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Sevenoaks, Kent TN13 1XR(GB)(54) **Hydraulic pile hammer.**

(57) The pile hammer comprises a guide cylinder (1), a drop weight (4) mounted on a hydraulic hoist cylinder (5), and a hydraulic operation and control system. A main valve (8) is switchable between two states: supply of high pressure oil to the hoist cylinder (5) to raise the drop weight (4), and drainage of oil from the hoist cylinder (5) to allow the drop weight (4) to fall. Switching is accomplished by mechanical actuation of spring loaded pilot valves (6,7) which are switched from a normal state to an actuated state when the drop weight (4) reaches certain positions within the guide cylinder (1).

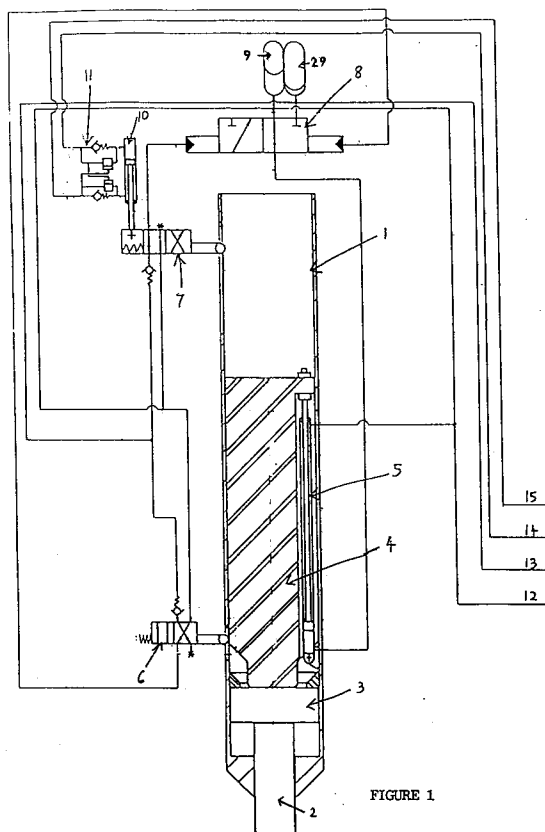


FIGURE 1

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The invention relates to a pile hammer with a hydraulic cylinder for hoisting the drop weight.

Hydraulic pile hammers are well-known and have a number of common features. These include a hydraulic cylinder, an external power pack for the cylinder, a drop weight (which may be the piston of the cylinder), hoses to connect the cylinder and power pack and a frame to hold all the hammer components together.

Two hoses connect the cylinder and the power pack. One carries high pressure hydraulic fluid from the power pack to the cylinder, whereas the other carries low pressure hydraulic fluid back from the cylinder to the power pack. A control system is also required to provide a metered amount of hydraulic fluid, normally an oil, to drive the hydraulic ram which raises the drop weight, and then to exhaust the oil when the weight has been raised.

The control system needs to be able to determine the status of the hammer in this cycle. It must also exert some control over the oil supply, as the pressure and volume of hydraulic fluid from the power pack will reflect variation in temperature and engine performance.

Electronic control systems are normally used on hydraulic pile hammers. These typically drive solenoid valves on the hammer casing for hydraulic control. The status of the ram weight is determined by electric proximity switches on the hammer casing. The control box is typically situated away from the hammer, and communicates with the valve and switches through a cable.

Although in general use, electrical control systems have attendant problems. A construction site environment is extremely destructive for machinery, and the relative fragility of electronic components leads to such systems being unreliable. They also increase the complexity of the pile hammer. A service engineer needs to diagnose and solve both hydraulic and electrical faults, so maintenance is expensive.

An attempt to solve this problem used no electrical components on the hammer. The control valve on the hammer casing was actuated by a hydraulic pulse through a small hose from the power pack. The longer the pulse, the higher the hoist cylinder would lift. The pulse length was controlled by an electrical timer on the power pack.

This attempt was not satisfactory, as the control system had no knowledge of the status of the ram weight. The system could thus fall out of synchronization, and the hoist cylinder be actuated while the ram weight was still falling. Thus, the problem of producing a simple and reliable hydraulic pile hammer with no electrical control system remains.

Accordingly, the invention provides a hydraulic pile hammer comprising a hoist cylinder, a drop

weight lifted by the hoist cylinder, and a hydraulic system for operation and control of the hoist cylinder, wherein the system is switchable between a first state of provision of high pressure hydraulic fluid to the hoist cylinder to lift the drop weight, and a second state of draining of high pressure fluid from the hoist cylinder hence allowing the drop weight to fall, wherein the system is switched from the first state to the second state by actuation of a first, upper, switch and the system is switched from the second state to the first state by actuation of a second, lower, switch, wherein said switches are hydraulic valves actuated mechanically by the position of the drop weight.

Preferably, at least one of the two switches is movable to allow adjustment of the hammer drop height. In a preferred embodiment, the first switch is movable. Preferably, movement of the first switch is achieved by movement of the corresponding valve, actuated by a hydraulic cylinder controlled by the power pack through connecting hoses for the supply and return of hydraulic fluid.

A specific embodiment of the invention is described below, with reference to the accompanying diagram, in which:

Fig. 1 shows a schematic diagram of a hydraulic pile hammer according to a specific embodiment of the invention.

Fig. 2 shows the lower switch of a pile hammer according to a specific embodiment of the invention.

Fig. 3 shows the upper switch of a pile hammer according to a specific embodiment of the invention.

Fig. 1 shows a pile hammer and a pile in schematic form. The pile hammer comprises a guide cylinder 1 placed over the pile 2. An anvil 3, preferably made of steel, in the guide cylinder 1 rests on the pile 2. A drop weight 4, is located above the anvil 3. There may be a resilient dolly (not shown) between drop weight 4 and anvil 3. The drop weight 4 is mounted upon a hydraulic hoist cylinder 5. The hoist cylinder 5 is mounted on the guide cylinder 1.

Two mechanically actuable hydraulic pilot valves 6, 7 are mounted on the guide cylinder. The lower pilot valve 6 is fixed on the cylinder. The upper pilot valve 7 is adjustable; its height on the guide cylinder 1 may be varied.

Fig. 2 shows pilot valve 6; Fig. 3 shows pilot valve 7. Pilot valves 6 and 7 are each able to switch between two different fluid path configurations. Each valve comprises a cam member 16 mounted on a shaft 17, a spring member 18 and a roller operated valve member 19. Spring tension in spring member 18 normally holds the cam 16 and hence the valve in one given configuration, the normal state. However, the cam member 16 may

be rotated about shaft 17 against the tension of spring member 18. Rotation of cam member 16 causes a different portion of cam member 16 to press against the roller 20 of roller operated valve member 19. The valve member 19 moves from its normal height to its actuated height. A sufficient torque will thus cause the valve to be switched to the actuated state, with its accompanying fluid path configuration. Each valve 6,7 is mounted so that the drop weight will press on the valve member at some given range of drop weight heights, and that this pressure will be sufficient to switch the valve into the actuated state.

The pile hammer is controlled and powered by a hydraulic system. In this embodiment, control of and power for the hammer is provided by this hydraulic system alone. No electric circuits or components are found on the pile hammer. In addition to pilot valves 6,7 and hoist cylinder 1, the hydraulic system comprises main valve 8, accumulators 9 and 29, height adjustment cylinder 10, height adjustment circuit 11, supply hose 12, drain hose 13 and height adjustment hoses 14,15. Main valve 8 and accumulators 9 and 29 are mounted on top of guide cylinder 1. The height adjustment cylinder 10 and adjustment circuit 11 are mounted on a lip of the guide cylinder 1.

The normal operation of the pile hammer follows a given cycle. For convenience, the starting position is taken as that shown in Figure 1. High pressure oil is supplied through supply hose 12. Part of the supply is valved through to the upper part of the hoist cylinder 5, and another part supplied to a high pressure accumulator 9. Further supply of the high pressure oil is dependent on the configuration of pilot valves 6,7 and hence main valve 8. Initially, the drop weight is on the anvil and thus presses on the actuating member for lower pilot valve 6. This switches valve 6 out of its normal state, which is to supply low (drain) pressure oil to the right hand input to the main valve 8. Instead, high pressure is supplied to the right hand input, which outweighs the left hand input and forces the right hand valve condition, as shown in Figure 1. The left hand input is controlled by the upper pilot valve 7; in its normal state it is provided with low pressure oil.

The main valve 8 in right hand condition allows the supply of high pressure oil to the lower part of the hoist cylinder 5 from the high pressure accumulator 9. The pressure balance is such that the hoist ram is forced upwards, lifting drop weight 4.

When drop weight 4 rises, lower valve 6 is no longer actuated and it returns to the normal state. The pressure on the right hand input of the main valve drops to drain pressure. The inputs to the main valve thus balance, and no switching occurs, so the drop weight 4 continues to rise.

When the drop weight 4 reaches the actuating member for upper pilot valve 7, it presses on it and moves the upper valve 7 from normal to actuated state. Accordingly, high pressure is supplied to the left hand main valve input. This outweighs the low pressure at the right hand input, and forces the main valve to left hand condition. This connects the lower hoist cylinder input with a low pressure accumulator 29 and the drain hose 13. The hoist cylinder drains through the lower input, and the drop weight is no longer supported, and is indeed forced down by the supply of high pressure oil to the upper hoist cylinder input. Thus the drop weight falls under gravity with hydraulic assistance.

When the drop weight falls, upper pilot valve 7 is no longer actuated and the left hand input drops to drain pressure. As before, this does not switch main valve 8. The state only changes when the lower valve 6 is actuated, and the cycle begins again.

As an advantageous alternative to the main valve shown in Figure 1, main valve 8 may comprise a load holding valve. This feature is desirable to prevent motion of the main valve when neither valve is actuated. Under these conditions, the inputs to the main valve balance, and fluctuations could lead to floating of the valve from the desired to the undesired position. This can be prevented by use of a load holding valve, by which the main valve is locked in one position unless there is a positive injection of fluid in the input needed to send it towards the other position. The operation of one type of load holding valve is described below with reference to the control system 11 for the ram height adjustment cylinder.

The drop height can be controlled by adjusting the position of the upper pilot valve 7. Upper pilot valve 7 is attached to the ram height adjustment cylinder 10. This ram is raised and lowered as a result of the pressure supplied by height adjustment pressure hoses 14 and 15, as controlled by height adjustment control system 11.

As stated above, the height adjustment control system comprises a load holding valve. The hydraulic circuit for such a valve is shown in Figure 1 for the control system 11. When there is no input to either hoses 14 or 15, the valve is locked in position and cylinder 10 cannot move. This is because there is no path for fluid to escape from either the top or bottom of the ram. Two paths are available, but one leads to a one-way valve which allows no flow away from the ram, and the other leads to an actuated check valve, which allows no flow in its normal position.

When a pressure input is received from one of hoses 14 or 15, two effects result. One is that the appropriate one-way valve is forced open, allowing fluid to be fed to the appropriate part of the ram

10. The other is that the pressure forces open the check valve on the other line, allowing fluid to flow out of the other ram line. The same principle can be employed for main valve 8.

For ram 10, the change in ram height and hence of the height of valve 7 is dictated by the volume of fluid input through pressure hoses 14 and 15. This enables the drop height, and thus the drop force, energy per blow, and the number of blows per minute to be controlled.

In an alternative embodiment, the lower valve 6 can also be adjustable or variable in height with respect to the guide cylinder. A particular embodiment of this kind allows for lower valve 6 to move over a range of relative heights, but for the valve only to be capable of actuation if in its highest position relative to the guide cylinder. The valve is then biased to that highest position by a bias member connecting the valve and the anvil. When the anvil is in a normal working position, the biasing force is sufficient to retain the valve in a normal working position also. However, if the anvil has been allowed to travel downwards with relation to the guide cylinder and thus to the working position of the lower valve, to such an extent that it may damage the pile hammer assembly, appropriate choice of bias member will result in the bias force being insufficient to retain the lower valve in its working position. This has the effect that the pile hammer can no longer be lifted. This assembly provides a safety feature for the hammer, as the hammer can thus be prevented from functioning when its continued operation would damage the hammer itself. One manner of realising this feature is by mounting lower valve 6 on a carriage, mounted on the hammer on two spring legs.

Claims

1. A hydraulic pile hammer comprising a hoist cylinder, a drop weight lifted by the hoist cylinder, and a hydraulic system for operation and control of the hoist cylinder, wherein the system is switchable between a first state of provision of high pressure hydraulic fluid to the hoist cylinder to lift the drop weight, and a second state of drainage of high pressure fluid from the hoist cylinder hence allowing the drop weight to fall, wherein the system is switched from the first state to the second state by actuation of a first, upper, switch and the system is switched from the second state to the first state by actuation of a second, lower, switch, wherein said switches are hydraulic valves actuated mechanically by position of the drop weight.
2. A hydraulic pile hammer according to claim 1,

wherein said second switch is fixedly mounted on a guide cylinder for said drop weight.

3. A hydraulic pile hammer according to claim 1, further comprising an anvil and bias means connecting the anvil and the second switch, the second switch being mounted to the guide cylinder with the possibility of relative movement between an operating position in which the second switch can be actuated and other positions in which the second switch cannot be actuated, the bias member urging the second switch towards the operating position.
4. A hydraulic pile hammer according to any preceding claim, wherein said first switch is mounted on a guide cylinder for said drop weight, and wherein the height along the guide cylinder of an actuating member for said first switch is adjustable.
5. A hydraulic pile hammer according to claim 4, wherein the adjusting means for adjusting the height of the actuating member for the first switch is a hydraulic height adjustment cylinder on which the actuating member is mounted, the hydraulic height adjustment cylinder being controlled by a second hydraulic system.
6. A hydraulic pile hammer according to claim 5, wherein said second hydraulic system comprises a load holding valve.
7. A hydraulic pile hammer according to any preceding claim, wherein each of the hydraulic valves comprise a spring on which the valve is mounted, an actuating member, an actuated and a normal fluid path configuration and a set of channel connections, whereupon the actuating member being pressed against the spring tension with sufficient force, the channel connections are connected through the valve according to the actuated fluid path configuration, whereas otherwise the channel connections are connected through the valve according to the normal fluid path configuration.
8. A hydraulic pile hammer according to claim 7, wherein said actuating member is a rotatably mounted cam member rotatable against the spring tension from a normal position to an actuated position, and wherein each of said valves further comprises a fluid channel member with a bearing mounted thereon, whereupon the bearing is held adjacent to the cam member, such that when the cam member is in the normal position, the path member is in a

first position corresponding to the normal fluid path configuration, and that when the cam member is in the actuated position, the path member is in a second position corresponding to the actuated fluid path configuration.

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9. A hydraulic pile hammer according to any preceding claim, wherein the drop weight is mounted on a ram of the hydraulic cylinder.

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10. A hydraulic pile hammer according to any preceding claim, wherein hydraulic fluid is supplied to the pile hammer at controlled pressures by an external power pack.

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11. A hydraulic pile hammer according to any preceding claim, wherein said hydraulic system comprises a main valve, the inputs to said valve being the outputs of the first switch and the second switch, and wherein the main valve is switchable between a first position being the first state of the system and a second position being the second state of the system.

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12. A hydraulic pile hammer according to claim 11 wherein said main valve comprises a load holding valve.

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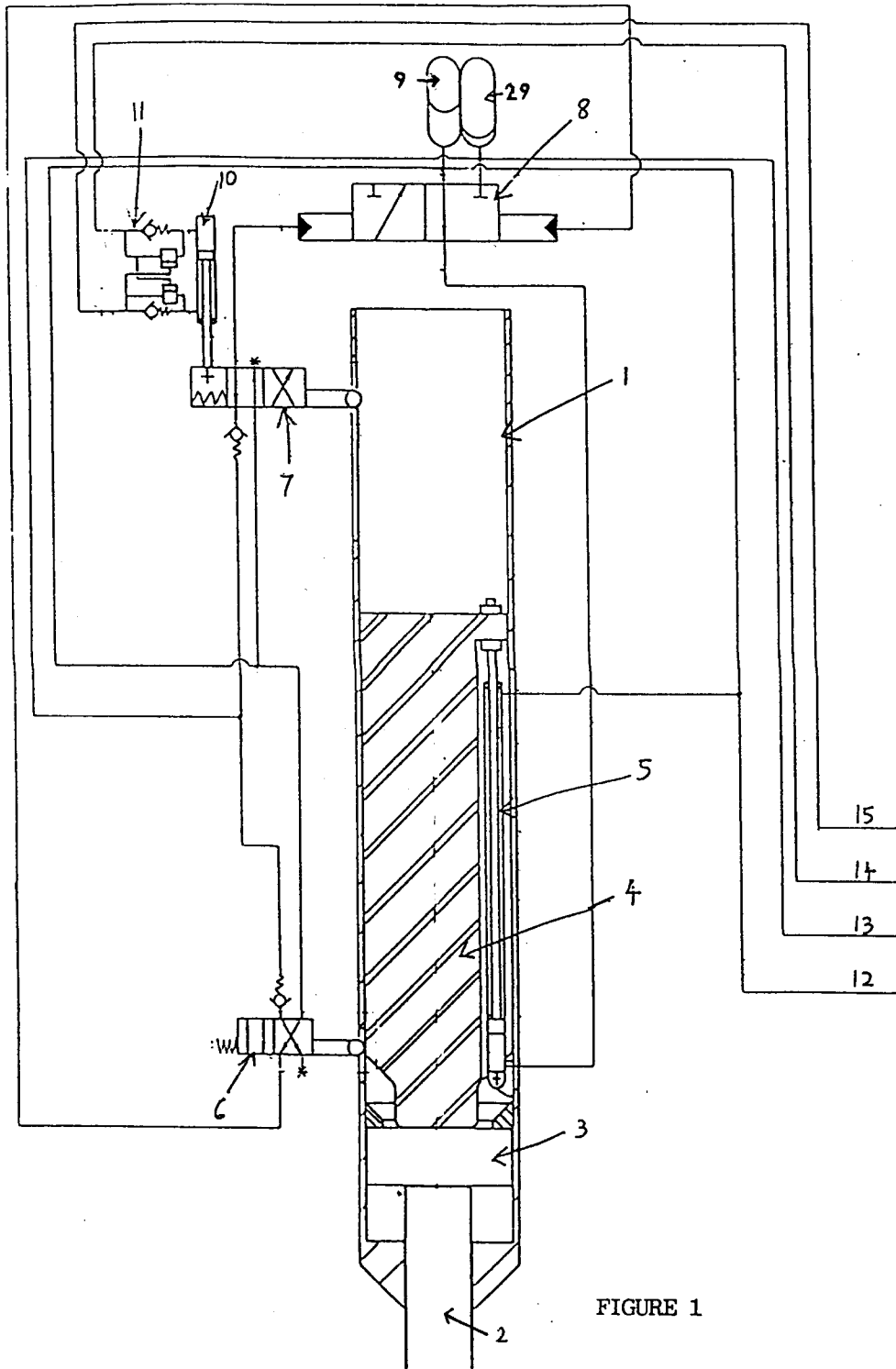


FIGURE 1

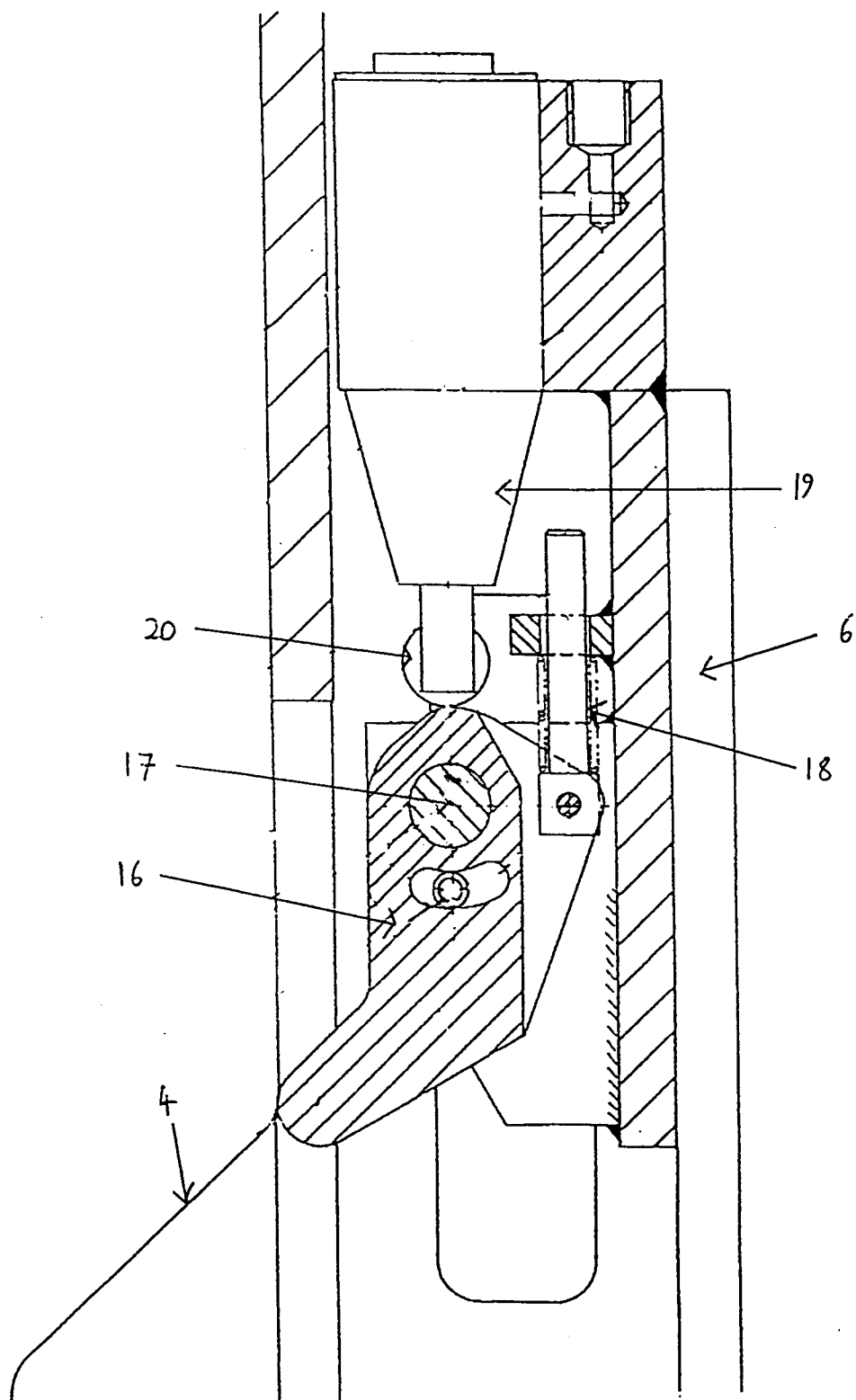


FIGURE 2

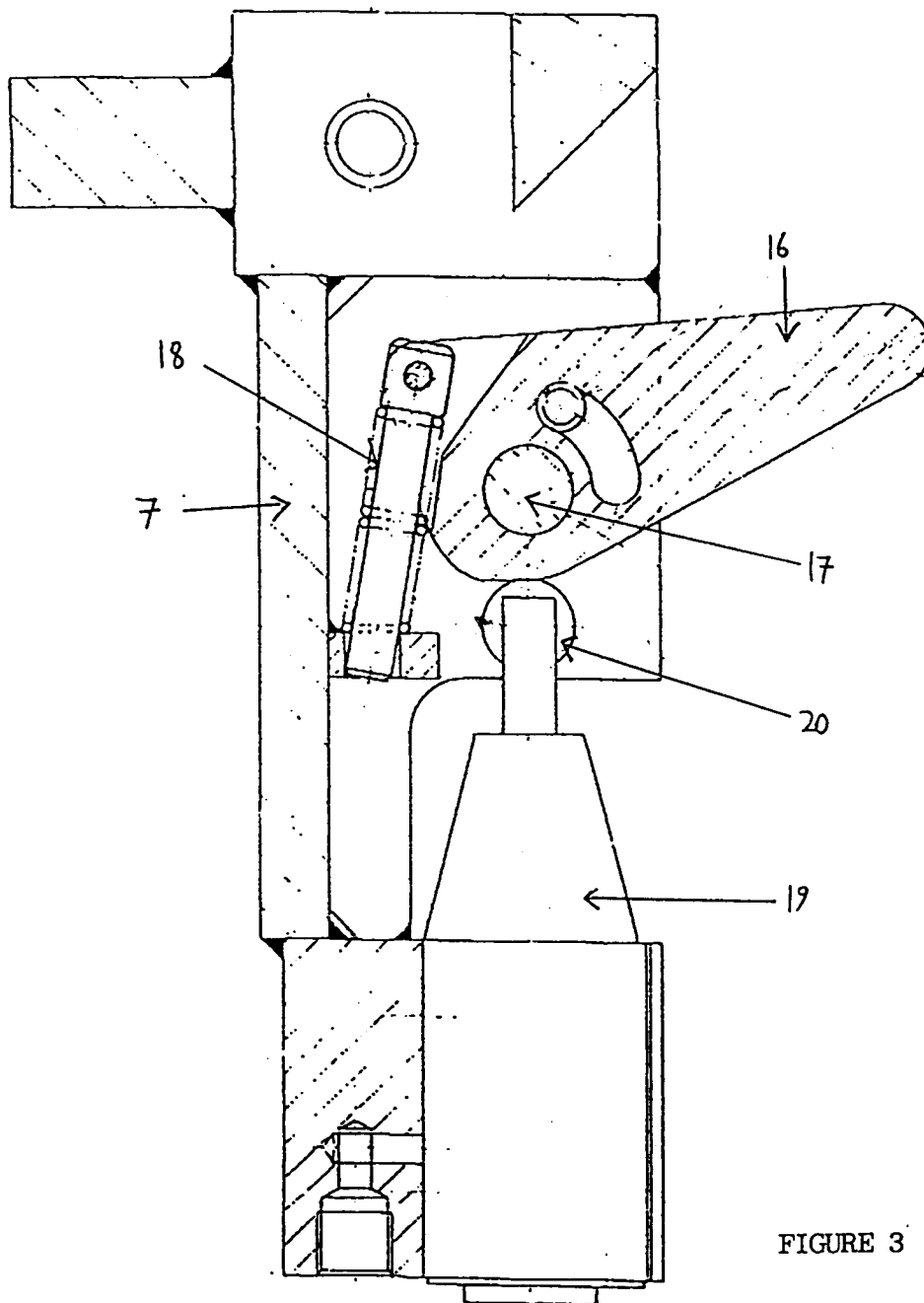


FIGURE 3



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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 3433

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	FR-A-1 490 760 (ICEIS-PALI) * page 1, right column, line 10 - line 36; figure 1 *	1,2,10	E02D7/10
Y	US-A-3 146 835 (MERRICK) * column 3, line 4 - line 24; figure 2 *	1,2,10	
A	FR-A-2 272 829 (HARE LTD) * page 7, line 32 - page 8, line 18; figures 1A,1B,3 *	1,7,8	
A	FR-A-663 726 (BONEHILL) * page 2, line 17 - line 94 * * page 3, line 7 - line 17; figure 1 *	4,5	
A	US-A-3 283 832 (SPANNHAK)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			E02D B21J B25D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 06 JULY 1992	Examiner BELLINGACCI F.
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