(12) **PATENT**

(19) NO (11) **337771** (13) **B1**

NORWAY (51) Int Cl.

E21B 1/00 (2006.01)
E21B 1/24 (2006.01)
E21B 4/14 (2006.01)
B25D 9/00 (2006.01)
B25D 9/04 (2006.01)

Norwegian Industrial Property Office

(21)	Application nr.	20150341	(86)	International Filing Date and Application Number
(22)	Date of Filing	2015.03.18	(85)	Date of Entry into National Phase
(24)	Date of Effect	2015.03.18	(30)	Priority
(41)	Publicly Available	2016.06.20		
(45)	Granted	2016.06.20		

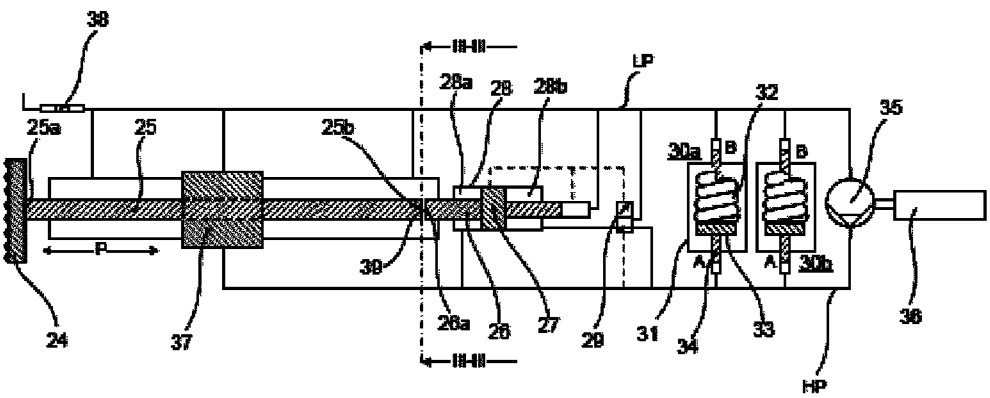
(73) Applicant RESONATOR AS, Pustutveien 18, 1396 BILLINGSTAD, Norge
(72) Inventor Svein Hestevik, Myraveien 38, 1550 HØLEN, Norge
André Dahl-Jacobsen, Gunnar Schjelderups vei 33, 0485 OSLO, Norge
(74) Agent or Attorney Curo AS, Industriveien 53, 7080 HEIMDAL, Norge

(54) Title **Percussive hammering assembly**

(56) References Cited:
US 3470970 A
US 3903972 A
US 2881739 A
US 4676323 A
US 4343227 A
US 6119795 A

(57) Abstract

A percussive hammering assembly comprises a tool assembly (24, 25). The tool assembly (24, 25) is arranged to be oscillated in a direction (P) within a casing. An impact piston (27) is arranged slideably in a housing (28), together with a control valve (29) forming an impact assembly. An optional rotation module (37) is connected to the tool assembly (24, 25) to index the tool head (24) in contact with material to be removed. A drive assembly comprises a hydraulic pump (35) and a drive means (36), supplying pressure to a closedloop hydraulic circuit. Constant liquid volume accumulators (30a, 30b) are arranged between a high pressure line (HP) and low pressure line (LP) within the closed-loop hydraulic circuit. A differential pressure compensator (38) is arranged between the LP line of the closed-loop hydraulic circuit and environmental pressure. The respective components are all accommodated within a liquidfilled casing.



The present invention concerns a percussive hammering assembly, as stated in the preamble of claim 1.

Background

The present invention is related to a percussive hammering assembly, e.g. for use in offshore drilling, land drilling, and for removing scaling inside pipelines. Contrary to traditional drilling, where a drill bit is rotated, percussive drilling involves impacting a tool head with the material to be removed, in a reciprocating manner. As examples of percussive hammer devices from the prior art, the following can be mentioned: US 2014/0262395; WO 03/046330 and US 2015/0041223.

Hammer drilling is an attractive alternative to rotational drilling, which in some applications is too time-consuming. Prior art pneumatic hammers have very poor efficiency because of the high compressibility of the air. This will be more pronounced at greater depths and hence pressures. Water hammers exhibit low efficiency because of leakages because of low viscosity of the fluid combined with quite big clearances. High clearances are needed since the lubricating effect of water is very poor. Water driven hammer drills would also possess a limitation to maximum drilling depth, because of the high pressure prevailing downhole. Accordingly, a water powered hammer drill would have a maximum operative depth of about 1600m. Mud hammers suffer from low reliability because of solid particles in the mud that cause seizing problems and damage because of erosion.

US Patent 3,470,970 describes a percussive tool or a hydraulic rock drill comprising a piston which reciprocates in a cylinder to impart volume chambers to which pressurized liquid is fed alternately via a distribution valve. A constant velocity pump supplies the liquid. The supply circuit includes a pulsation damper which enables the liquid being supplied to be maintained at a substantially constant pressure. An accumulator imparts to the hammer piston on its working stroke energy store during its return stroke.

US Patent 3,903,972 describes an impact tool assembly especially adapted for generating percussive forces for drilling. The tool assembly exhibits a housing in which a piston can execute oscillatory motion along the longitudinal axis of the housing. The piston serves as a hammer, which impacts a shank. The shank is part of an anvil system, which transmits force pulses created by the impact of the lower end of the piston thereon to a load, which may consist of a drill steel and rock bit. A hydraulic fluid is pressurized by a suitable pump having a supply and a return, which can be connected by hoses or other conduits to the tool in a closed loop circuit. The tool assembly is provided with at least one accumulator, to minimize pressure fluctuations in the closed-loop hydraulic circuit.

US Patent 2,881,739 relates to percussion tools and is particularly directed to a hammer comprising: a casing having a cylinder formed therein, a piston reciprocally mounted within the cylinder, a striker operable by and movable in unison with the piston, a pump or a constant-volume source, and means for actuating said piston comprising two high-pressure hydraulic conduits for conducting a pressurized liquid to the cylinder, one of which conduits communicates with the working side of the piston and the other of which conduits communicates with the return side of the piston, a low-pressure hydraulic return line for conducting pressurized liquid from the return side of the piston on its working stroke, control means between said high-pressure conduits and said low-pressure hydraulic return line for controlling the pressurized liquid, and two pressure accumulators carried by the casing. One of the pressure accumulators is operatively associated with both of the high pressure conduits and the other one of the pressure accumulators is operatively associated with the low-pressure return line.

Object

An object of the present invention is to provide an improved percussive hammering assembly that enables faster drilling or removal of hard material. Another object is to provide a percussive hammering assembly that exhibits a more durable and reliable operation than prior art assemblies. Another object is to provide an improved percussive hammering assembly that enables drilling operations and removal of hard material to be performed at depths and pressure levels that heretofore has been unattainable. Yet another object is to provide an improved percussive hammering assembly that may operate in a practically temperature-independent manner.

The invention

The objects above, and others, are achieved by a percussive hammering assembly in accordance with the characterizing part of claim 1. Further beneficial features appear from the accompanying dependent claims.

A percussive hammering assembly for removal of hard material from pipelines or formation comprises:

a tool assembly, for removal of said hard material, a hydraulically driven impact assembly, including a hydraulic fluid control valve, arranged to impact said tool assembly in a reciprocal manner, and

a hydraulic fluid supply device, comprising a hydraulic fluid pump, a pump drive means arranged to operate the pump, arranged to provide the impact assembly with pressurized fluid. A pressure relief valve is also included in the hydraulic fluid supply to protect the system. In accordance with the invention, the percussive hammering assembly is further provided with

a closed-loop hydraulic circuit, comprising

a high pressure line (HP), arranged to supply hydraulic fluid from an outlet side of the pump to the impact assembly via said hydraulic fluid control valve, and

a low pressure line (LP), in fluid communication with the impact assembly and with an inlet side of the hydraulic fluid pump.

Moreover, at least one constant liquid volume accumulator is provided to accumulate and store energy in the high pressure line (HP) in the closed-loop hydraulic circuit. The tool assembly, impact assembly, and hydraulic fluid supply device are all accommodated within a closed casing filled with a liquid, such as hydraulic oil or water.

A differential pressure compensator is advantageously arranged in fluid communication with the LP line of the closed-loop hydraulic line, and the environment, e.g., a downhole environmental pressure, to equalize any pressure difference between said LP-line of the closed-loop hydraulic circuit and environmental pressure. The pump is then generating pressure difference between the LP and HP lines to drive the impact assembly.

The hydraulic pressure accumulator is advantageously a spring type accumulator. A spring type pressure accumulator is durable and reliable, and is able to keep the operating characteristics constant at different external pressure levels, unlike the gas accumulators which behave differently at varying depths, unless the pre-charge pressure of the gas accumulator is not set to match the external pressure. This requires of re-pre-charging of the accumulator if the external pressure changes too much.

In a preferred embodiment, the tool assembly is provided with a rotary device to index the tool head, and shank, about the longitudinal axis of the shank. The indexing may occur either in one single direction, or in a reciprocal manner, e.g., within an angle range of -90° to +90°. The rotary device is advantageously a hydraulically operated indexing device.

The drive means for the pump in the hydraulic fluid supply device may be provided in the form of a mud motor. However, the pump drive means may also be provided in the form of an electric motor.

The fluid control valve may be provided integral with the impact piston, whereby the impact piston itself is arranged to serve the function as a control valve.

During an impact between the impact piston and the tool assembly, the impact piston impacts the tool assembly at a high speed, typically about 10 m/s. Then, the surrounding liquid in the impact zone will flow at an extreme velocity along the surfaces of the respective ends of the tool assembly and the impact piston. As a result, the surfaces of the tool assembly and the impact piston may wear out, with a premature change by a new assembly as a result. Thus, in another preferred embodiment, the impact surface of the shank of the tool assembly and/or the impact face of the piston is/are provided with recesses, known *per se*, to allow fluid escaping from the impact zone. A groove arrangement allows the liquid to escape at a lover velocity and hence lower surface wear.

Definitions

The term “fluid” as used herein, is meant to include a substantially incompressible fluid. The term precludes gases. The term “fluid” has been used interchangeably by the term “liquid”.

The term “tool assembly” as used herein, is meant to include a tool head and an attached shaft or shank.

The term “impact assembly” as used herein, is meant to include the components producing impact force to the “tool assembly”. The term “control valve” is meant to include a hydraulic control valve. The term “control valve” may be interpreted as being constituted as a part of the “impact assembly”.

The term “hydraulic fluid supply device” as used herein, is meant to include a hydraulic fluid pump and a pump drive means, to drive the impact assembly defined above by means of pressurized hydraulic fluid. The term “drive assembly” has also been used interchangeably by the term “hydraulic fluid supply device”.

The term “removal of hard material” as used herein is meant to include removal of, e.g., hard material deposited on the internal wall of a pipeline (scale). The term is also meant to include removal of material from a formation, on land, or offshore, during drilling of a well or similar.

The term “closed-loop” hydraulic system as used herein, is meant to describe a hydraulic arrangement with a fixed volume, contrary to an open-loop system that allows for variation of the fluid volume.

The term “pressure accumulator” as used herein, is meant a device for accumulation of pressure and hence energy.

The term “pressure compensator” as used herein, is meant to include a device that is able to equalize or compensate for pressure differences between environmental pressure and LP line of the closed-loop circuit pressure.

The term “constant liquid volume pressure accumulator” as used herein, is meant to include any pressure accumulator device that enables reduction of pressure changes. The accumulator operates in a manner that the liquid volume inside the accumulator remains constant during its operation.

The term “percussive hammering assembly” as used herein, is meant to refer to a complete assembly comprising all components of the assembly, both illustrated and not illustrated.

Drawings

The invention is described in further detail with reference to drawings, where

Fig. 1 is a schematic view of a percussive hammering assembly in a downhole position,

Fig. 2 is a schematic cross-section through a percussive hammering assembly in accordance with the invention, where casing and drilling fluid flow paths have been omitted for clarity sake, and

Fig. 3 is a top view of an end surface of the tool head shank for impact by the shank of an impact piston assembly, taken along the line III-III of Fig. 2.

Detailed description

Now with reference to Fig. 1, the lower end of a percussive hammering assembly 10 is shown located in a borehole 11 in a formation 12. At the lower end of a casing of the percussive hammering assembly 10, a tool head is indicated at 13 having hard metal drill inserts 14 or similar. In use, the percussive hammering assembly 10 is brought to oscillate along its longitudinal axis and release material from the formation 12. Flow path for drilling fluid and cuttings have been omitted for clarity sake.

Now with reference to Fig. 2, a cross-section through components of the percussive hammering assembly is shown in a schematic manner. The casing has been omitted. The same applies to drilling fluid flow paths used to conduct the drilling fluid on the tool face to evacuate the drilling cuttings. However, flow paths are not necessarily required in scale removal. The drilling impact assembly comprises a tool assembly, provided with a tool head 24 attached to a first end 25a of a shank 25. The shank 25 and the attached tool head 24 are arranged to be moved in a reciprocal manner in a direction along the longitudinal axis of the shank and the drilling impact assembly casing itself (not shown). The direction of movement is indicated by the arrow P. The tool head 24 and shank 25 are also denoted herein as "tool assembly". To the opposite, second, end 25b of the shank, a impact assembly is arranged. The impact assembly comprises a piston 27 arranged slideably in a housing 28. The impact assembly further comprises a control valve 29 to control the operation of the piston 27. The control valve 29 is in flow connection with the piston 27 and housing 28 to bring the piston 27 and its shank 26 to move in a reciprocating manner and, impact the second end 25b of the tool assembly shank 25 in an impact zone or area 39. A pressure relief valve (not shown) is also included in the hydraulic fluid supply to protect the system.

An optional rotation module 37 is arranged at the tool assembly 24, 25 to bring the tool head 24 and the shaft 25 to be indexed in a continuous manner or in a reciprocating or an oscillating manner. In the embodiment illustrated in Fig. 2, the rotation module 37 is of a hydraulic type. The rotation module 37 is included in a preferred embodiment to facilitate release of material to be removed.

Moreover, the percussive hammering assembly according to the invention comprises a drive assembly comprising a pump 35 and a drive means 36 supplying power to the pump 35. The pump 35 delivers a flow of hydraulic liquid to a hydraulic circuit to operate the control valve 29, the accompanying impact piston, and finally the tool assembly. The hydraulic circuit and its function are described in further detail below. The drive means 36 may be provided in numerous ways. In one embodiment, the drive means 36 is a mud motor driven by the drilling fluid itself. In another embodiment, the drive means 36 is an electric motor, possibly with integrated power electronics.

Between a high pressure line and low pressure line within the hydraulic circuit, at least one constant liquid volume pressure accumulator is arranged, to accumulate pressure and store energy built up at the high pressure line during operation of the percussive hammering assembly. Fig. 2 illustrates constant liquid volume pressure accumulators, indicated generally at reference numerals 30a and 30b. The purpose of this pressure accumulator is to minimize pressure fluctuation in the circuit.

In accordance with the invention, the drilling impact assembly comprises at least one constant liquid volume pressure accumulator. However, with regard to redundancy and possible failure, it is preferred to include two or more such accumulators.

It should be mentioned that the commonly used gas type pressure accumulators could also have been used. A gas type accumulator generally comprises a housing comprising a first and second compartment mutually confined by a diaphragm means there between. For example, the first compartment is in fluid communication with the high pressure line, whereas the second compartment is filled by a gas. When the pressure in the high pressure line increases, the diaphragm means will move into the second compartment. For optimum performance of the accumulator, the gas compartment has to be pre-charged to a pressure close to the operating pressure of the hammer. The operating pressure of the hammer is the sum of the LP-line pressure and the pressure difference built up by the hydraulic fluid supply device i.e. the pump. Due to the pressure compensator the LP-line pressure equals to environmental pressure. Since the operating pressure also may vary with the external pressure, i.e. drilling depth, the pre-charge pressure needs to be adjusted accordingly. This is quite unpractical and tedious. Therefore, the percussive hammering assembly in accordance with the present invention comprises one or more constant liquid volume pressure accumulators.

In the illustrated embodiment, the constant liquid volume pressure accumulator is a spring type accumulator, comprising a closed housing 31 accommodating a spring device 32 connected to the low pressure line LP, and a piston 34 and connection plate 33 arranged slideably within the housing 31 and connected to the high pressure line HP. For practical reasons the diameter of the connection plate is bigger than the diameter of the piston. Therefore, the connection plate 34 may be provided with apertures to allow hydraulic liquid to flow around the connection plate without creating a pressure difference over the connection plate, and hence not degrading the performance of the accumulator. Alternatively, the diameter of the connection plate may be smaller than the internal diameter of the housing 31 to define an annular space serving the same purpose.

During the operation of the constant liquid volume accumulator, a pressure increase in the HP-line compresses the spring 32, and a liquid volume proportional to the change in the spring compression and to the area of the piston 34, is pushed into the accumulator from the HP-line. Simultaneously, an equal amount of liquid is pushed out from the LP-side of the accumulator into the LP-line. Therefore, the total liquid volume inside the accumulator stays constant. The two ports of the accumulator are in Fig. 2 indicated at A and B at the HP side and the LP side of the accumulator, respectively. In other words, the flow into the accumulator through the A-port equals to the flow out from the accumulator through the B-port, and vice versa.

It appears that the liquid is seemingly flowing through the accumulator, and the energy content of that flow is restored to the spring as elastic energy. This elastic energy can later be released back to HP-line when the pressure in the HP-line tends to decrease.

This is a crucial feature, since this allows operation of a closed-loop system, since the liquid volume of the system remains constant. This also allows using a common accumulator for the LP and HP lines. This is due to the fact that when operating the hammer, there will be in a pressure increase in the HP line, and a simultaneous pressure decrease in the LP-line. The accumulator arrangement will counteract against the pressure fluctuations on both lines at the same time.

The presence of the constant liquid volume pressure accumulator is of high importance to the present invention and facilitates the use of the percussive hammering assembly at higher environmental pressures and hence deeper locations than heretofore has been possible.

However, other types of constant liquid volume pressure accumulators are also conceivable, and are considered to be comprised by the present invention. The spring/piston combination may for example be replaced by a metallic closed bellow arranged within the housing 31, the closed bellow having an open end in fluid communication with the high pressure line HP, where the outside of the bellow is in fluid communication with the low pressure line LP. In this way, the bellow may expand and contract within the housing 31 to accumulate increased pressure at the high pressure line HP and keep the closed-loop pressure stable. A person skilled in the art will, with support from the present disclosure, be able to provide different types of constant liquid volume pressure accumulators that operate in an equivalent manner as the one illustrated herein. Accordingly, any constant liquid volume pressure accumulator is considered to be comprised by the present invention.

Moreover, the closed-loop hydraulic circuit do in a preferred embodiment include a differential pressure compensator 38, arranged to equalize pressure difference between the LP line of the closed-loop hydraulic circuit and environmental pressure, e.g. in a downhole location. The differential pressure compensator 38 ensures that the LP line pressure is the same as the environmental pressure.

The tool assembly, impact assembly, drive assembly, said at least constant liquid volume pressure accumulator, differential pressure compensator, and closed-loop hydraulic circuit, are all accommodated within a casing (not shown in Fig. 2, indicated at reference numeral 10 in Fig. 1) filled with a substantially incompressible flowing medium, particularly a liquid, e.g. hydraulic oil or water. The liquid-filled casing is in a preferred embodiment in fluid communication with the environments, e.g. the bottom of a well being drilled in a subsea formation.

Interpretation of the closed-loop hydraulic circuit illustrated schematically in Fig. 2 should be within the reach of a person skilled in the art. The control valve 29 is in Fig. 2 illustrated in a mode where the control valve 29 delivers hydraulic liquid pressure to a second chamber 28b of the housing 28. The first chamber (28a) is connected to HP line, and since the hydraulic working area of the second chamber (28b) is larger than the hydraulic working area (28a), the piston 27 is driven towards a first chamber 28a of the housing 28 and towards the impact area 39 to finally impact the tool assembly 25b, 25, 24 and perform the drilling operation. The dotted lines in Fig. 2 are so-called pilot lines. They deliver the piston position feedback to the control valve, i.e., when the piston reaches predetermined position, the pilot lines are connected to either HP or LP pressure, which in turn switches the control valve. The operating state of the control valve 29 is indicated by arrows within the valve. Further operation of the impact piston assembly has been omitted, since its principle should be within the reach of a person skilled in the art.

Any excessive pressure built up in the high pressure line HP will be accumulated, and stored, by said at least one constant liquid volume pressure accumulator 30a, 30b, and any excessive pressure difference between the environments, e.g. downhole in a subsea formation, and the LP line of the closed-loop hydraulic circuit will be compensated by the differential pressure compensator 38.

Fig. 3 illustrates a section taken along the line III-III in Fig. 2, illustrating a top view of the second surface 25b of the assembly tool shaft 25. In this example embodiment, numerous recesses 39a-d and 40 are arranged in the second end surface 25b of the shaft 25. As discussed above, the recesses assist in letting the surrounding fluid to escape from the impact zone 39 at a lower speed during an impact between the tool assembly 24, 25 and the impact assembly 26, 27, 28.

The arrangement described immediately above combined with the liquid-filled casing accommodating the percussive hammering assembly of the present invention, enables use of a percussive hammering at very high environmental pressures which heretofore has been unattainable by prior art apparatuses. As a result, for example in applications for exploring oil and gas, it is possible to drill at higher depths and hence increase production of the same.

Claims

1. A percussive hammering assembly for removal of hard material, including scale deposited on the internal wall of a pipeline, and for removal of material from a formation, on land, or offshore, said assembly comprising a hammering assembly casing (10) accommodating

a tool assembly (24, 25) for removal of said hard material, comprising a tool head (24) attached to a first end of a shank (25), said shank (25) and tool head (24) arranged to be moved in a reciprocal manner in a direction along the longitudinal axis of the shank (25) and the hammering assembly casing (10),

a hydraulically driven impact assembly (27, 28, 29) comprising a piston (27) arranged slideably in a housing (28), and a control valve (29) which is in flow connection with the piston (27) and the housing (28), arranged to bring the piston (27) and its shank (26) to move in a reciprocal manner and impact a second end of the tool assembly shank (25),

a hydraulic fluid supply device, comprising a hydraulic fluid pump (35), a pump drive means (36) arranged to operate the pump (35), arranged to provide the impact assembly (27, 28, 29) with pressurized fluid,

characterized in that the hammering assembly is provided with

a closed-loop hydraulic circuit, comprising

a high pressure line (HP), arranged to supply hydraulic fluid from an outlet side of the pump (35) to the impact assembly (27, 28, 29) via the hydraulic fluid control valve (29), and

a low pressure line (LP), in fluid communication with the impact assembly (27, 28, 29), and with an inlet side of the hydraulic fluid pump (35);

at least one constant liquid volume pressure accumulator (30a, 30b) in fluid connection with both the low pressure line (LP) and the high pressure line (HP), arranged to minimize pressure fluctuations in the closed-loop hydraulic circuit; and that

the tool assembly (24, 25), impact assembly (27, 28, 29), hydraulic fluid pump (35) and the pump drive means (36), and said at least one constant liquid volume pressure accumulator (30a, 30b), are accommodated within the closed casing (10) filled with a liquid.

2. The assembly of claim 1, **characterized in** that said at least one constant liquid volume pressure accumulator is a spring type accumulator (31, 32, 33, 34).

3. The assembly of claim 1, **characterized in** that said tool assembly (24, 25) is provided with a rotary device (37) to index the tool assembly (24, 25) about its longitudinal axis, either in one single direction or in a reciprocal manner.

4. The assembly of claim 3, **characterized in** that said rotary device (37) is a hydraulically operated indexing device.

5. The assembly of claim 1, **characterized in** that the pump drive means (36) is a mud motor.

6. The assembly of claim 1, **characterized in** that the pump drive means (36) is an electric motor.

7. The assembly of claim 1, **characterized in** that the liquid accommodated within the casing (10) is water.

8. The assembly of claim 1, **characterized in** that the liquid accommodated within the casing (10) is oil.

9. The assembly of claim 1, **characterized in** that the impact assembly (27, 28) itself is arranged to operate as a valve (29).

10. The assembly of any one of the preceding claims, **characterized in** that a differential pressure compensator (38) is arranged to equalize pressure difference between said LP line of the closed-loop hydraulic circuit and environmental pressure.

Patentkrav

1. Støthammeranordning for fjerning av hardt materiale, inkludert belegg avsatt på den innvendige veggen av en rørledning, og for fjerning av materiale fra en formasjon på land eller offshore, hvilken anordning omfatter et hammermodul-hus (10) som opptar

en verktøymodul (24, 25) for fjerning av nevnte harde materiale, omfattende et verktøyhode (24) festet til en første ende av en aksel (25), hvorved akselen (25) og verktøyhodet (24) er arrangert for å beveges på en oscillerende måte i en retning langs lengdeaksen av akselen (25) og hammermodulhuset (10),

en hydraulisk drevet slagmodul (27, 28, 29) omfattende et stempel (27) arrangert glidbart i et hus (28), og en reguleringsventil (29) som er i strømningskontakt med stempelet (27) og huset (28), arrangert for å bringe stempelet (27) og dets aksel (25) i bevegelse på en oscillerende måte og slå en andre ende av verktøymodulens aksel (25),

en forsyningsanordning for hydraulisk væske, omfattende en hydraulikkpumpe (35), et pumpedrivorgan (36) arrangert for å drive hydraulikkpumpa (35), arrangert for å slå slagmodulen (27, 28, 29) med trykksatt fluid, **karakterisert ved** at hammermodulen er forsynt med

en lukket hydraulikkrets, omfattende

en høytrykksledning (HP), arrangert for å tilføre hydraulikkfluid fra en utløpsside av pumpen (35) til slagmodulen (27, 28, 29) via hydraulikkreguleringsventilen (29), og

en lavtrykksledning (LP) i fluidkommunikasjon med slagmodulen (27, 28, 29), og med en innløpsende av hydraulikkpumpen (35);

i det minste trykkakumulator (30a, 30b) for konstant væskevolum, i fluidkommunikasjon med både lavtrykksledningen (LP) og høytrykksledningen (HP), arrangert for å minere trykkfluktuasjoner i den lukkede hydraulikkretsen; og at

verktøymodulen (24, 25), slagmodulen (27, 28, 29), hydraulikkpumpen (35) og pumpedrivanordningen (36), og nevnte i det minste en trykkakumulator (30a, 30b), er opptatt inne i det lukkede huset (10) fylt med en væske.

2. Anordning ifølge krav 1, **karakterisert ved** at nevnte i det minste en trykkakumulator er akkumulator av fjærtypen (31, 32, 33, 34).

3. Anordning ifølge krav 1, **karakterisert ved** at verktøymodulen (24, 25) er forsynt med en rotasjonsanordning (37) for å dreie verktøymodulen (24, 25) om sin lengdeakse, enten i en enkelt retning eller på en oscillerende måte.

4. Anordning ifølge krav 3, **karakterisert ved** at rotasjonsanordningen (37) er en hydraulisk drevet rotasjonsanordning.

5. Anordning ifølge krav 1, **karakterisert ved** at pumpedrivorganet (36) er en slammotor.

6. Anordning ifølge krav 1, **karakterisert ved** at pumpedrivorganet (36) er en elektrisk motor.

7. Anordning ifølge krav 1, **karakterisert ved** at væsken opptatt inne i huset (10) er vann.

8. Anordning ifølge krav 1, **karakterisert ved** at væsken opptatt inne i huset (10) er olje.

9. Anordning ifølge krav 1, **karakterisert ved** at slagmodulen (27, 28) i seg selv er arrangert for å virke som en ventil (29).

10. Anordning ifølge et av kravene foran, **karakterisert ved** at en differensialtrykkompensator (38) er arrangert for å utlikne trykkforskjell mellom nevnte LP-ledning i den lukkede hydraulikkretsen og omgivelsestrykk.

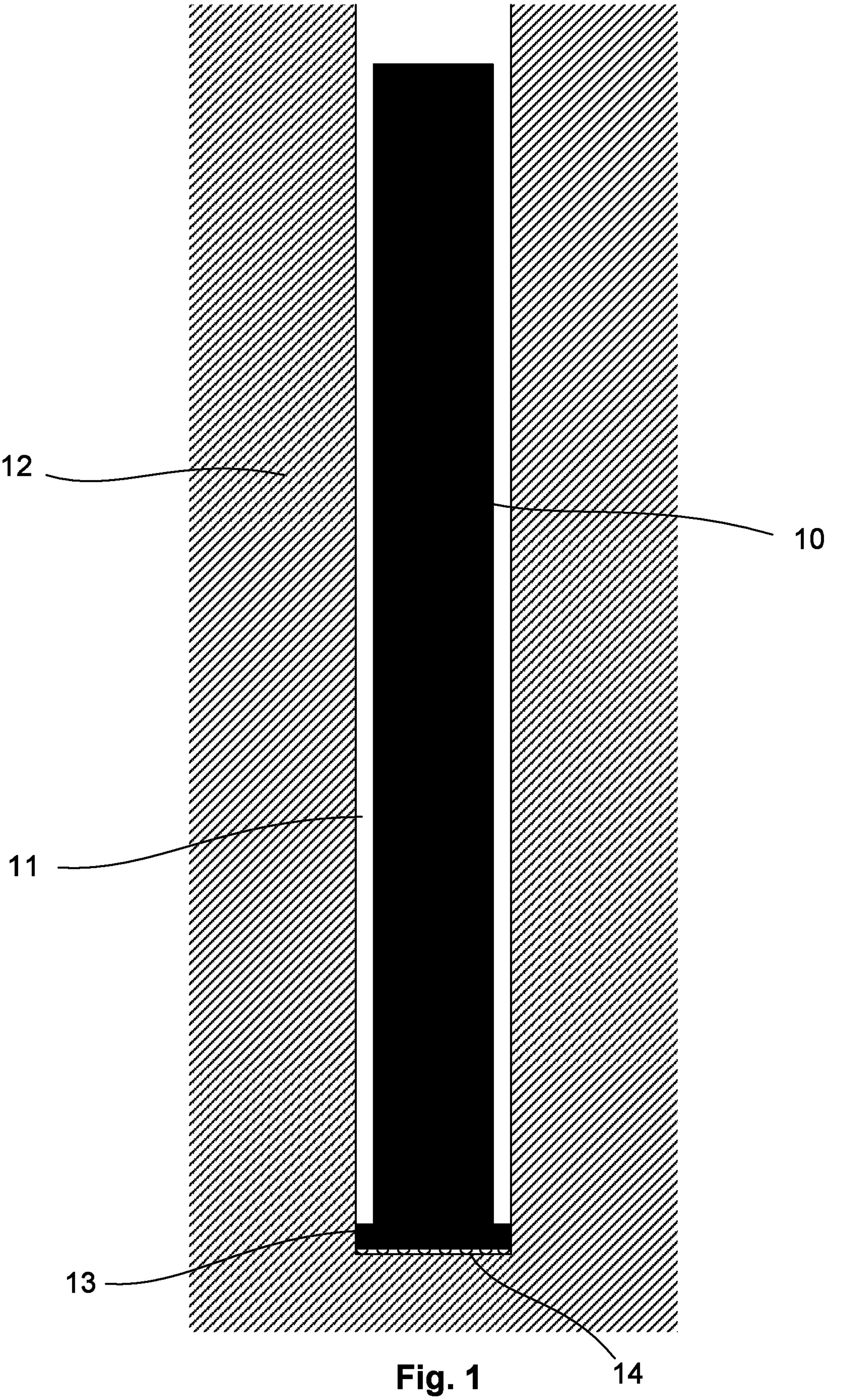


Fig. 1

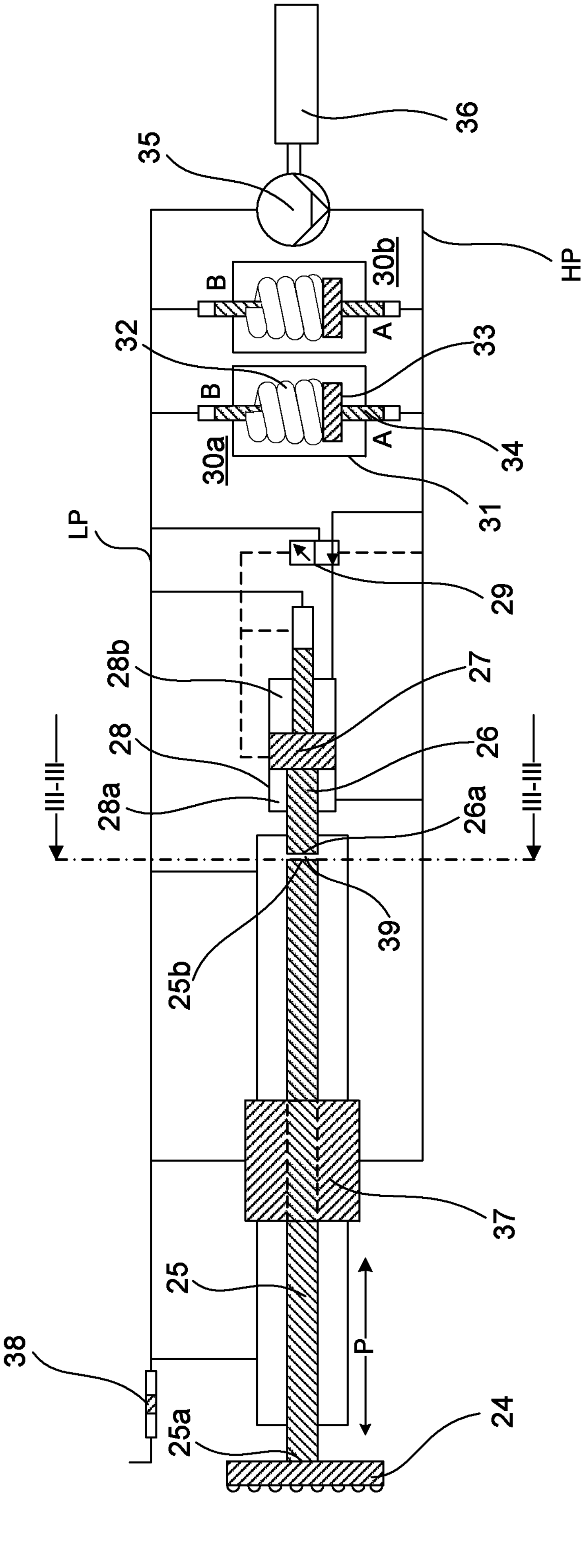

36
35
HP
30b
B
A
32
33
34
30a
31
LP
29
28b
27
28
26
28a
26a
III-III
III-III
39
25b
37
25
P
38
25a
24

Fig. 2

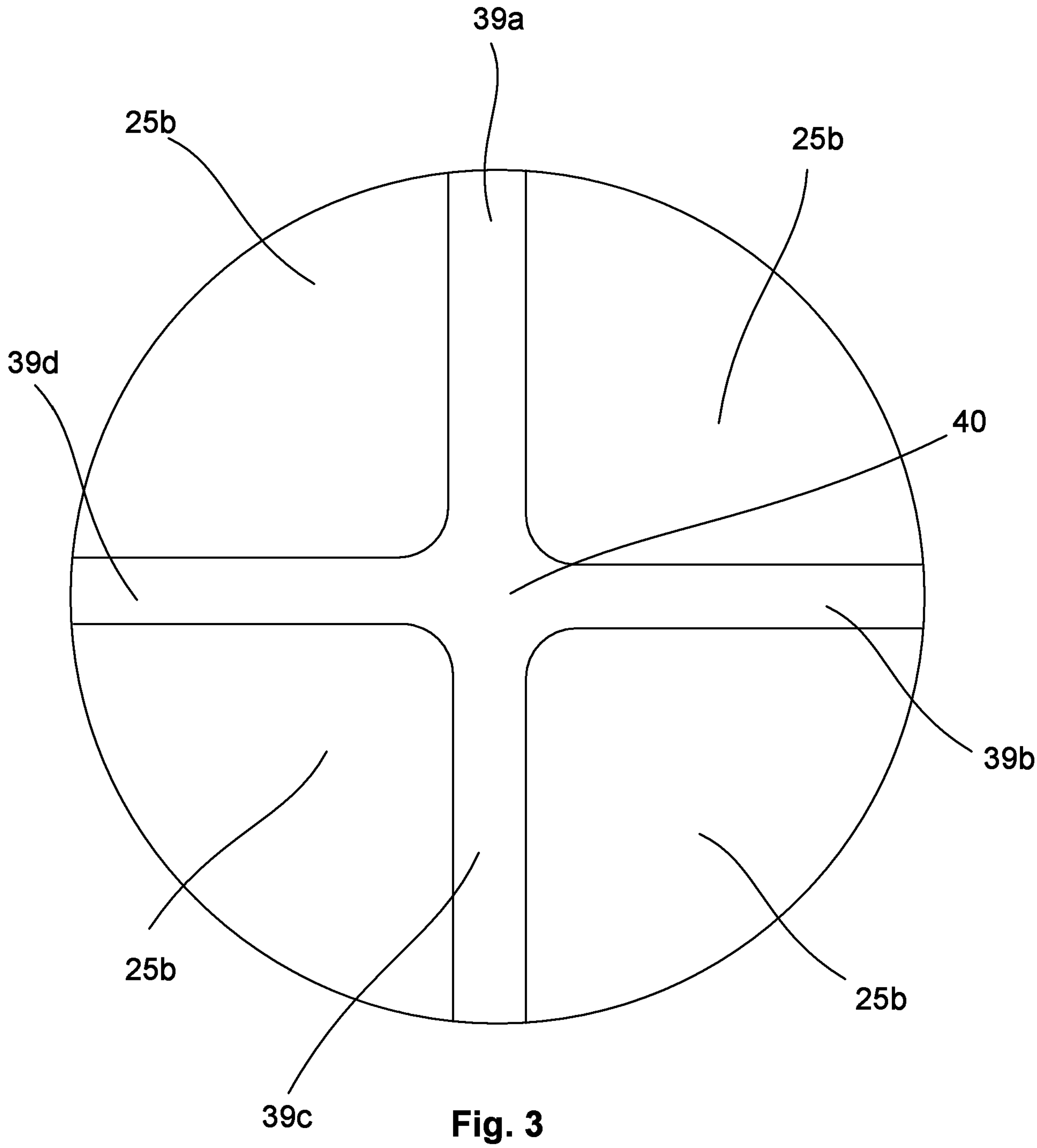


Fig. 3