the piston, and a third pair of fluid passages leading from opposite ends of the casing to the cylinder and opening into the cylinder adjacent respectively the anvil-striking end and head end of the piston whereby said latter passages are normally blocked by said ends and are open to communication with the respective reduced sections of the piston at the terminal ends of the piston stroke to thereby effect axial shifting of the valve; said valve member having thereon a plurality of axially spaced passage-controlling portions and shiftable axially in the casing between a first position in which the first supply passage and said second return passage are in communication with the fluid inlet and outlet respectively and said second supply passage and said first return passage is blocked to thereby effect the anvil-striking stroke of the piston and a second position in which the second passage and said first return passage is in communication with the fluid inlet and outlet respectively and said first supply passage and said second return passage is blocked to thereby effect the return stroke of the piston; a communicating duct between the anvil end and head end of the cylinder; and check valve means in the duct permitting flow of fluid in the duct during the anvil-striking stroke of the piston and preventing flow of fluid in the duct during the return stroke of the piston to thereby effect a pressure build-up in advance of the piston in its return stroke.

4. A hydraulic tool comprising: an impact tool having a shank portion; a main body defining a hydraulic cylinder and having one end thereof supporting the shank of the impact tool for axial movement; an anvil supported at the one end and alined with the shank for striking the latter; a piston having an anvil-striking end, an opposite end, and a central portion, said ends and central portion being separated by first and second fluid-receiving reduced sections; a valve including a valve casing connected to the main body and having a valve bore and an axially shiftable spool valve member contained therein, said casing having a pressure inlet and outlet, a first pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation comprising a first supply passage and a first return passage for supplying and returning fluid from said first reduced section of the piston, a second pair of axially offset passages leading from said casing

to said cylinder and opening into the cylinder in axial offset relation including a second supply passage and a second return passage for supplying and returning fluid from said second reduced section of the piston, and a third pair of fluid passages leading from opposite ends of the casing to the cylinder and opening into the cylinder adjacent respectively the anvil-striking end and head end of the piston whereby said latter passages are normally blocked by said ends and are open to communication with the respective reduced sections of the piston at the terminal ends of the piston stroke to thereby effect axial shifting of the valve; said valve member having thereon a plurality of axially spaced passage-controlling portions and shiftable axially in the casing between a first position in which the first supply passage and said second return passage are in communication with the fluid inlet and outlet respectively and said second supply passage and said first return passage is blocked to thereby effect the anvil-striking stroke of the piston and a second position in which the second passage and said first return passage is in communication with the fluid inlet and outlet respectively and said first supply passage and said second return passage is blocked to thereby effect the return stroke of the piston; a communication duct between the anvil end and head of the cylinder to relieve pressure build-up in advance of the piston.

5. A hydraulic tool comprising: an impact tool having a shank portion; a main body defining a hydraulic cylinder and having one end thereof supporting the shank of the impact tool for axial movement; an anvil supported at the one end and alined with the shank for striking the latter; a piston having an anvil-striking end, an opposite end, and a central portion, said ends and central portion being separated by first and second fluid-receiving reduced sections; a valve including a valve casing connected to the main body and having a valve bore and an axially shiftable spool valve member contained therein, said casing having a pressure inlet passage and outlet passage, a first pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation comprising a first supply passage and a first return passage for supplying and returning fluid from said first reduced section of the piston, a second pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation including a second supply passage and a second return passage for supplying and returning fluid from said second reduced section of the piston, and a third pair of fluid passages leading from opposite ends of the casing to the cylinder and opening into the cylinder adjacent respectively the anvil-striking end and head end of the piston whereby said latter passages are normally blocked by said ends and are open to communication with the respective reduced sections of the piston at the terminal ends of the piston stroke to thereby effect axial shifting of the valve; said valve member having thereon a plurality of axially spaced passage-controlling portions and shiftable axially in the casing between a first position in which the first supply passage and said second return passage are in communication with the fluid inlet and outlet respectively and said second supply passage and said first return passage is blocked to thereby effect the anvil-striking stroke of the piston and a second position in which the second passage and said first return passage is in communication with the fluid inlet and outlet respectively and said first supply passage and said second return passage is blocked to thereby effect the return stroke of the piston; communicating duct means between the anvil end of the cylinder and the outlet passage effective to relieve pressure build-in advance of the piston in its anvil striking stroke.

6. A hydraulic tool comprising: an impact tool having a shank portion; a main body defining a hydraulic cylinder and having one end thereof supporting the shank of the impact tool for axial movement; an anvil supported at the one end and alined with the shank for striking the latter; a piston having an anvil-striking end, an opposite end, and a central portion, said ends and central portion being separated by first and second fluid-receiving reduced sections; a valve including a valve casing connected to the main body and having a valve bore and an axially shiftable spool valve member contained therein, said casing having a pressure inlet passage and outlet passage, a first pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation comprising a first supply passage and a first return passage for supplying and returning fluid from said first reduced section of the piston, a second pair of axially offset passages leading from said casing to said cylinder and opening into the cylinder in axial offset relation including a second supply passage and a second return passage for supplying and returning fluid from said second reduced section of the piston, and a third pair of fluid passages leading from opposite ends of the casing to the cylinder and opening into the cylinder adjacent respectively the anvil-striking end and head end of the piston whereby said latter passages are normally blocked by said ends and are open to communication with the respective reduced sections of the piston at the terminal ends of the piston stroke to thereby effect axial shifting of the valve; and said valve member having thereon a plurality of axially spaced passage-controlling portions and shiftable axially in the casing between a first position in which the first supply passage and said second return passage are in communication with the fluid inlet and outlet respectively and said second supply passage and said first return passage is blocked to thereby effect the anvil-striking stroke of the piston and a second position in which the second passage and said first return passage is in communication with the fluid inlet and outlet respectively and said first supply passage and said second return passage is blocked to thereby effect the return stroke of the piston.

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