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(11) **EP 1 366 864 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:

03.12.2003 Bulletin 2003/49

(51) Int Cl.7: **B25D 9/20, B25D 17/04**

(21) Application number: **02291339.6**

(22) Date of filing: **31.05.2002**

(84) Designated Contracting States:

**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**

Designated Extension States:

AL LT LV MK RO SI

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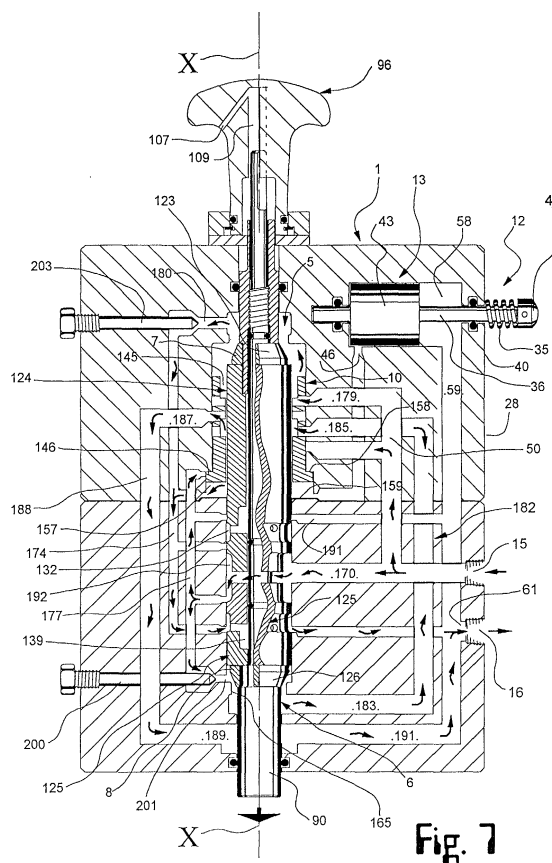
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(54) **Portable hydraulic power operated impact apparatus, such as a spike driver or tamper tool**

(57) The invention relates to a portable hydraulic power operated impact apparatus.

The apparatus comprises a housing (1), a striking shaft assembly axially movable in said housing (1) in a reciprocating manner and comprising upper (5) and lower (6) hydraulic fluid chambers for controlling said movement of said striking shaft assembly (2) and alternately connectable to a hydraulic pressure fluid inlet port (15) and to a return hydraulic fluid outlet port (16) and a device for controlling the reciprocating movement of said striking shaft assembly by establishing passageways between each chamber (5, 6) and respectively said fluid inlet and outlet ports (15, 16). The apparatus is characterized in that said control device (10) is a slide valve slidingly mounted within said housing on said striking shaft assembly (2).

The invention can be used for spike driver or tamper tools.



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Description

[0001] The invention relates to a portable hydraulic power operated impact apparatus, such as a spike driver or tamper tool, comprising a housing, a striking shaft assembly axially movable in said housing in a reciprocating manner between an upper position and a lower impact position and comprising an upper downward impact stroke control surface and a lower upward movement control surface, and upper and lower hydraulic fluid chamber for receiving respectively said upper and lower control surfaces and alternately connectable to a hydraulic pressure fluid source and to a hydraulic fluid reservoir, passageways enabling the flow of fluid between each chamber alternately respectively to said pressure fluid source and said reservoir and a device for controlling the reciprocating movement of said striking shaft assembly by establishing said passageways between each chamber and respectively the fluid source and the reservoir.

[0002] Hydraulic apparatus of the type disclosed above are already known but have the inconvenience that their structure is very complicated and that their operation is not sufficiently easy. Furthermore, improvements to this apparatus, for instance for allowing an adjustment of the striking shaft working length and hydraulic shock reducing make this apparatus further complicated.

[0003] One object of the present invention is to propose an apparatus of the above identified type which eliminates the inconveniences of the prior art.

[0004] For reaching this object, the apparatus according to the invention is characterized in that the control device is slidably mounted on the striking shaft assembly within the housing.

[0005] In accordance to another feature of the invention, the apparatus comprises a striking shaft working length adjustment device by means of an external adjustment member.

[0006] In accordance to still another advantageous feature the striking shaft working length adjustment device comprises an external rotating knob rotatably connected to a striking shaft of said striking shaft assembly, having a threaded portion engaged in a corresponding threaded portion of a stationary housing member, so that rotation of said knob causes said strike shaft to move axially within the housing of the apparatus.

[0007] In accordance to still another advantageous feature the said striking shaft assembly comprises said striking shaft and axially mounted thereon top and bottom hydraulic cushions having conical peripheral surfaces which constitute said upper and lower control faces and, between said cushions, top and bottom pistons.

[0008] In accordance to still another advantageous feature the said upper and lower pistons are axially movable on said striking shaft with respect to one another, with a chamber between them which is constantly connected to the pressure fluid inlet port so that upon shock

load on the striking shaft assembly as a blow is struck, hydraulic fluid flows out of the chamber allowing the pistons to move together for hydraulically reducing said shock.

[0009] Further details and advantages of the invention will result from the following detailed description of the invention and the annexed drawings which are only given as examples for the putting into practice of the invention.

[0010] Figure 1 is a pictorial view of an apparatus according to the invention.

[0011] Figure 2 is an exploded view of the parts fitted onto the hydraulic manifold 18 of the figure 1.

[0012] Figure 3 shows the sequence of assembly of the internal moving components of the apparatus according to the invention.

[0013] Figure 4 is a continuation of figure 3 and shows the sequence of assembly of parts that surround the moving components shown in figure 3.

[0014] Figure 5 is a part exploded view of the invention with the internal components shown in figures 2, 3 and 4, assembled together.

[0015] Figures 6 to 9 are simplified schematic views of the apparatus according to the invention, with each view showing progression in the accomplishment of one cycle of reciprocation of the striking shaft assembly.

[0016] Figure 10 is similar to figures 6 to 9, except the apparatus is shown in the switched-off condition.

[0017] Figure 11 is similar to figure 6, except the hydraulic flow part is changed to show another embodiment of the invention.

[0018] Figure 12 is a part section view of the moving parts of the invention that comprise the striking shaft assembly 2.

[0019] Figure 13 is similar to figure 12, except the preferred method of adjusting the striking shaft length is shown.

[0020] Figure 14 is a part section view similar to figure 13, with a striking shaft assembly shown in the up-position as indicated by the physical relationship to non-moving parts.

[0021] Figure 15 is a part section view similar to figure 14, except the striking shaft assembly is shown in the down-position.

[0022] The invention will be described by taking as example a portable hydraulic power operated spike driver/tamper tool, without however being limited thereto.

[0023] As results from the figure 1 and schematic views on figures 6 to 9, the apparatus comprises substantially a housing 1, a striking shaft assembly 2 axially movable in said housing in a reciprocating manner between an upper position and a lower impact position, under the effect of a hydraulic pressure fluid furnished by a non-represented pressure fluid source and a handle section 3 allowing an operator to control the pressure fluid supply to the apparatus.

[0024] The housing 1 includes an upper working chamber 5 and a lower working chamber 6 which are

alternatively connectable by appropriate fluid passage means within the housing to the pressure fluid source or a hydraulic fluid reservoir and the striking shaft assembly 2 comprises top and bottom control faces 7 and 8 movable within said top and bottom working chambers 5 and 6 for causing the axial movement of the striking shaft assembly when the hydraulic pressure fluid is acting thereon. The reciprocating movement of the striking shaft assembly 2 is controlled by a slide valve 10 included in the housing 1 and slidably movably mounted on the striking shaft. The slide valve 10 is adapted to connect each working chamber 5 and 6 alternatively to the pressure fluid source and to the fluid reservoir by opening and closing appropriate passageways within the housing. The apparatus comprises furthermore a start-stop control device 12 including a spool valve 13 movable between an apparatus working position and an apparatus non working position. The fluid passageway system within said housing is connected by a pressure fluid port 15 through a flexible conduit to the pressure fluid source and by a fluid return port 16 through another flexible conduit to the reservoir.

[0025] The pictorial view 1 of the proposed apparatus and the exploded view of figure 2 show that the upper portion of the housing 1 is formed by a hydraulic manifold 18 with a top surface 19, a bottom surface 20 and a longitudinal hole 21 opening to the top and bottom surfaces and wherein the striking shaft assembly 2 is axially moving. Hole 21 has several changes to the diameter (not shown) to enable the striking shaft assembly 2 to be axially movable therein. To the top surface 19 are attached collars 22 and 23 by threaded fasteners 24, the function of said collars being explained below. To the bottom face of the hydraulic manifold is sealingly and removably attached a barrel portion 26 of the housing (fig. 4), by threaded fasteners 27.

[0026] Below the barrel 26 is shown an endcap 28 that is sealably attached to the barrel by threaded fasteners 29. Attached to the endcap so that threaded fasteners 29 are concealed is a guide tube 31 having a lower end open to expose one hand of the moving parts within. Guide tube 31 is attached to end cap 28 with two or more spring fasteners 34 and is easily removed for cleaning or to incorporate additional fixtures for ballast tamping (not shown).

[0027] Manifold 18 has one or more internal fluid conduits constantly connected to fluid inlet and outlet ports 15 and 16 and leading to one or more channels 30 in barrel 26.

[0028] Fluid inlet and outlet 15 and 16 are provided on the hydraulic manifold 18, which also comprises the start control device 12 with its spool valve 13.

[0029] This start/stop control device comprises a spool valve 13 inserted into a blind hole 33 of the manifold 18 and wherein said spool valve is axially movable. Spool valve stem extends through an opening 39 in the side surface 40 of manifold 18 and carries at its outer end a control button 41. A spring 35 mounted around

the spool valve stem 36 between said control button and side surface 40 of the blind hole 33, provides the mechanical force to normally maintain spool valve 13 switched-off and extended in the outward position as shown in figure 10. The start/stop control device is sealably and removably inserted into blind hole 33.

[0030] The spool valve comprises a cylindrical collar section 43 which is adapted to sealingly close an appropriate throughhole 46 which communicates with fluid passage channel 49, within the manifold 18. The spool valve is in the form of a substantially cylindrical body with a concentric stem 36 and stem 48 projecting outward from each end, and one or more throughholes 44 connecting each end of the cylindrical body. Blind hole 33 is adapted with change in diameter to fit the spool valve cylindrical body 43 and inwardly projecting stem 48. An air vent hole 55 connects the end of stem 48 that is inserted into blind hole 33 with normal atmosphere through hole 32 in stem 36. As will be understood from figure 10, the spool valve is unbiased by any fluid pressure acting upon it. In the switched-off position (fig. 10) of the spool valve, with the control button 41 extending outwards from the side surface 40 of manifold 18, the valve cavity 58 communicates through hole 44 with the inner manifold channel 59 opening in the fluid outlet 16. In its switched-on position (fig. 6) the sealing collar 43 obturates the opening 46.

[0031] Here below there will be described the handle section 3. As shown in figures 1 and 2, handle section 3 comprises a U-shaped formed plate 65 which is attached preferably to the upper surface 19 of the hydraulic manifold 18 by one or more threaded fasteners 66, two U-shaped torque arms 67a, 67b secured by pivoting fasteners 68 to the upstanding walls 69 of formed plate 65, a stabilizing frame 71 positioned parallel with the U-shaped torque arms 67a, 67b in the same horizontal plane. The middle section of each U-shaped arm 67a, 67b is positioned against a small side of the stabilizing frame 71 and clamped onto stabilizing frame 71 by a clamp 75 comprising a first piece 76 having a U-shaped cross section and a second plate like piece 77 secured to one another by threaded fasteners 78 and surrounding top and bottom identical shapes 79 made from flexible moulded rubber. The flexible moulded rubber shapes 79 are interposed between the clamp 75 and the U-shaped torque arms 67a, 67b and the stabilizing frame 71.

[0032] The handle section 3 comprises furthermore two handles 80 each one attached to a U-shaped clamp piece 76 and pointing in opposite directions. These handles enable an operator to hold the driver/tamper tool in a preferably upright position or move it around on the job site.

[0033] From the pictorial view in figure 1 it will be readily understood that reactive force transmitted from operating the tool will be distributed equally to each handle 80 through the two torque arms 67a, 67b. It is to be noted that the compressive force exerted equally onto the top

and bottom moulded rubber shapes 79 can be varied by the degree of tightness provided with the threaded fasteners 78.

[0034] Reactive force transmitted from the tool results in a twisting action by the middle section of each U-shaped torque arm 71, held between clamp pieces 76 and 77. The twisting action progressively increases the deformation of moulded rubber shapes 79. Unequal pivoting movement of torque arms 76a, 76b is constrained by the stabilizing effect of frame 71. Increased twisting by the torque arms is countered by increase in resistance to deformation of the moulded rubber shapes 79 and a progressive increase in the internal damping.

[0035] In a preferred embodiment of the invention, the geometry of frame 71, torque arms 67a, 67b and the pivoting relationship with the formed plate 65 is arranged to maintain stability and parallel motion of the assembly in a horizontal plane whilst allowing a vertical movement in response to reactive forces from the tool.

[0036] In another embodiment each small end of the stabilizing frame 71 is rigidly coupled to a plate member 77 of clamp 75, such that the two handles 80 are held at all times in a common axis pointing away from one another.

[0037] It is advantageous to provide moulded rubber shapes 79 with a ribbed or grooved or dimpled inner surface 82 engageable over the torque arms 67a, 67b and stabilizing frame 71, to allow proportionately more resilience in this moulded rubber shapes 79. Because the load bearing area is initially much less than the free surface area, it will be appreciated that as torque arms 67a, 67b rotate about the center of pivot 68, the deformation of the moulded rubber causes the load bearing area and free surface area to become equal. Thus a more progressive damping of reactive forces at low frequency and better isolation of higher frequency vibration is obtained. It is furthermore possible to change the compressive strength of the rubber from softer to harder grade. Since a harder rubber is able to exert more stress, the device may be subject to higher reactive forces without detriment.

[0038] The handle section 3 comprises furthermore an apparatus control lever 85. Lever 85 is pivotally mounted by a pivot pin 88 on clamp plate 77. Lever 85 comprises an approximately vertically extending spool valve actuating arm 86 and an approximately horizontally extending manually operated arm 87 near to one handle 80 so as to be pushed against this handle by the operator during the working of the apparatus, this movement of the lever causing the spool valve control arm 86 applied on apparatus start button 41 to push this button from its valve switched-off position (fig. 10) to its valve switched-on position (fig. 6). It is to be noted that the position of the formed plate 65 is laterally adjustable on the hydraulic manifold upper surface 19 due to elongated holes 89 for the passage of the fasteners 66. This allows a positioning of attached pivoting lever 85 in a way that start button 41 is fully depressed when the con-

trol arm 86 of the lever is preferably in a vertical position.

[0039] An important advantageous aspect of the present invention resides in the fact that it provides striking shaft length adjustment means which will be explained here-below particularly with reference to figures 2 and 3.

[0040] Striking shaft assembly 2, the structure of which will be described in a detailed manner below, comprises a shaft 90 provided in its upper portion with one or more external flat areas 91 extending a required distance longitudinally from the upper end. The striking shaft has a threaded section 92 next to the flat area 91, to engage with a matching internal thread on an adjusting nut 93. This nut similarly has one or more flat areas 94 extending longitudinally from the upper end. The flat areas 94 are engaged in the complementary shaped inner hole 95 of the collar 23 sealably and removably fixed with the collar 22 by the fasteners 24 to the top of hydraulic manifold 18. The extension of the flat areas 94 of adjusting nut 93 corresponds to a required distance being the sum of the maximum amplitude of the reciprocation movement of the strike shaft assembly and the thickness of the external collar 23 that engages flat nut area 94. Flat area 91 on striking shaft 2 is required to protrude out of adjusting nut 93 by a distance equal to the sum of the amplitude of reciprocation and a distance of approximately 5mm to ensure engagement in a rotating knob 96 (fig. 2).

[0041] With reference to figure 2, it will be understood that the rotation of knob 96 will cause striking shaft assembly 2 to rotate with respect to adjusting nut 93. As shown in part section in figure 13, rotating knob 96 is held in position by a spring clip 98 which engages in groove 99 at the lower end portion of the knob. The complete assembly is held in position by collar 22. An O-ring seal 101 below the threaded strike shaft assembly section 91 prevails sealing contact, as well as static resistance to prevent any unintended rotation of knob 96.

[0042] Knob 96 comprises an inner flat area 103 which engages with flat area 91 of the striking shaft 90. Since flat area 94 on adjusting nut 93 engages with the inner flat area 95 on collar 23, the amplitude of the reciprocation movement of the striking shaft assembly can be varied by rotating the knob 96.

[0043] It is further to be noted that knob 96 is provided with one or more holes 107 allowing displacement of air by the reciprocating movement of the striking shaft assembly in chamber 109 of knob 96 both to and from the exterior. A porous filter (not shown) covers the holes 107 and prevents ingress of foreign particles into chamber 109. The striking shaft assembly has free action movement throughout the full range of adjustment to its working length.

[0044] The means described above allow to alter the striking shaft working length. Knob 96 provides easily accessible external adjustment for the user of the apparatus to make major changes to the tool operating characteristics. Those skilled in the art will appreciate that

different means of external adjustment may be devised in order to change the working length of the striking shaft. It will be described later, in further detail, why external adjustment of striking shaft length provides such an important control over the operating characteristics of the tool, including the selection of the operating speed, distance moved by the reciprocating parts and the force of the blows delivered.

[0045] In the following will be described in a more detailed manner the striking shaft assembly 2 and the slide valve 10.

[0046] The striking shaft assembly is composed from a plurality of separate parts and comprises the shaft 90 mentioned before with different portions, i.e. at the upper end the flat area portion 91, the threaded portion 92 and a constant diameter central portion 112 with a circumferential groove 113 below the threaded portion 92, an intermediate circumferential groove 114 and a circumferential groove 115 near the lower end of this portion 112, each groove being adapted to receive an appropriate O-ring seal respectively 256, 257 and 258. Below this constant diameter intermediate portion 112, shaft 90 comprises a first cylindrical portion of greater diameter 117 with a shoulder 118 between portions 112 and 117 and a second cylindrical portion 119 of still greater diameter with a shoulder 120 between this portion 119 and portion 117 and at the lower end a conical portion 121 pointing downward.

[0047] Striking shaft assembly 2 comprises furthermore a plurality of tubular parts which are adapted to be mounted concentrically on shaft 90, i.e. from the upper to the lower end of the assembly, the aforementioned adjusting nut 93, a conically shaped top hydraulic cushion 123 pointing upward, a cylindrical top piston 124, a cylindrical bottom piston 125 and a conically shaped bottom hydraulic cushion 126 pointing downward. The conical peripheral faces of cushions 123 and 126 constitute the afore-mentioned control faces 7 and 8 of the striking shaft assembly.

[0048] Adjusting nut 93 has a lower smaller cylindrical diameter portion 128 with a shoulder 129 and has an internal thread engaged with the threaded section 92 of striking shaft 90. Top hydraulic cushion 123 is located between shoulder 129 of adjusting nut 93 and top piston 124. This tubular piston 124 comprises a cylindrical outer portion 130, with a lower end 254 and a circumferential groove 132 provided in portion 130 near the lower end thereof. One or more holes 133 pierce the groove wall. The diameter of the inner surface of top piston 124 is increased over a distance starting at a location above hole 133 to a location below hole 133 so as to form an annular chamber 134 between the inner piston face and the striking shaft assembly.

[0049] As results for instance from figure 6, the inner surface of bottom piston 125 is a diameter to be slidably fitted on the portion 112 of shaft 90. Tubular piston 125 comprises a cylindrical outer portion 253, with an upper end 255 and a circumferential groove 135 near said up-

per end and one or more holes 136 that pierce the groove wall. As can be seen from the figure due to the increase in diameter of portion 117 of shaft 90, this piston locates on shoulder 118 and bottom hydraulic cushion 126. Bottom hydraulic cushion 126 is located between bottom piston 125 and the cylindrical lower end portion 119 of shaft 90 and is supported on shoulder 120 of shaft 90.

[0050] As shown on figures 3 and for instance 6, slide valve 10 has an upper end 45 and a lower end 146 and a longitudinal hole 147 that is a sliding fit over top piston 124, as seen in the figures 6 to 9. The external diameter of sliding valve 10 is increased at a circumferential band at the lower end 146 and the complete external surface is a sealable sliding fit in the housing. In the inner cylindrical face of sliding valve 10 is provided an upper cylindrical increased diameter portion forming an annular space 145 and an intermediate increased diameter portion forming an inner groove 150 with throughhole 152, and through holes 151 and 153 respectively at the transitions with the increased diameter portion therebetween.

[0051] Concerning the housing cavity wherein the striking shaft assembly 2 and the sliding valve 10 are axially movable, it comprises a lower cylindrical cavity portion 155 in which the striking shaft assembly is slidably movable and has accordingly an inner diameter corresponding to the outer diameter of the upper and lower striking shaft assembly pistons 124 and 125, and an upper cylindrical cavity portion 156 adapted to slidably receive the sliding valve 10. This upper portion has an enlarged lower section 157 engaging the increased diameter lower end 146 of the sliding valve 10 and having therefore an upper shoulder 158 and a radial shoulder 159 at its transition to the lower cavity portion 155. These two shoulders 158 and 159 limit the axial movement of the sliding valve 10.

[0052] Upper cavity portion 156 comprises an upper smaller diameter section 161 separated from the main part of the portion 156 by a radially inwardly protruding collar 163 having an inner diameter greater than the outer diameter of top cushion 123 but smaller than the outer diameter of top piston 124. This collar constitutes a stop for the upward movement of the striking shaft assembly. Similarly, the lower cavity portion 155 comprises a radially inward protruding collar 166 separated from the main portion 155 which constitutes a stop for the downward movement of the striking shaft assembly. The inner diameter of collar 155 is greater than the outer diameter of bottom cushion 126 but smaller than the outer diameter of bottom piston 125.

[0053] With reference to simplified systematic views shown on figures 6 to 9, the reciprocating assembly operation and the system of fluid flow conduits provided to this purpose within the housing will be described. The fluid flow paths are indicated by arrows.

[0054] It will be understood from figures 6 to 9, that intermittent movement of slide valve 10 is governed by

movement of the striking assembly 2 and more particularly by groove 132 in top piston 124 and groove 135 in bottom piston 125. As shown in figure 6, slide valve 10 is at a maximum upward position and the striking shaft assembly is at the maximum upward position, at the start of downward movement of the striking shaft assembly. Spool valve 12 is in its inward switched-on position after having been pushed in by the control lever 85. Hydraulic pressure fluid from inlet port 15 communicates through a horizontal conduit portion 170 with cavity 192 formed between a lower surface 254 of top piston 124 and an upper surface 255 of bottom piston 125, and the intermediate diameter portion 112 of striking shaft 90. Conduit 174, in this position of the striking shaft assembly 2, communicates with cavity 192 and cavity 157 below the sliding valve end 146 and the lower radial shoulder face 159 to maintain maximum upward position of the sliding valve.

[0055] It will be understood from figure 6, that any pressure fluid which seeps from cavity 192 between the sliding surfaces of top piston 124 and striking shaft 90, is collected within annular chamber 134 which communicates with low pressure fluid through holes 133 in groove 132 and through horizontal conduit 191 and conduit 59 to outlet port 16. Also in this position of the striking shaft assembly, conduit 174 communicates with groove 135 in the external surface of bottom piston 125. Any pressure fluid from cavity 192 which seeps between the sliding surfaces of the bottom piston and striking shaft 90, is collected in annular chamber 139 and communicated with low pressure fluid through holes 136 in groove 135. From figure 8 it will be understood that also in the fully downward position low fluid pressure is maintained at grooves 132 and 135, since cavity 139 in bottom piston 125 communicates with low pressure fluid through holes 136 in groove 135, and through horizontal conduit 251 to outlet port 16. Cavity 134 similarly communicates through holes 133 in groove 132 to conduit 174 and the low pressure fluid in groove 135.

[0056] As shown in figure 7, at a point in the cycle of reciprocation near to maximum downward movement, hydraulic pressure fluid flows from inlet port 15 through horizontal conduit 170, connecting with cavity section 192 and through conduit 177 into the upper part of cavity section 157 above the enlarged slide valve end 146. At the same time low fluid pressure is communicated below the enlarged slide valve end 146 through conduit 174 which allows the downward movement of slide valve 10 to take place. Accordingly, slide valve 10 will be pushed against the lower shoulder surface 159 and maintained at its lowest position.

[0057] Concerning the reciprocating movement of the striking shaft assembly, it results from figure 6, that in its upper position slide valve 10 enables hole 151 to connect vertical conduit 50 through a horizontal conduit 179 with the upper housing cavity 156. Vertical conduit 174 also communicates through a conduit 180 with the upper cavity portion section 161. Accordingly, pressure fluid

is applied to the conical surface of top cushion 123 which constitutes the upper control face 7 and tends to push the striking shaft downward. In this position of the slide valve 10 and the striking shaft assembly 2, the bottom working chamber 6 communicates with the return flow port 16 so that the pressure fluid in upper chamber 5 can push the striking shaft assembly downwardly. Indeed, the lower working chamber 6 communicates with a fluid return conduit 182 which comprises a lower horizontal portion 183, a vertical portion 184, and an upper horizontal portion 185. In this slide valve position, inner groove 150 of the slide valve communicates with a conduit 259 having an upper horizontal portion 187, a vertical portion 188, and a lower horizontal portion 189 extending to a horizontal conduit 191, and leading to return fluid outlet 16. As shown for example on figure 6, conduit portions 189 and 191 communicate with one another around the lower portion 119 of striking shaft 90, through annular chamber 256 in the housing. It is to be noted that the start of the downward reciprocation movement of the striking shaft assembly, as shown in figure 6, occurs with slide valve 10 in the upward position.

[0058] Figure 8 shows the striking shaft assembly 2 at the end of the downward reciprocation movement. It will be understood that a change from a downward reciprocating movement of the striking shaft assembly, to upward, occurs when slide valve 10 moves into the downward position shown in figure 8. In the downward slide valve position the upper horizontal conduit portion 179 that was communicating through vertical conduit portion 50 with pressure fluid inlet 15 is obturated by the peripheral surface of the slide valve so that the upper working chamber 5 is isolated from the fluid power source. Chamber 5 is now connected through internal slide valve groove 145 with the upper horizontal conduit portion 187 of conduit 259, a vertical portion 188 and the lower portion 189 which is connected through an annular chamber 256 with the return flow port 16. Unlike the fluid path shown on figure 6, the lower chamber 6 receives pressure fluid by the flow path formed by the inlet port 15, vertical conduit 50 and upper horizontal conduit portion 193 extending from conduit 50, through the internal groove 150 of the slide valve. Conduit 182 communicates pressure fluid from groove 150 of the slide valve through the upper conduit portion 185 of conduit 182, and through the vertical portion 184 and lower portion 183 which is constantly connected with the chamber 6.

[0059] Figure 9 shows that the pressure fluid path during the upward movement of the striking shaft assembly are those which have just been described until the striking shaft assembly reaches its upward position shown on figure 6 with the slide valve 10 moving in its upward position changing the fluid flow path conditions.

[0060] After the description of the apparatus operation and the fluid flow passageways provided to this purpose, the spool valve working will be disclosed herebelow.

[0061] In figure 10 the start/stop control device 12 comprising spool valve 13 is shown in the switched-off condition. In this condition spool valve 13 is shown fully extended outwards from the side of manifold 18, so that hydraulic fluid flows through hole 46 from vertical conduit 49. Hydraulic fluid next flows through one or more holes 44 that pierce valve spool 13 around the circumference and then through conduit 59 to outlet port 16. Also shown in figure 10 is the flow path of hydraulic pressure fluid from inlet port 15 through conduit 50 and through conduit 193, and then through internal slide valve groove 150 communicating with the upper conduit portion 185 and vertical portion 184 of conduit 182. The lower portion 183 communicates with bottom working chamber 6, and pressure fluid is applied to the lower working chamber 6 to push the striking shaft assembly upwards.

[0062] The hydraulic pressure fluid flow path extends from inlet port 15 through horizontal conduit 170 to cavity 192 and connects with vertical conduit 174.

With spool valve 13 switched-off and the slide valve in the downward position, the hydraulic fluid flow path passes from conduit 174 through the lower part of cavity section 157, below the slide valve end 146, and through opening 257 into vertical conduit 49. It will be understood from figure 10, with the striking shaft assembly at a maximum upward position, the total flow of hydraulic fluid from inlet port 15 is discharged through holes 44 in spool valve 13, and through conduit 59 to outlet port 16.

[0063] As will be understood from figure 10, when the device is switched-off further movement of the striking shaft in a downward direction is prevented because there is a complete hydraulic pressure balance maintained on slide valve 10 that will keep it in the downward position. Fluid pressure is the same in the cavity section 157 above the enlarged lower section 146 of slide valve 10, and in the upper housing cavity 156, and in cavity section 157 below the lower end 146 of slide valve 10. Similarly, fluid pressure balance is maintained on the striking shaft 2 because the fluid pressure is equal in the upper working chamber 5 and lower working chamber 6.

[0064] Figures 6 to 9 show valve spool 13 to be fully depressed into manifold 18, which will enable the apparatus to commence reciprocation movement of the striking shaft assembly, as has been explained above. Indeed, with valve spool 13 in this position, conduit 49 is shut-off by the cylindrical outside surface of spool 13. All hydraulic fluid from inlet connection 15 is therefore directed through conduit 50 to slide valve 10 and is directed to reciprocating movement of the striking shaft assembly.

[0065] In another embodiment, compression spring 35 provides mechanical resistance acting on spool 13 when start button 41 is depressed to commence reciprocating movement of the apparatus. This embodiment provides sufficient mechanical resistance to allow lever 85 to pivot at point 88. Low downward force is required on lever 85 to depress start button 41 so that additional

force-multiplying linkage that is generally used in prior art portable hydraulic tools of this type is not required.

[0066] The portable hydraulic power operated impact apparatus according to the invention provides a balanced volumetric flow, as will be shown in reference to figures 6 to 9. As has just been described above, these figures show the cycle of reciprocation in a simplified schematic form, commencing with the striking shaft assembly in a maximum upper position, progressing through to a maximum downward position and returning to the upward position. After figure 9, the sequence of striking assembly reciprocation commences again from the view shown in figure 6. Because the hydraulic fluid is supplied at a constant volumetric flow rate, it will be appreciated that to maintain constant volumetric flow requires the redirection of hydraulic fluid at the extreme top, and at the extreme bottom of the reciprocating cycle.

[0067] Near to the top of the reciprocating cycle as shown in figure 8, an increasing restriction of hydraulic flow occurs between collar 165 and hydraulic cushion 128 in the top region of cavity 156 as fluid is pushed out of the upper working cavity 5 by the top piston 124. Similarly, near the bottom of the reciprocating cycle as shown schematically in figure 6, hydraulic fluid being pushed out of the lower working chamber 6 by the bottom piston 125 is increasingly restricted by the projection of hydraulic cushion 126 into the orifice defined by collar 166. Hydraulic cushions 123 and 126 are a form of hydraulic fluid control that is well known and therefore a detailed description is not required. As best seen in figure 6 and figure 14, the by-pass provided for the hydraulic flow past bottom cushion 126 is a threaded adjustment screw 200 which may be rotated to a position that partly restricts a conduit 201 extending between the vertical conduit 177 and the lower cavity portion 155 just above the collar 165. Enough hydraulic fluid is allowed to by-pass bottom cushion 126 to slow the striking shaft assembly, and reduce the reaction forces from the reversal in the direction of reciprocation. Similarly a threaded adjustment screw 203 in hydraulic manifold 18 can be rotated to a position that partly restricts conduit 180 so that upward movement of the striking shaft assembly is slowed and the reaction forces occurring at the reversal in direction of reciprocation are reduced.

[0068] As seen for example in figure 6, hydraulic fluid by-pass around bottom cushion 126 and through conduit 201 occurs because conduit 177 is at low pressure and connected to return flow port 16 through groove 132 in the top piston 124 communicating with conduit 191 and conduit 59. Thus a metered flow of hydraulic fluid past bottom adjusting screw 200 slows the striking shaft assembly as described. At a point close to the end of downward movement, slide valve 10 changes position, causing the reversal of hydraulic pressure fluid in conduits 177 and conduit 174. As seen in FIG. 8, the hydraulic flow path through conduit 174 changes to low pressure fluid just as upward movement of the striking shaft

assembly is about to start. Therefore, near the end of upward movement of the striking shaft, hydraulic fluid in the upper working chamber 5 pushed out of cavity portion 156 by top piston 124 is metered by adjusting screw 203 to slow upward movement of the striking assembly. The flow path of hydraulic fluid from cavity portion 156 is through conduit 180 and conduit 174, and unlike figure 6, this position of the striking shaft assembly occurs with conduit 174 communicating through horizontal conduit 251 with outlet port 16.

[0069] Another important embodiment to the patent is the addition of extra pressure force on the upper control face 7 to initiate reciprocation in the downward direction, and extra pressure force on the lower control face 8 to initiate reciprocation of the striking shaft assembly in the upward direction.

[0070] As shown schematically in figure 6, at the start of downward movement of the striking shaft assembly upper cavity portion 161 receives a metered flow of hydraulic pressure fluid from conduit 174, past adjusting screw 203 and through conduit 180. Additional pressure force on the striking shaft assembly, at the point of reversal in reciprocating direction, is important to ensure the rapid transition from upward to downward motion. It will be appreciated that commencement of downward movement in the striking shaft could be slow and uncertain because of restriction to the hydraulic fluid flow path from cavity 156 to cavity 161, caused by the projection of hydraulic cushion 123 into the orifice defined by collar 163. The extra pressure force acting on the top control face 7 to start of the striking shaft assembly moving downward, rapidly opens the orifice defined by collar 163 allowing hydraulic pressure fluid in cavity 161 and 156 to drive the top piston 124 downward. In figure 8, at the start of upward movement of the striking shaft assembly, lower cavity portion 250 also receives a metered flow of hydraulic pressure fluid from conduit 177, past adjusting screw 200 and through conduit 201. This allows similar rapid transition from downward to upward motion at the point of reversal in direction of movement of the striking shaft with extra pressure force acting on the bottom control face 8 to start the striking shaft moving upward, and rapidly opens the orifice defined by collar 166 to allow hydraulic pressure fluid into cavity 250 and 165 to drive the bottom piston upward.

[0071] Another embodiment to the invention provides additional hydraulic damping to the reciprocating movement by the striking shaft assembly, at the extreme limits of upward and downward movement. As shown in figure 11, cavity section 161 is extended to form an additional cavity 205 in an upward direction and cavity 155 is extended downward to form an additional cavity 207. It will be understood from figure 11, that entrapment of hydraulic fluid in cavities 205 and 207 occurs at the extreme top and bottom positions in reciprocating movement of the striking shaft assembly. This embodiment will prevent physical contact of the striking shaft assembly with the manifold at the extreme top and bottom po-

sition and physical contact with the end cap 28 in the extreme bottom position, due to entrapment of hydraulic fluid.

[0072] Although hydraulic fluid by-pass around top and bottom hydraulic cushions 123 and 126 assist in maintaining a constant volumetric flow of hydraulic fluid throughout the reciprocating cycle, this alone is not sufficient to ensure a balanced hydraulic flow. In a preferred embodiment of the present invention, a total balance in hydraulic fluid is achieved through the movement of slide valve 10. Although slide valve 10 moves intermittently, it moves in exact sequence with the striking shaft assembly, and as the striking shaft assembly nears each end of the reciprocating cycle the volumetric flow of hydraulic fluid is redirected from the reciprocating piston movement to movement of slide valve 10.

[0073] An understanding of the relationship between movement of the slide valve 10 and balance volumetric flow rate is obtained from figures 6 to 9. It has previously been described that movement of slide valve 10 occurs in downward direction as the striking assembly nears the end of downward reciprocation. Similarly slide valve moves upwards as the striking assembly nears the end of upward reciprocation. Hydraulic fluid is therefore redirected from moving either bottom piston 125 upward or top piston 124 downward, into moving slide valve 10 either upward or downward. As previously described, groove 135 on bottom piston 125 controls the timing of downward movement of slide valve 10, and groove 132 on top piston 124 controls upward movement of slide valve 10. In a preferred embodiment of the invention, the function of grooves 132 and 135 is also to provide means of redistributing volumetric hydraulic flow from top piston 124 and bottom piston 125 at the extreme ends of reciprocation by the striking shaft assembly.

[0074] The balanced volumetric flow according to the invention is advantageous with respect to other portable hydraulically operated tools including top and bottom pistons of different diameters and a hydraulic accumulator device. There are difficulties to the known devices to achieve a balanced volumetric flow rate in the tool. Indeed at a reciprocating speed of 1500 blows-per-minute there will be 3000 reversals in direction per minute of the striking shaft assembly. It is not feasible to move the large quantity of hydraulic fluid required at this speed into and out of accumulator, or from one piston to another. Even at a reduced speed of reciprocation, there is significant loss in output power from the tool due to energy expended in moving hydraulic fluid internally, into and out of various receptacles, such as a hydraulic accumulator device.

[0075] The invention allows furthermore to obtain a hydraulic shock reduction, as will explained herebelow with reference to figures 6 to 9. It will be understood from these figures that over the distance of reciprocation movement by the striking shaft assembly, including the range of working length adjustment, there is an open conduit between the internal annular space 192 and the

hydraulic fluid inlet port 15. In a preferred embodiment of the invention hydraulic fluid under pressure is provided constantly between top piston 124 and bottom piston 125 from conduit 170, so that top and bottom pistons move closer together, as when the apparatus is in operation upon the impact of the striking shaft assembly against a solid object. This is advantageous, because it provides additional shock-absorbing capability to moving parts of the striking shaft assembly, in both upward and downward directions of reciprocation.

[0076] In this embodiment, hydraulic fluid pressure from conduit 170 will replenish cavity 192 during reciprocating movement in upward or downward direction. At high shock loading as occurs during operation, when the striking shaft strikes against a solid object, hydraulic fluid is displaced from cavity 192 and through vertical conduit 177 into the lower working cavity 6. This significantly limits the reactive forces transmitted upward to handles 80 during operation of the apparatus and even more particularly the case when operating conditions require knob 96 to be set for high blow force.

[0077] In the foregoing the invention has been described with reference to schematic views.

[0078] Figure 4 illustrates an embodiment of the apparatus proposed by the invention which comprises barrel 26 which constitutes the outer casing that contains top and bottom sleeves 212 and 214, sliding valve 10 and the striking assembly 2 as previously disclosed. Barrel 26 is removably secured with threaded fasteners 27 (figure 1) preferably to the lower surface of hydraulic manifold 18, as shown at figures 2 and 5. It will be understood from figure 3 and 4, the outer surface diameters of top and bottom sleeves 212 and 214, fit slidably in the inside diameter of barrel 26. When top and bottom sleeves 212 and 214 are assembled inside barrel 26, they are the exact equivalent in length to barrel 26, from top surface 216 to bottom surface 217. Two or more longitudinal channels 30 are also formed in the internal surface of barrel 26 over the full length, with circumferential distance 220 separating adjacent channels 30. These channels constitute the axially extending conduits shown on figures 6 to 9.

[0079] Figures 4 and 15 show the preferred mode of assembly of barrel 26, with blind hole 222 in the barrel top surface to except a locating pin 224 (figure 3) that provides radial orientation to top sleeve 212 with respect to the radial orientation of channels 30 inside barrel 26. Another blind hole in the bottom surface of barrel 26 exerts a locating pin 225 to provide radial orientation to bottom sleeve 214 with respect to the orientation of channels 30 inside barrel 26.

[0080] Fluid sealing against hydraulic fluid leakage between two or more joining channels 30 of barrel 26, at the interface of top surface 216 and bottom surface 217 with end cap 28 and manifold 18 is obtained with O-ring seals 229. Each channel formed in barrel 26 is contained at the top surface 216 and bottom surface 217, by an individual O-ring 229, which locates in a blind

hole of the joining assembly. As best seen in figures 4 and 15, O-rings 229 locate in blind holes 231 of end cap 28, to seal the lower surface 217 of barrel 26 against the unintended leakage of hydraulic fluid. Similarly O-rings 229 are located in blind holes (not shown) in hydraulic manifold 18 and provide a seal against unintended leakage of hydraulic fluid at top surface 216 of barrel 26.

[0081] As shown in figure 6, hydraulic fluid pressure from the inlet port follows conduit 170 and connects with vertical conduit 50 through a horizontal conduit 179 to pass through hole 151 into the internal slide valve groove 145 and the upper housing cavity 156. As better shown in figure 14, hydraulic fluid pressure from inlet port or connection 15 follows a conduit formed by a channel 30 in barrel 26 and vertically down through a longitudinal channel 30 to one or more holes 233 piercing top sleeve 212, then passing through one or more holes 151 in slide valve 10 to exert force upon top piston 124 and cause the striking shaft assembly to move downwards.

[0082] In a preferred embodiment it has previously been described that upward and downward movement of slide valve 10 changes the conduit path supplying hydraulic pressure fluid from inlet port 15 which reverses the direction of reciprocation of the striking shaft assembly. As shown in schematic form in figure 8 and also in figure 15, slide valve 10 is represented in the downward position and therefore hydraulic pressure fluid that was passing through hole 233 in top sleeve 212 has been shut off. Furthermore, as shown on figure 8, fluid opening 152, and fluid openings 153 provide a connection between conduit 193 and conduit 182 allowing pressure fluid from inlet port 15 to act on the bottom piston 125 and force the striking shaft assembly upward. In the same view shown in part section in figure 15, hole 152 in slide valve 10 will be seen to align with hole 239 in top sleeve 212, allowing hydraulic pressure fluid to flow from a channel 30 into internal slide valve groove 150. From internal groove 150 pressure fluid passes through hole 153 in sliding valve 10 and hole 237 in top sleeve 212 then into a channel 30, where hydraulic pressure fluid flows downward past bottom sleeve 214 to exert force on bottom piston 125 and cause the striking shaft assembly to move upward.

[0083] Until now, embodiments of the present invention have been described wherein the slide valve 10 moves intermittently and in perfect sequence with the striking shaft assembly 2. In yet another embodiment as shown in figure 11, the slide valve 10 still moves intermittently and in perfect sequence with the striking shaft assembly, but in direction opposite to the reciprocating movement. Movement by slide valve 10 into its maximum upward position occurs near the end of downward reciprocation of the striking shaft assembly. Similarly, movement of the slide valve 10 to maximum downward position occurs near the end of upward reciprocation of the striking assembly. It will be understood from the figure 11, the best mode for carrying out the invention of

this embodiment is similar to that already described. However, a physical change is required to top sleeve 212. The change to the sequence of conduit connections, as shown in basic schematic form in figure 11, requires the radial rotation of one or more holes 245 in top sleeve 212 to be changed.

[0084] In still another embodiment of the invention, also shown in figure 11, hydraulic fluid pressure from fluid inlet port 15 is connected at all times by conduit to threaded connection 247 on the hydraulic manifold 18 (figure 2). This embodiment has application in particular operating conditions where fluid cavitation may occur within the spike driver/tamper tool. Particular operating conditions where cavitation may occur include increased volumetric fluid flow through the tool, or when high back pressure occurs at hydraulic fluid outlet port or connection 16 due to increased resistance to fluid flow through the return conduit or another reason.

[0085] Fluid cavitation usually occurs following a momentary spike in hydraulic pressure or change in volumetric flow rate, and may occur in the spike driver/tamper tool if it is operated under the particular conditions noted above. Fluid cavitation can be damaging and may lead to the erosion of metal surfaces in contact with hydraulic fluid. To eliminate this condition a generally accepted practice is to incorporate hydraulic pressure accumulator device, or devices, into the hydraulic circuit, that is appropriately sized to absorb undue pressure spikes. The intended purpose of threaded connection 247, as shown in figures 1 and 11, is to incorporate a hydraulic accumulator device (not shown) externally on the hydraulic manifold in particular operating circumstances that warrant the use of such device.

[0086] In the following remarks will be made to the best mode for carrying out the invention.

[0087] A common practice in the portable hydraulic powered tool industry, which includes the present invention of a portable spike driver/tamper tool, is to supply hydraulic fluid power from an external source (not shown), at an industry standard fluid pressure and volumetric flow rate. Typical fluid pressure and flow rate supplied for the present invention could be 2000 P.S.I. and 10 US. GPM. The volumetric flow and supply pressure of hydraulic fluid must remain constant to avoid overheating of the supply system, even if the spike driver/tamper tool is used only in intermittent operation. Thus, portable hydraulic tools of the type described in the present invention require means to adjust the speed of the tool operation, or vary the force of operation, other than by reducing fluid pressure or volumetric flow rate.

[0088] In the present invention, variation in the speed of operation of the tool, generally measured as blows-per-minute, is achieved by physical adjustment of the working length of the striking shaft assembly, as described previously, without requiring change to fluid supply pressure or volumetric flow rate. Typically, the tool may be operated at a speed of reciprocation that is infinitely variable between approximately 800 blows per

minute and 1600 blows-per-minute. The blows-per-minute rate is set with the tool in the off-position, by turning adjusting knob 96. Two important conditions are controlled by the blows-per-minute rate; they are the energy, or force of the blow, and the distance moved by the reciprocating parts.

[0089] The relationship between the three operating conditions of said invention, is that energy, or force of the blow, and the distance moved by the reciprocating parts, both increase in direct proportion to the decrease in blow-per-minute rate.

[0090] The invention such as described above yields numerous operation advantages some of which will be precised here-below.

[0091] Operated as a spike driver, it is important that the force of the blow is varied depending on such factors as whether holes for the spikes are pre-drilled, and the type of wood used for railway ties or sleepers. If drilled holes pre-exist in the railway tie then less force is required to insert spikes. On the other hand, hardwood instead of softwood material into which the spikes are to be driven requires much more force. An advantage claimed for the present invention is the easy adjustment of force of the blow, simply by turning a knob on top of the tool. Another advantage is the range of available operating conditions may be marked onto the tool. Or the adjusting knob on the tool may be turned to a premarked position with recommended setting for a particular job tasks such as; deep driving spikes, light spike driving to final depth, heavy ballast tamping, light ballast tamping, etc.

[0092] Still another advantage claimed for the present invention, is that the force of the blow increases in proportion to increased downward movement of the striking shaft assembly. The advantage claimed is advantageous because the tool contacts the spike over an increased distance of downward movement, as the energy of blow force is increased and the spike is required to be driven deeper. This is important because driving a metal spike into a wooden railway tie, or sleeper, absorbs a large amount of the energy of each blow at the start the initial movement of the spike through the fibers of the wood. Extending the distance over which the tool has contact with the spike, once initial resistance to deformation of fibers in a wooden railway tie is overcome, is very effective in obtaining increased depth of spike penetration.

[0093] Yet another claimed advantage of the invention is related to the operation of the device in tamping railway ballast, and particularly for tamping ballast consisting of crushed rock of inconsistent size. Tamping this type of ballast requires that a specific speed of reciprocation of the tool is maintained, with a higher or lower speed being required depending on ballast size and the degree of compacting. As previously described, the operating speed of the present invention is easily adjustable to accommodate variations material formation and size composition, for an effective ballast tamping speed

range of 1200 to 1500 blows-per-minute.

[0094] A further advantage of the present invention as a tool for railway ballast tamping, is that higher blows-per-minute operating speed is combined with a smallest distance travelled by the moving parts. This has particular benefit since light surface tamping without unnecessary disturbance of underlying ballast, requires a high blows-per-minute rate together with a small distance travelled by the moving parts. Conversely, deep tamping penetrating to the underlying ballast bed needs a slow rate of blows per minute but greater distance travelled by the moving parts.

[0095] Still another advantage of the invention, relates to the spike driver/tamper tool being placed in position for driving a spike, with the tool in the off-position. Most frequently, and particularly without a pre-drilled hole, a spike is insecurely positioned at the commencement of driving into the wooden railway tie which results in the spike being driven at a slant, or the driving tool falling off the end of the spike. The tool falling off the spike or deflecting the spike may result in personal injury to the tool operator, or injury to others in the vicinity. A spike incorrectly driven at a slant provides inadequate positioning of the rail track and must be avoided.

[0096] In the said invention, as previously described, the moving parts of the tool always retract when the on/off lever is set to the off-position. This is particular advantageous as it enables the driving end of the tool to be positioned fully onto the head of the spike before it is driven into the wooded tie. Proper positioning on the spike greatly helps to prevent the tool falling off the spike, and allows the operator to hold the tool slightly off the vertical position in a way that avoids the spike being driven at a slant. Other portable tools of the spike driving type do not possess the feature of automatic retraction of moving parts in the off-position, and therefore proper positioning of the tool onto the head of a spike is difficult.

[0097] The invention is not limited to the example which has been described.

[0098] The present invention has benefits that are applicable to many other fields of use, in addition the intended purpose of spike driver/tamper for railway ties or sleepers. The conversion of energy from hydraulic fluid under pressure, into mechanical impact force, is particularly high compared to other devices of this type. Also, the internal hydraulic conduits and holes can be large and able to pass contaminants without blockage. The device is self-starting from any point in the reciprocating cycle. A very important feature is that hydraulic fluid redirection at the extreme ends of striking shaft assembly reciprocating movement, resulting in a balanced volumetric flow rate, allows the reactive forces to be controlled and reduced.

[0099] These benefits are particularly suited to underwater operation such as an underwater descaling device. With the addition of a turning mechanism, to separately rotate the striking tool, the device is also suited

to rock drilling operation. Because the present invention is also small in diameter, the benefits previously mentioned are advantageous in deep earth boring, for exploration and well drilling.

Claims

1. Portable hydraulic power operated impact apparatus, such as a spike driver or tamper tool, comprising a housing (1), a striking shaft assembly (2) axially movable in said housing (1) in a reciprocating manner between an upper position and a lower impact position and comprising an upper downward impact stroke control surface (7) and a lower upward movement control surface (8), and upper (5) and lower (6) hydraulic fluid chambers for receiving respectively said upper and lower control surfaces (7, 8) and alternately connectable to a hydraulic pressure fluid source and to a hydraulic fluid reservoir, passageways enabling the flow of fluid between each chamber (5, 6) alternately respectively to a pressure fluid inlet port (15) and a return fluid outlet port (16) and a device (10) for controlling the reciprocating movement of said striking shaft assembly (2) by establishing said passageways between each chamber (5, 6) and respectively the fluid source and the reservoir, **characterized in that** said control device (10) is a slide valve slidingly mounted within said housing on said striking shaft assembly (2).
2. Apparatus according to claim 1, **characterized in that** it comprises a start/stop control device (12) adapted to maintain the sliding valve (10) in a position where the upper working chamber (5) is cut off from the pressure fluid inlet port (15), when it is in its switched-off condition.
3. Apparatus according to claim 1 or 2, **characterized in that** said start/stop device (12) is adapted to maintain the slide valve (10) in positions wherein the upper working chamber (5) or the lower chamber (6) is connected to the pressure fluid inlet port (15) and the lower working chamber (6) or the upper chamber (5) is connected to the return fluid outlet port (16), when it is in its switched-on position.
4. Apparatus according to any of claims 1 to 3, **characterized in that** it comprises a handle section (3) having a control level (85) for moving said start/stop device between its switched-on and switched-off positions.
5. Apparatus according to any of claims 3 or 4, **characterized in that** said start/stop device (12) comprises a spool valve (13) movable by said control level (85) against a spring (35) between the said

switched-off and switched-on positions.

6. Apparatus according to any of foregoing claims 1 to 5, **characterized in that** it comprises a striking shaft working length adjustment device by means of an external adjustment member (96). 5
7. Apparatus according to claim 6, **characterized in that** said striking shaft working length adjustment device comprises an external rotating knob (96) rotatably connected to a striking shaft (90) of said striking shaft assembly and having a threaded portion (92) engaged in a corresponding threaded portion of a stationary housing member, so that rotation of said knob causes said strike shaft (90) to move axially within the housing (1) of the apparatus. 10 15
8. Apparatus according to claim 7, **characterized in that** said striking shaft assembly (2) comprises said striking shaft (90) and axially mounted thereon top and bottom hydraulic cushions (123 and 126) having conical peripheral surfaces which constitute said upper and lower control faces (7, 8) and, between said cushions, top and bottom pistons (124, 125). 20 25
9. Apparatus according to claim 8, **characterized in that** said upper and lower pistons (124 and 125) are axially movable on said striking shaft (9) with respect to one another, with a chamber (192) between them which is constantly connected to the pressure fluid inlet port (15) so that upon shock load on the striking shaft assembly (2) as a blow is struck, hydraulic fluid flows out of the chamber allowing the pistons (124, 125) to move together for hydraulically reducing said shock. 30 35
10. Apparatus to any of claims 1 to 9, **characterized in that** said handle section comprises two handles (80) connected to the apparatus housing (1) by resilient shock absorbing connecting means (75, 79, 82). 40

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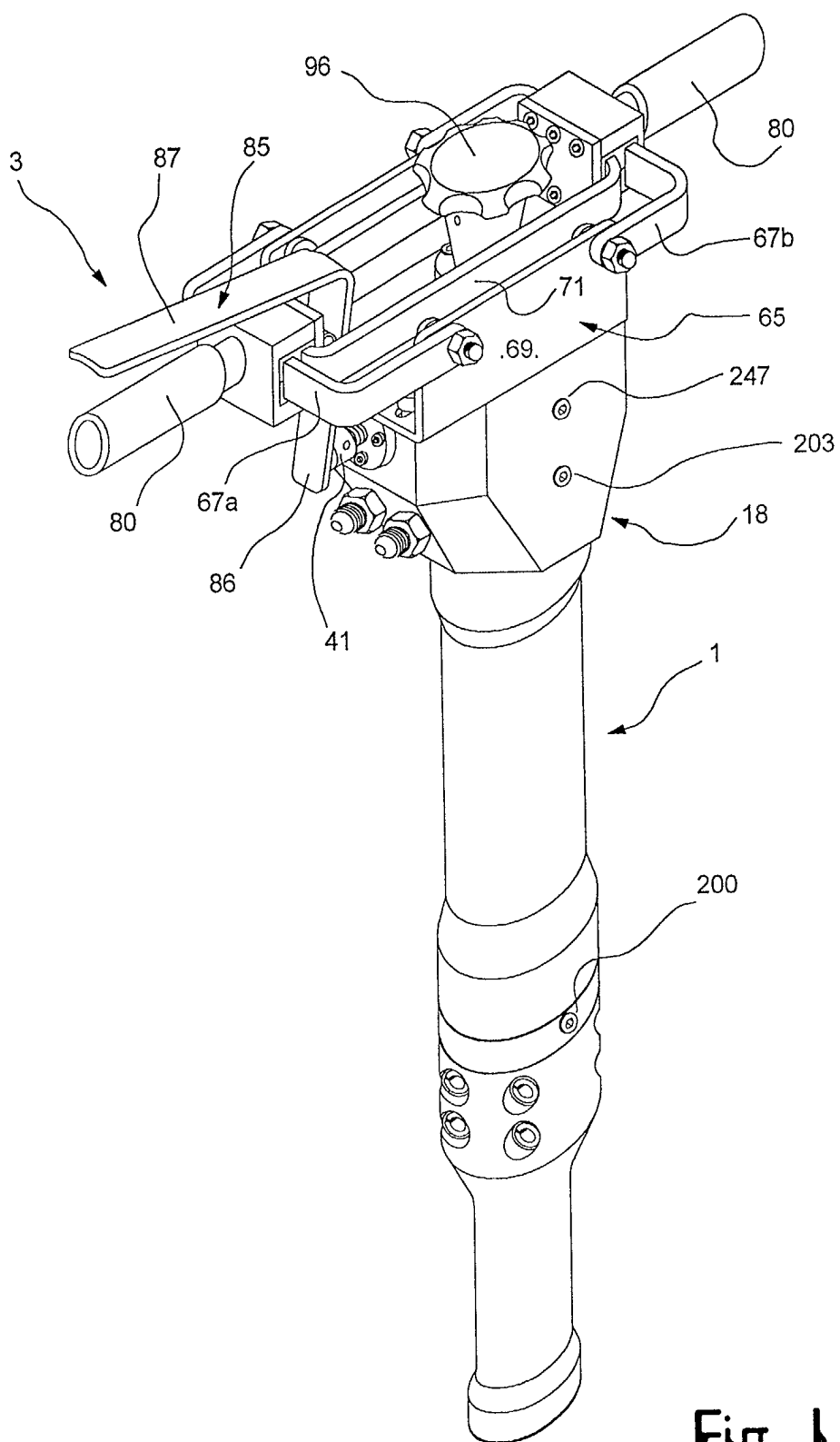


Fig. 1

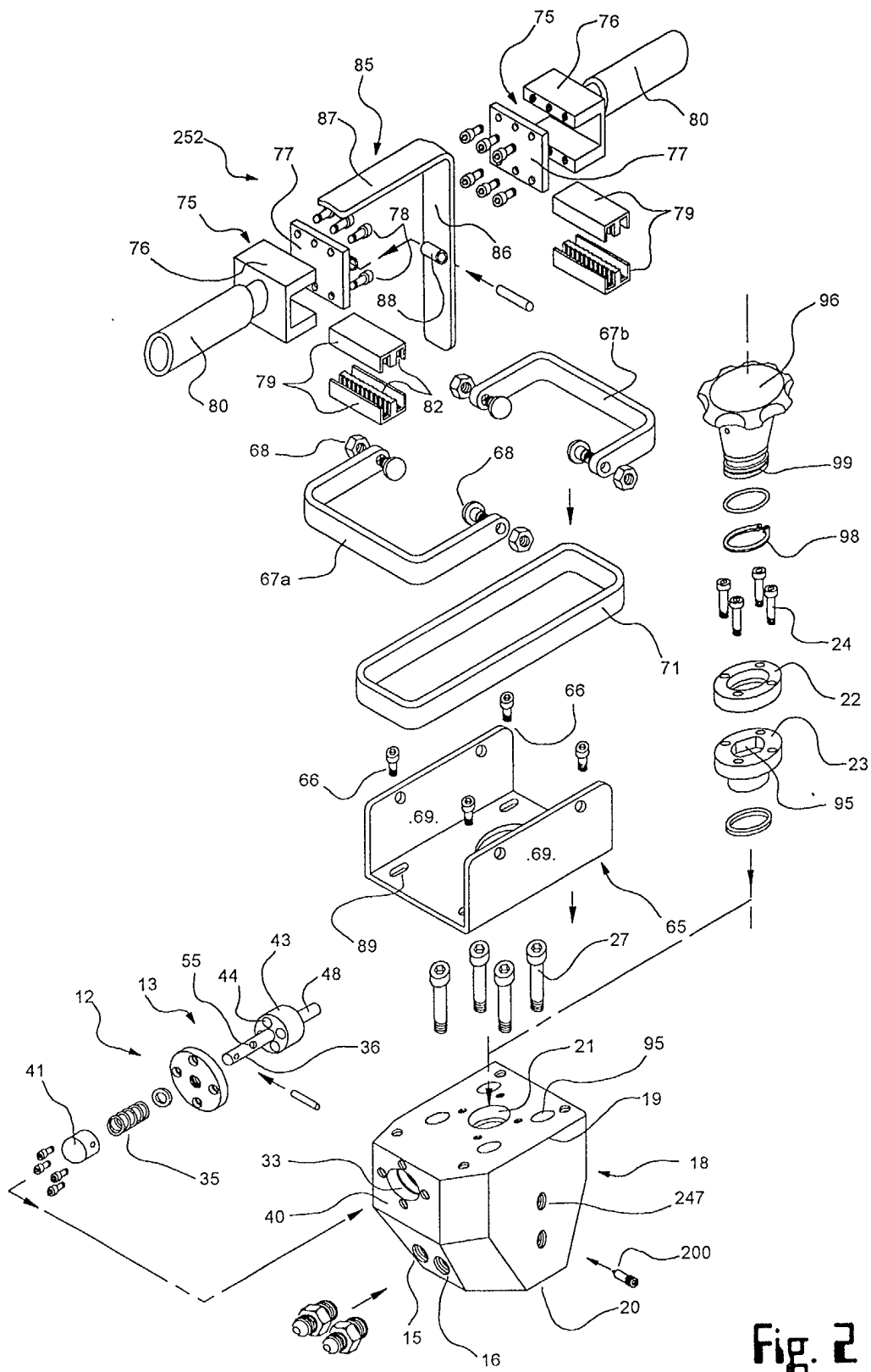
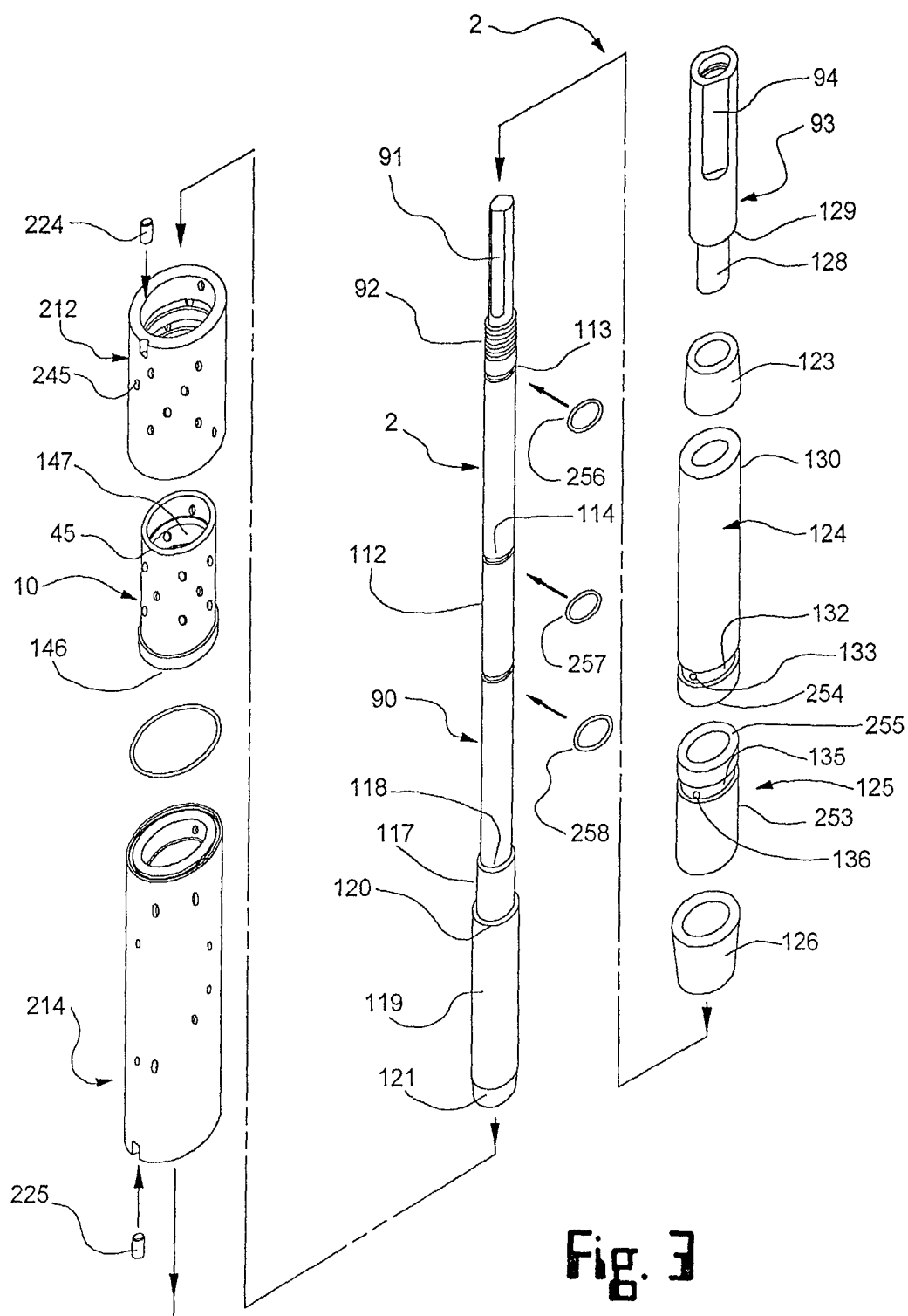


Fig. 2



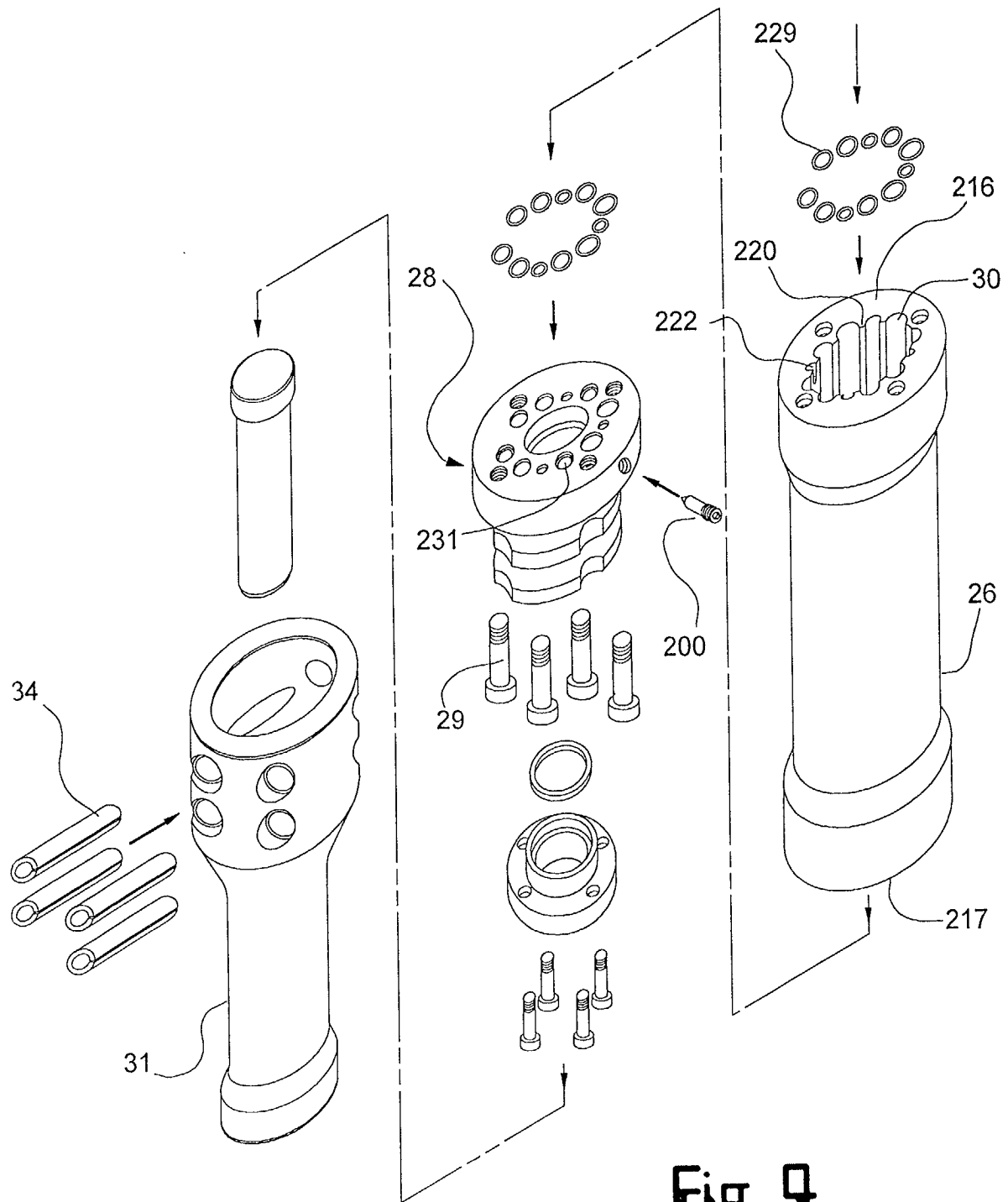


Fig. 4

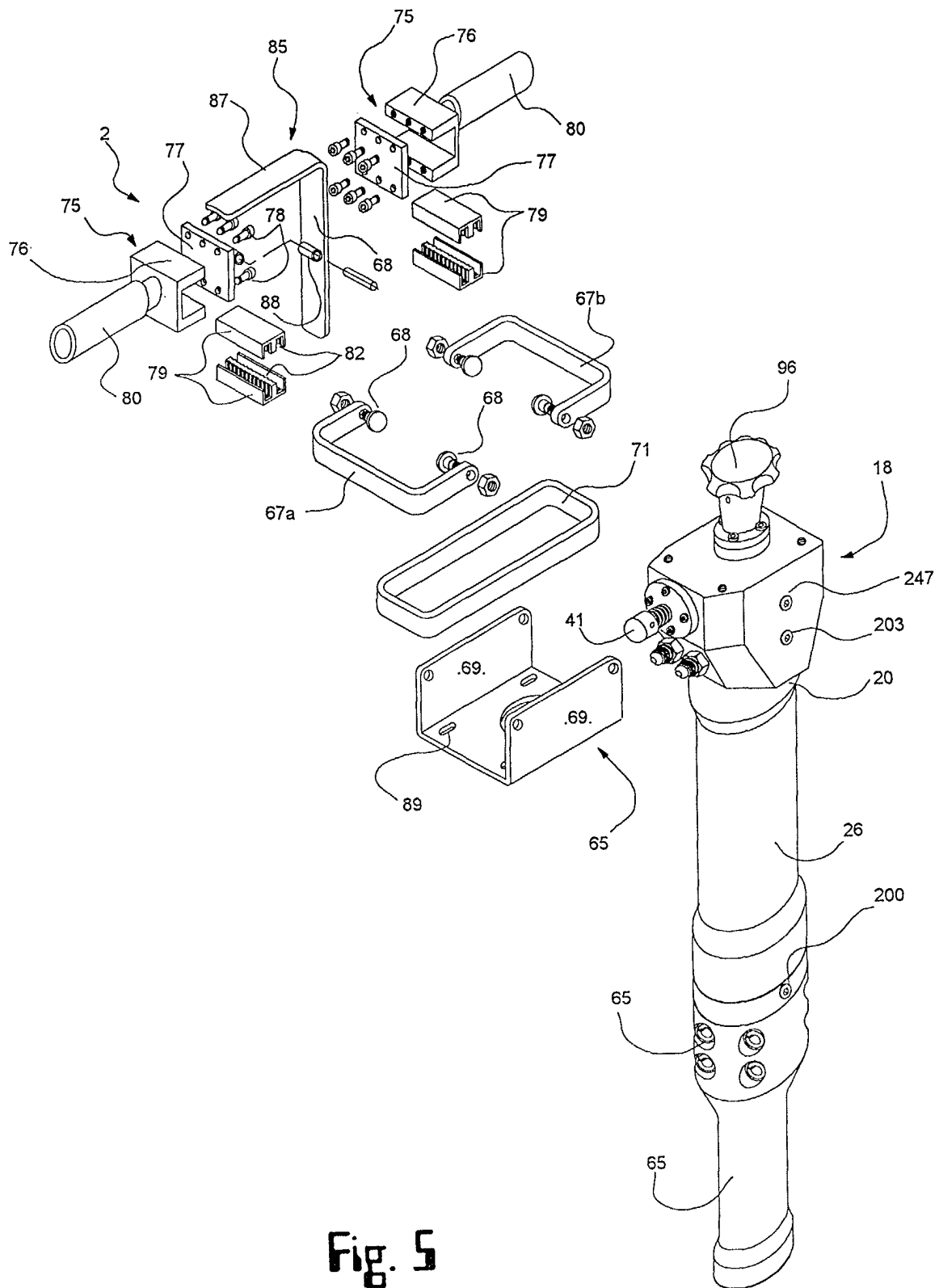
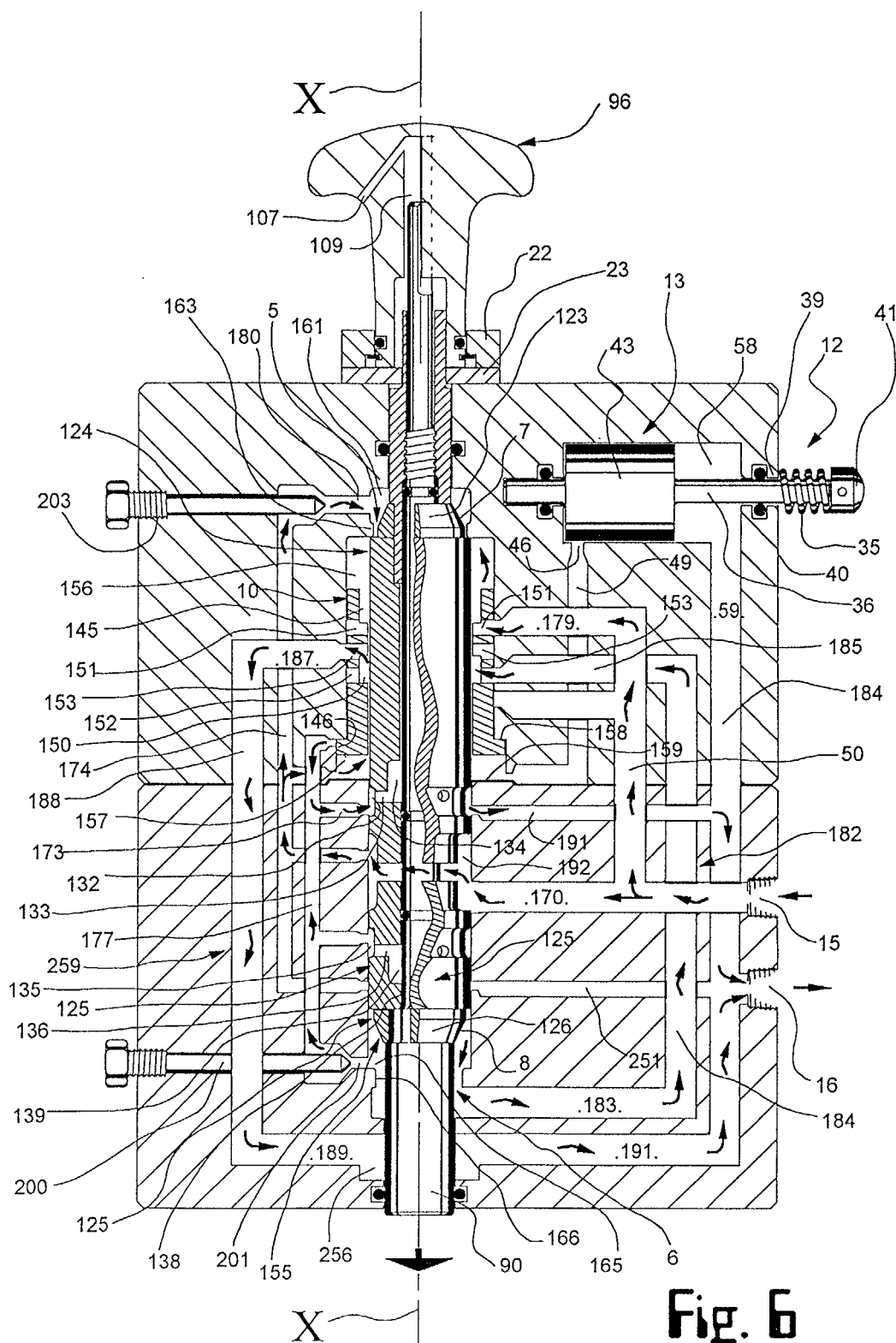
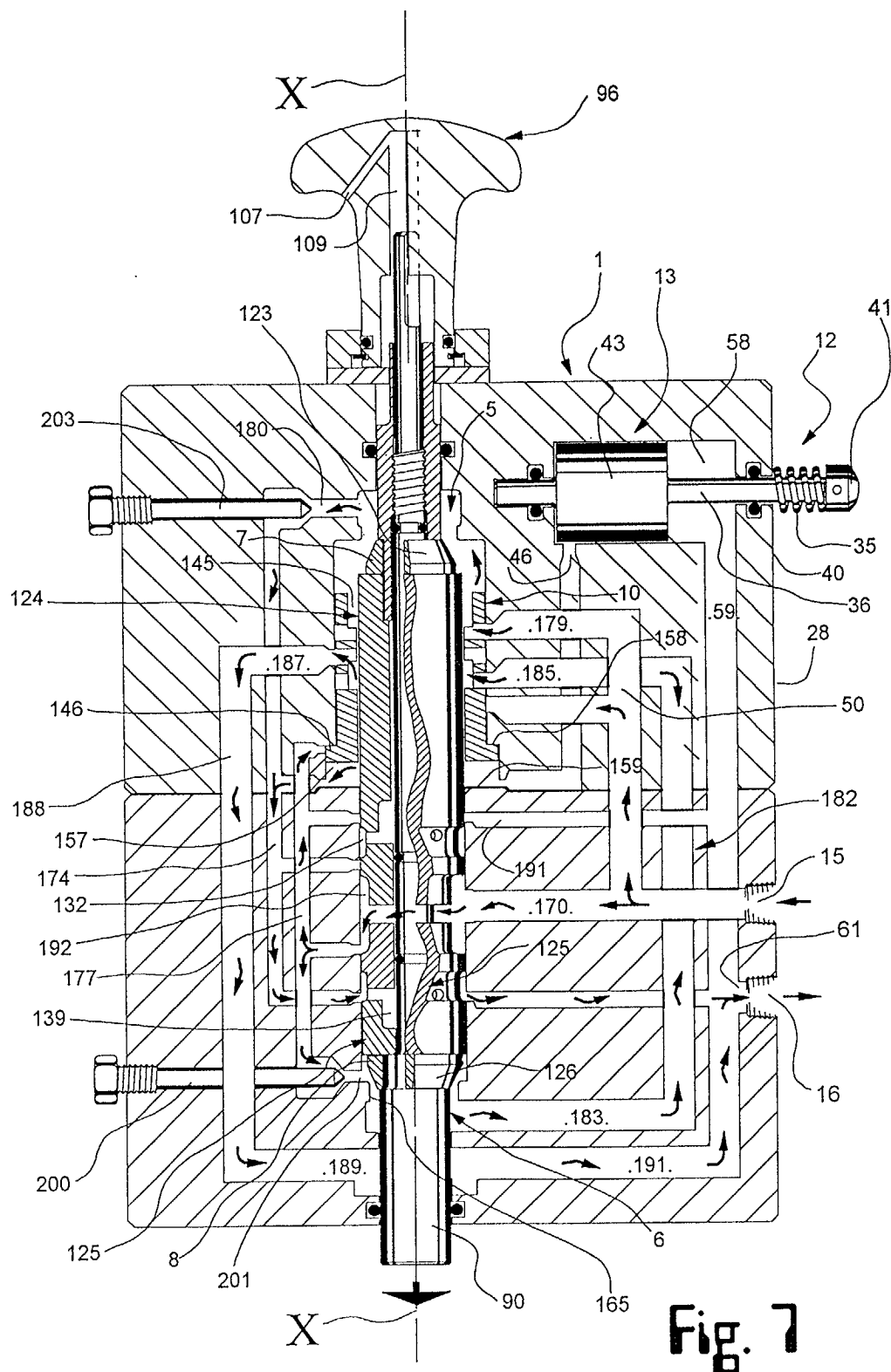
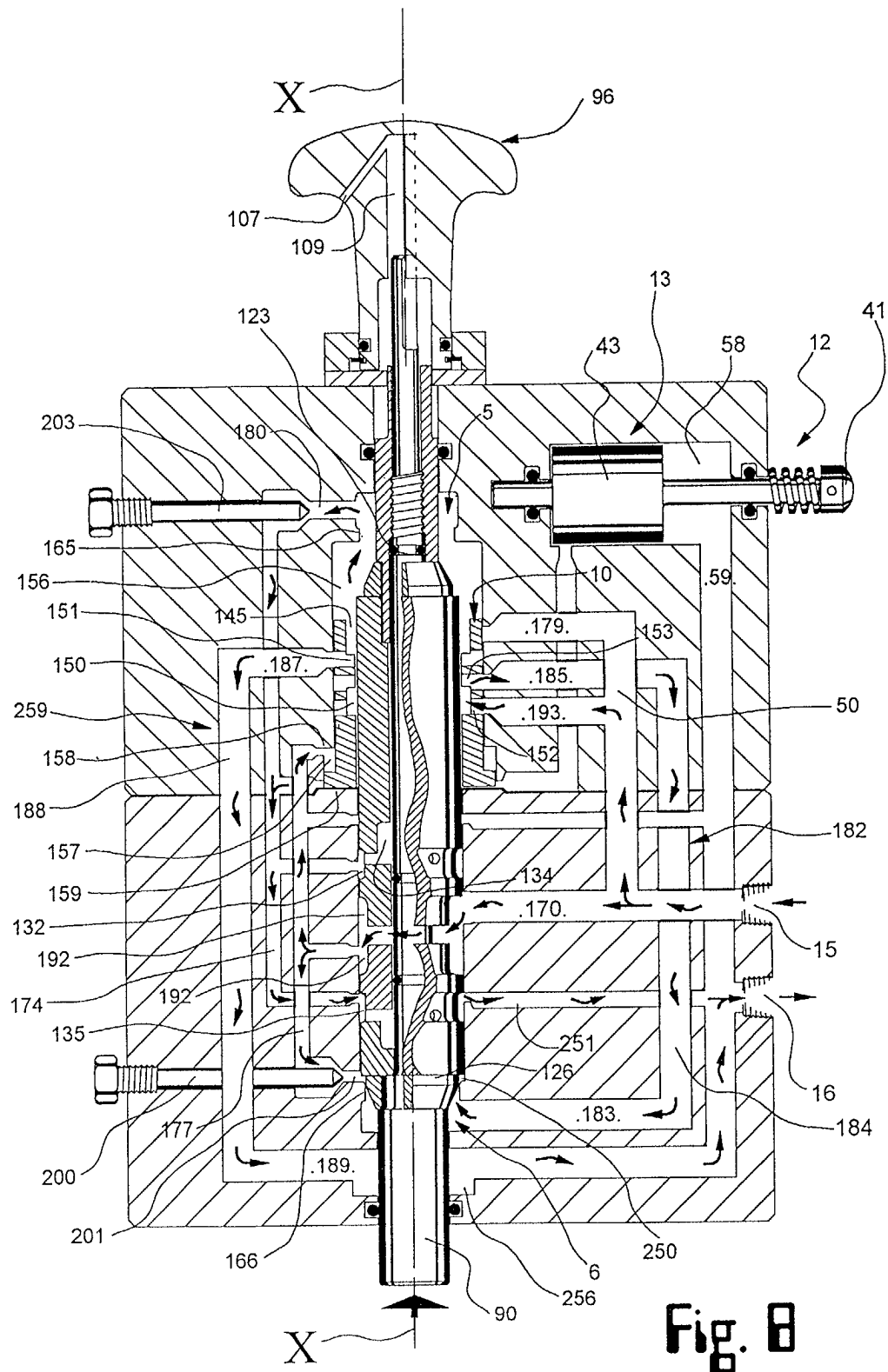
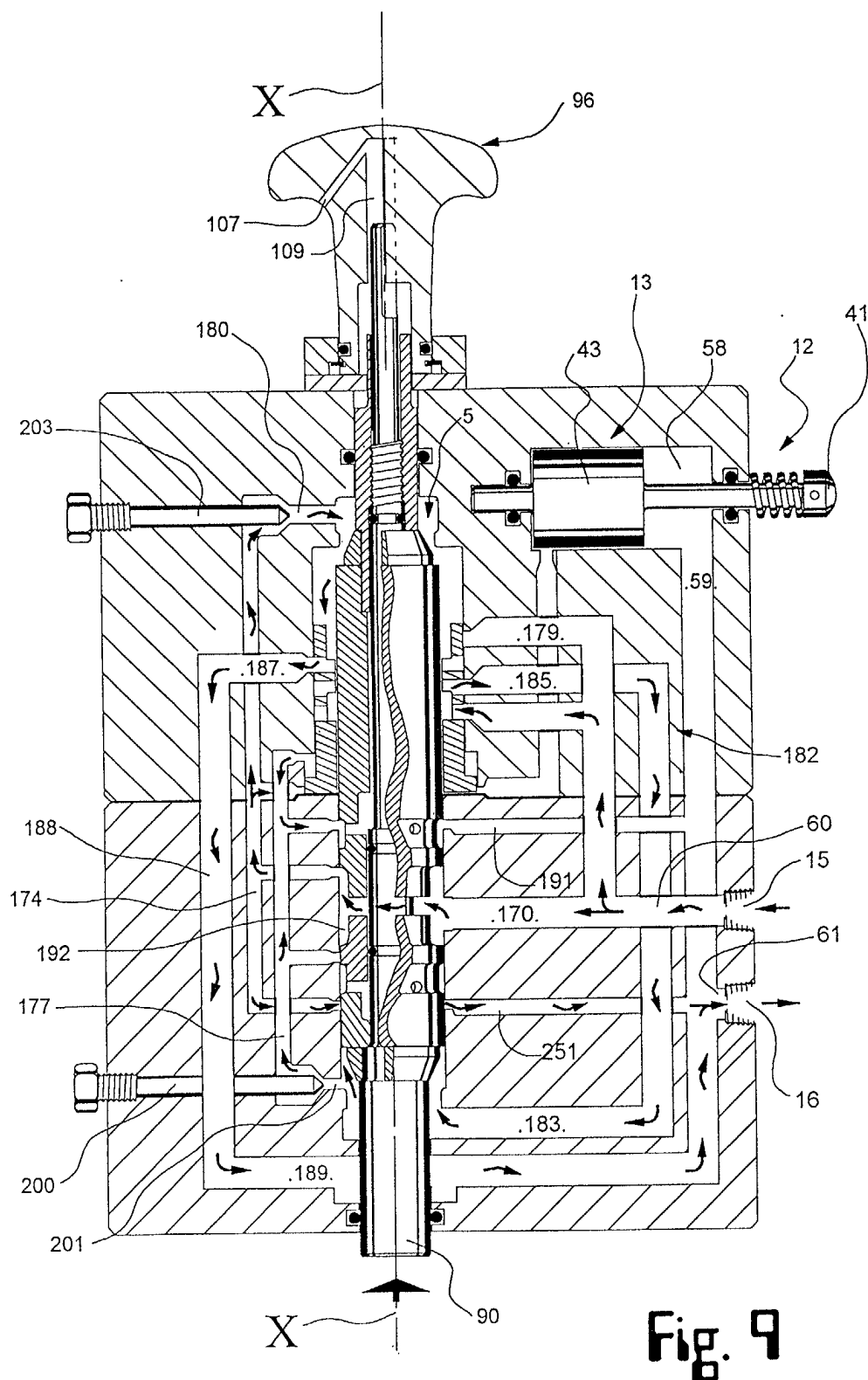


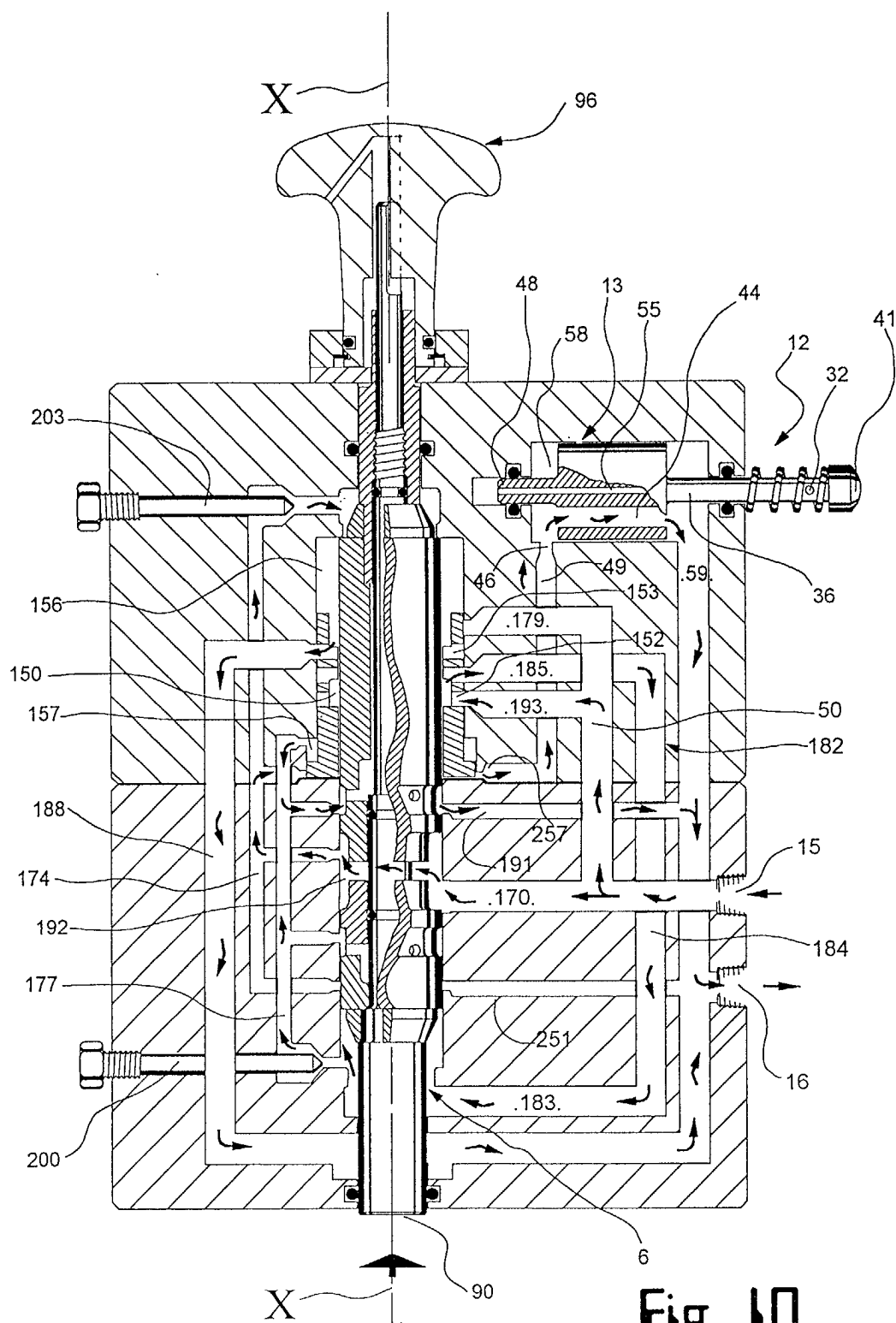
Fig. 5











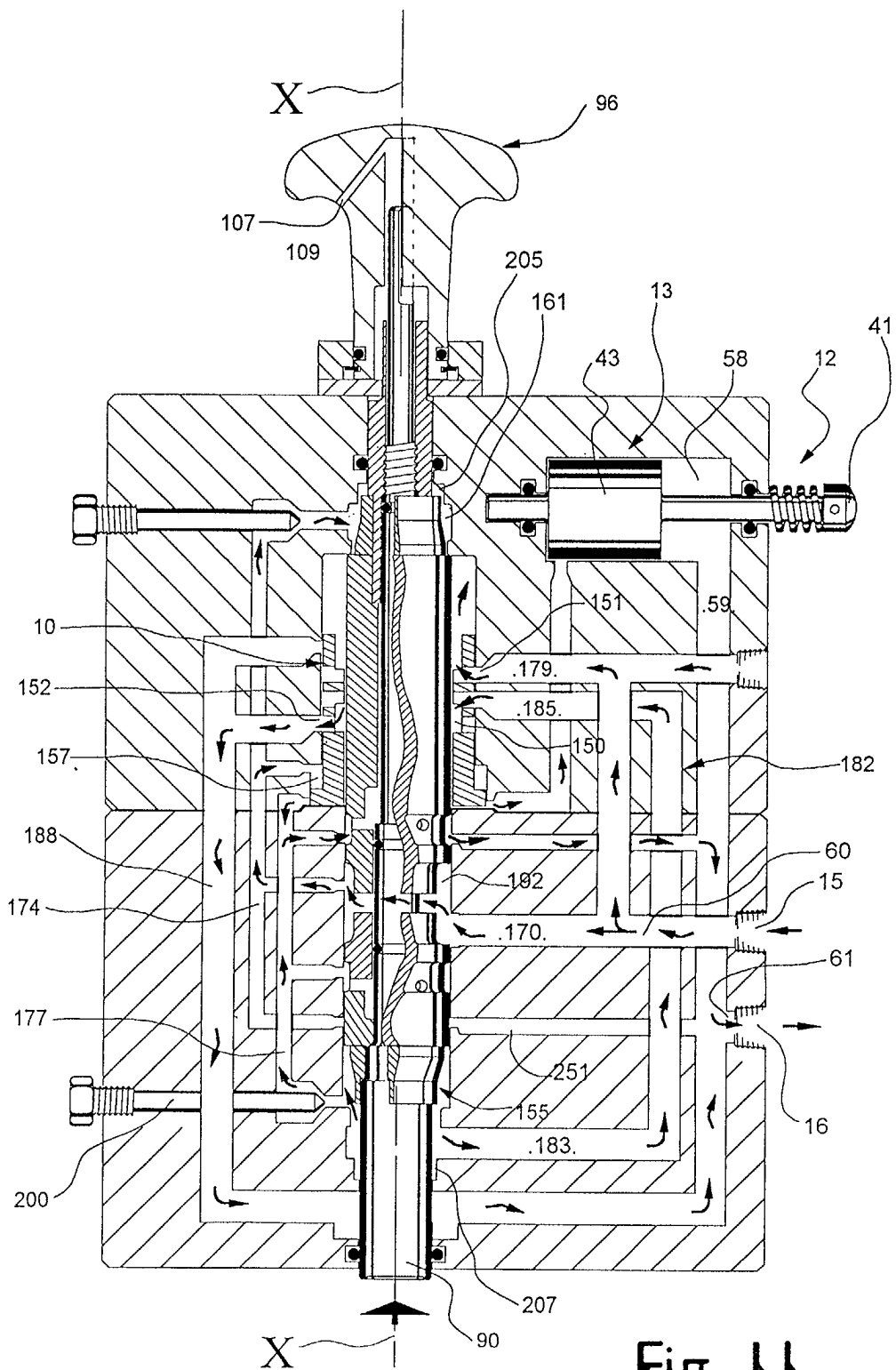


Fig. 11

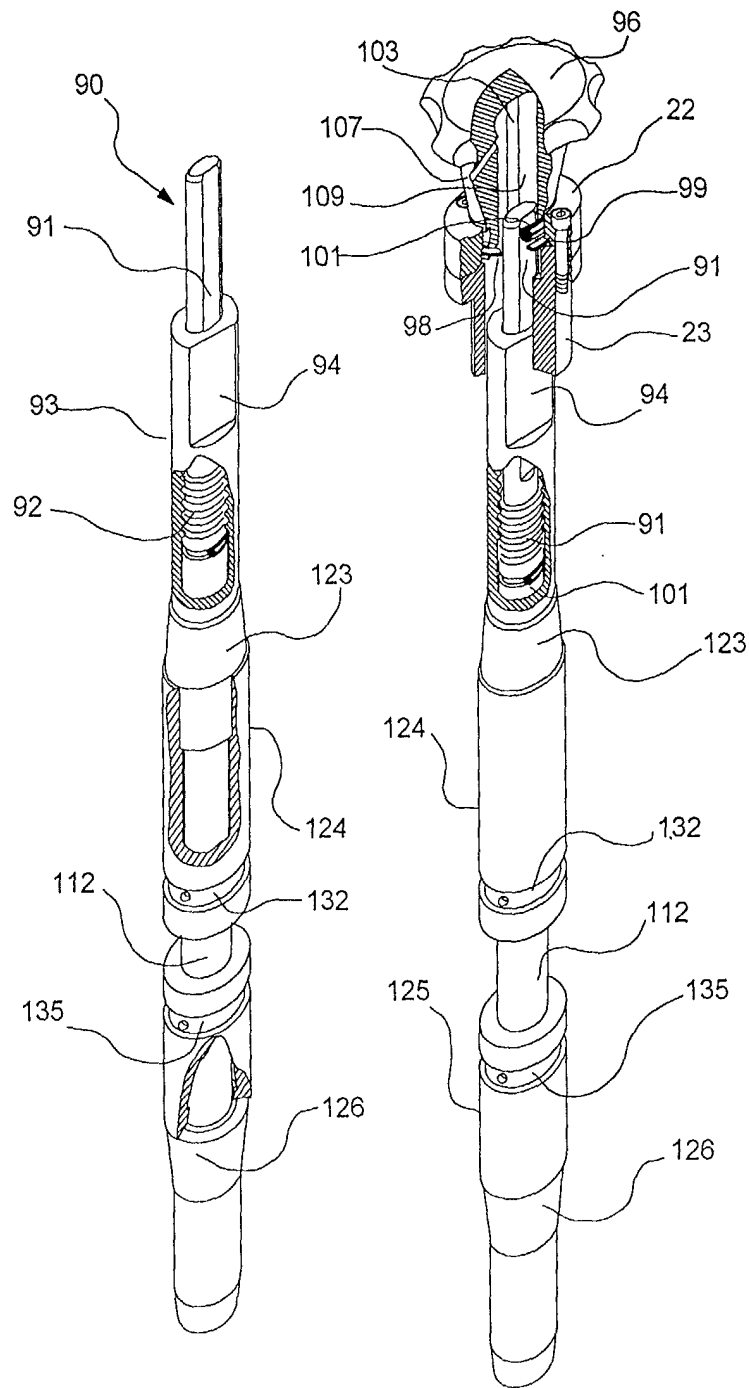


Fig. 12

Fig. 13

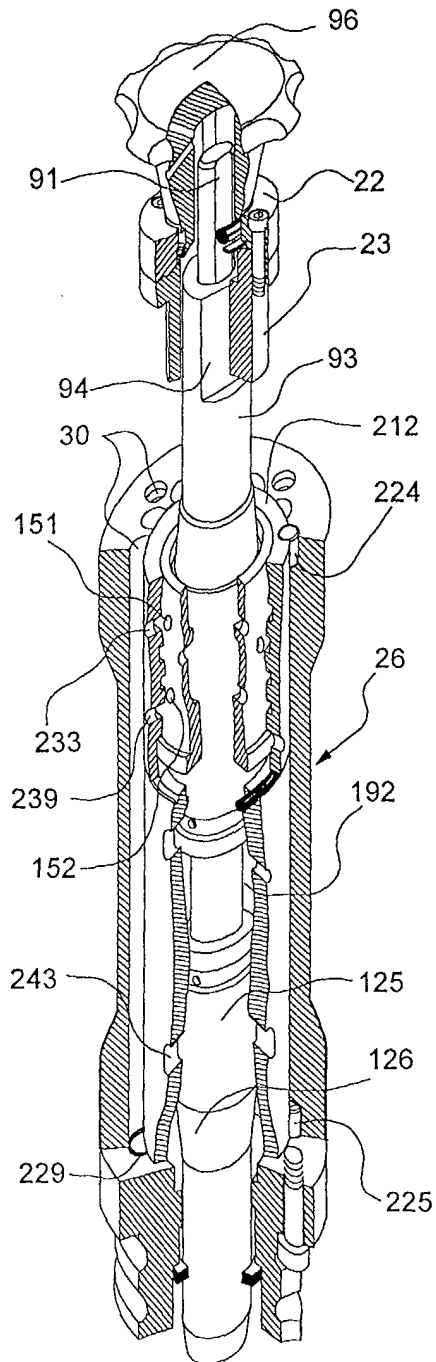


Fig. 14

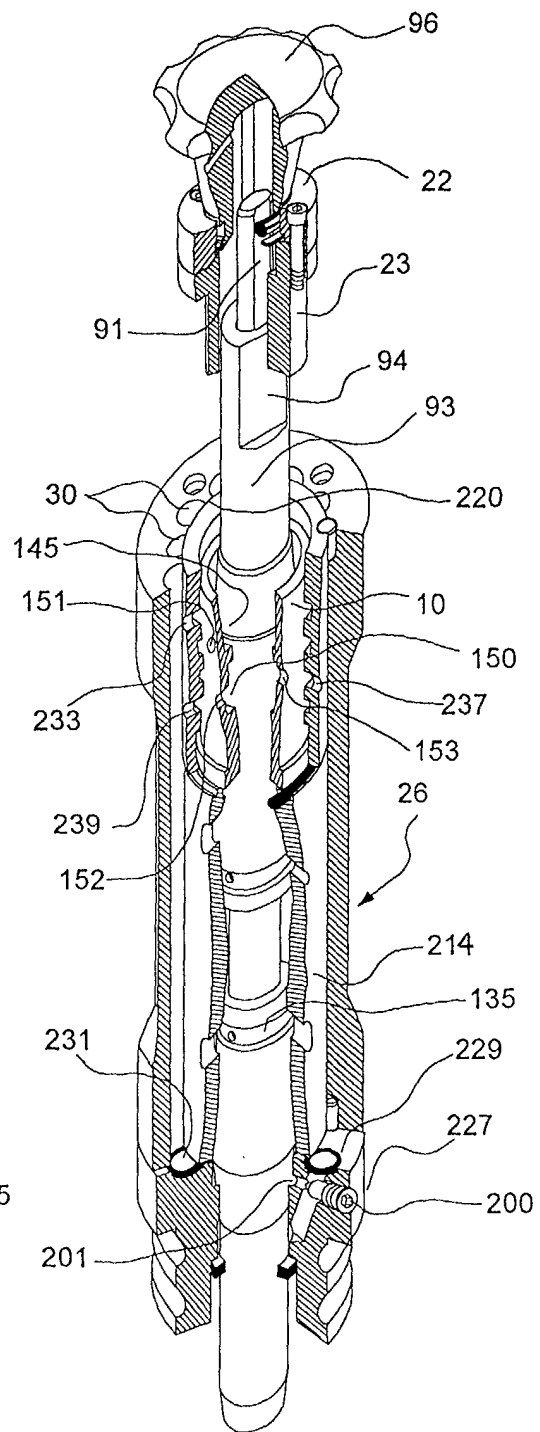


Fig. 15



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 29 1339

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Place of search THE HAGUE		Date of completion of the search 14 November 2002	Examiner Rilliard, A
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 02 29 1339

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The members are as contained in the European Patent Office EDP file on
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14-11-2002

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