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(54) Dart launching system for sub-sea cementing head or sub-sea tool for oil wells.

(57) The invention relates to a launching system for one or several darts (12).

The system includes rotating cocks (7, 8) and an annulus (16, 18).

Reliable launching. Capacity of more than two launchers. Compact, balanced and light system.

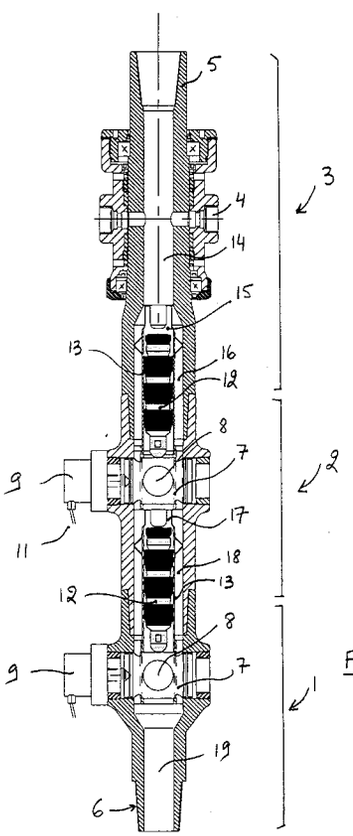

Fig. 1

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The present invention relates to the field of oil well or similar drillings, starting from sub-sea bottoms, from a work structure which may be a floating or fix platform, of any type.

Whereas the more particularly related technique is off-shore drilling, the definition of sub-sea drilling must be understood to include any application case where a well is drilled starting from a surface covered with a certain height of water, whether salty or not, whether stagnant or not.

The invention more particularly concerns the hardware, installation or equipment to be operated in order to insure internal casing cementing in such a drilling.

Without it being necessary to very precisely describe the internal casing cementing technique for a drilled well, which those skilled in the art well know, it however is appropriate to remind that this cementing technique consists in launching a tight, so-called "bottom plug" inside the internal casing, for a scraping cleaning of the internal casing surface to eliminate any drilling mud traces and preclude any mud/cement contact.

Launching the so-called bottom plug is performed by means of a pressurized fluid such as cement, in particular. After the bottom plug has been positioned on the float collar or similar, in a known manner, the overpressure which builds up will perforate the bottom plug rupture membrane. In an equally well known manner, a so-called top plug will be launched in the same casing to also be propelled by means of a pressurized fluid during a separate later operation, generally after the cement slag has been pumped.

The bottom plug function consists in forcing the previously pumped cement or analogous product back through the bottom plug so as to have it to raise in the annulus between the internal casing and either the adjacent formations or an external casing.

It will be understood that such a process is difficult to be operated in the case of sub-sea drillings due to the fact that the ordinary cementing head, supporting the plug, usually is adapted on the rig. In the case of sub-sea drillings, such an approach would lead to have all plugs travelling over a long path between the rig and the sub-sea bottom, with all the inconveniences and problems which such a technique could induce.

The French Patent Application Nr 90 03 129, applied March 7, 1990, describes an improved sub-sea cementing head.

The present invention is designed for cooperating with said cementing head and the teachings of application FR-90 03 129 consequently are incorporated here by reference. In particular, the details of the cementing head operation and of the plug launching will not be repeated here.

The present invention, however, concerns a launching system for one or more darts, using conventional darts: it is thus obvious that the present invention also can be employed in cooperation with sub-sea cementing heads of any type, activated by the mentioned launchers or by launchers of an equivalent type.

A dart launching system of the prior art is described in French Patent Application FR 90 03 129 (Fig. 1 reference 10 and Fig. 2). Such systems are well known by those skilled in the art and so are their inconveniences: high weight, presence of the high pressure pumped fluid manifold, lack of flexibility in use, manipulation risks, fairly long installation time.

Such a prior art system is also described in the European Patent Application EPA 0 167 285, Fig. 1.

The present invention concerns a dart launching system of such a fully original design as to bring extremely marked improvements.

Said dart launching system (hereinafter referred to as "system") includes three main parts:

1. a bottom part
2. a modular part, attached above the bottom part
3. a revolving joint including side inlet swivels for the pumped fluid. This joint itself is attached above the central modular part. The top part of this body is adapted to continuously form a connection for cooperating with an appropriate part of a lifting tool or a drill pipe of a conventional type. The central part is designated as "modular" because it can include, as hereinafter explained, one or several, in particular two, modules, which allows launching either two or more than two, in particular three darts.

The bottom part may directly be attached below the revolving connector, which only allows one dart launch.

The big interest of this design lies in allowing one, two or three cementing plug launches with a relatively simple and fast system modification.

This was inconceivable under any circumstances with such systems as described for instance in Fig. 2 of the FR-A-90 03 129 application which are solid systems.

The whole system is conceived in such a way that fluids to be pumped into the well will pass through the system from top to bottom and either may be circulated along the darts or alternately may propel the first, then the second, etc., dart.

This avoids any need for a heavy and voluminous manifold which would impair the tool balance when installed.

In addition, this arrangement also allows the system both to be rotated, a very important feature within the frame of modern cementing operations,

and to be reciprocated up and down, which is equally important in many operations to insure a good cementing quality. Both movements may be operated simultaneously or separately.

Other elements and advantages of the invention are described in the following description and in the drawings wherein:

Fig. 1 is a general longitudinal sectional view of the system of the invention, in a two darts configuration;

Fig. 2 is a general longitudinal sectional view of the sub-sea cementing head (or "sub-sea tool") described in the previously mentioned French Patent Application (as indicated above, construction and operation details concerning this head will not be reminded here);

Fig. 3 is a longitudinal sectional view of the system of the invention, during the bottom dart launching operation;

Fig. 4 and Fig. 5 are longitudinal sectional views of this first plug acting on the cementing head (ejection of bottom, or first, plug);

Fig. 6 is a longitudinal sectional view of the system of the invention, during the top, or second, dart launching operation;

Fig. 7 and Fig. 8 are longitudinal sectional views of this second plug acting on the cementing head (ejection of top, or second, plug).

In all figures, the same reference numbers will designate the same elements.

1. bottom part
2. modular part
3. side inlet swivel revolving joint
4. two lateral fluid inlets
5. connection with the lifting tool (or drill pipe)
6. connection with the drill pipe
7. pivoting cock
8. cock opening
9. detent
10. system assembly of the invention
11. remote control wiring or piping
12. dart
13. system basket
14. inside cavity of the revolving joint
15, 17 zones adjacent to each dart upper face
16, 18 annular spaces or annuli
19. fluid output tube
20. drill pipe
21. casing
22. piston ram
23. radial piston ram openings
24. ram
25. seat
26. sub-sea head basket
27. bottom (first) plug
28. top (second) plug
29. cock surface for closing annuli 16, 18
30. dart upper surface
31. calibrated rupture means P1
32. calibrated rupture means P2 (P2 > P1)
33. sub-sea tool annulus.

Referring to Fig. 1 the system generally is designated by (10). It is made up of three main elements, which from bottom to top are the bottom part (1), the modular part (2) and the revolving joint (3) with lateral fluid inlets (4).

It will be noted that the revolving heads obviously are known in the industry.

These three elements are connected with one another in a conventional manner known by those skilled in the art, in particular by appropriate threads, and the assembly has to withstand pressures which can be in the range of 70 MPa (10,000 PSI).

The top part (5) of the revolving joint (3) is so designed as to conventionally form a connection able of mechanically cooperating with such a lifting tool or drill pipe, or top drive as conventionally used on drilling platforms and similar installations such as drilling ships, etc.

The bottom part (6) of the lower part (1) of the system (10) is provided for being attached on the drill pipe.

Various connection designs can conventionally be considered, but an advantageous design for this connection consists in rendering it mechanically compatible with a bottle-neck lifting sub.

This preferred version is represented in Fig. 1 and allows withstanding a tensile load reaching up to 250 t (500,000 pounds).

Preferably, both connections (5) and (6) will receive threads known in the oil industry and able of withstanding any previously mentioned pressure and load stresses.

Preferably also, the revolving joint (3) will have two lateral fluid inlets (4) in order to allow sizable flow rates. Equivalent embodiments obviously are possible.

As indicated above, one of the substantial advantages of the present system consists in offering a high degree of operator freedom in rotating and/or reciprocating the system, and the assembly of drilled pipes, casings, etc. It namely is known that such movements are recommended in modern cementing techniques for a very definite improvement of the operation quality.

The darts (12) are of a conventional type and their description will be omitted as useless.

They however most preferably will contain a magnetic insert generating a large enough magnetic field for a positive detection from the outside of the drilling pipe.

The darts are positively held in position by means of pivoting cocks (7), with a central opening (8) aligned with the common longitudinal dart axis and with a large enough diameter to allow for the

darts passing through.

In the dart holding position, each cock (7) is vertically arranged, as represented in Fig. 1.

When a dart should be launched, the corresponding cock is rotated by a quarter of a turn around its rotation axis, which is perpendicular to the common longitudinal axis of the system and the darts.

This pivoting is obtained by a detent (9) which preferably is an electric, hydraulic or pneumatic motor remotely controllable by means of the wirings or pipings (11).

The result of this pivoting is an opening of a downward passage for the dart through the considered cock opening. The dart then is propelled towards the well by the pump fluid, as indicated hereinafter.

If it includes a magnetic insert, its launching is positively detectable by the above mentioned magnetic detector.

It finally should be noted that darts (12) are housed in the system (10) in baskets (13). Each dart is contained in its own basket.

Each basket is held in place by appropriate mechanical means such as represented in Fig. 1. These mechanical means include attaching means in the vertical direction and centering means in the system body (10).

Several passages thus are available for the pumped fluid in (4).

The fluid which is pumped in (4) will first flow into the internal, preferably cylindrical, cavity (14) of the revolving joint (3).

Inside zone (15), the fluid will exert a pressure on the top surface of the top dart (12). This dart will insure the tightness with the internal basket (13) wall, and the fluid can only flow into the annulus (10) since the dart is held in position by the vertical cock (7) position. This same phenomenon also is produced when said fluid reaches the bottom dart level. Finally, the fluid, in the Fig. 1 configuration, will flow through annuli (16) and (18) then through the outlet tube (19) towards the well, without launching the darts (12).

Fig. 2 represents a highly preferred though not limiting example of the sub-sea tool, the essential elements of which are connected to the drilling pipe (20) and contained in the casing (21) to be cemented: a piston ram (22) with lateral openings (23), a piston (24) sliding inside said ram and having at its upper part a seat (25) for receiving the launchers (12), and a basket (26) which, for instance, includes two cementing plugs: bottom, or first, plug (27) and top, or second, plug (28).

Those elements are completed by various attaching, position holding, pressure equalizing and launching means, as mentioned above, the details of which are indicated in French Patent Application Nr 90 03 129, which it will be possible to refer to.

Fig. 3 represents the bottom dart launching (12). For this purpose, the cock (7) of the lower part (1) is pivoted by a quarter of a turn. This movement induces two simultaneous effects, namely aligning opening (8) with dart (12) and closing the bottom of annulus (18) at the level of surface (29). Pumping the fluid in (4) - which fluid is circulated in the modular part around the dart blocked in this part by the maintained vertical position on the cock - then induces a pressure effect on the top face (30) of the first dart, which propels the dart through the drilling casing through conduit (19).

Fig. 4 represents the first dart (12) arriving onto the seat (25) of the sub-sea tool piston. While the fluid pressure is further exerted, the pressure will bring about the rupture of a first holding means with a shearing rupture calibrated for a pressure P1 (31).

Fig. 5 represents the movement which then appears: since means (31) has been ruptured, dart (12) activates the piston (24) until the radial openings (23) are free. The fluid may then be circulated towards the annulus and pressure P1 may drop to a lower value P'1. The piston is braked by the plug (28) resisting the movement. The pressure will quickly balance around the piston and will not exert any further pushing effort.

Another shearing rupture holding means, calibrated for a pressure P2 > P1 (32) positively limits the back up axial movement of the piston.

The magnitude of this movement is calculated, as explained in French Patent Application FR 90 03 129 in order to induce two effects: expelling plug (27) out of basket (26) and launching dart (12) from the radial openings (23). The fluid is then forced through annulus (33) and propels plug (27) towards the well bottom.

When launching the second dart (28) becomes necessary, the process is analogous.

As represented in Fig. 6, cock (7) of the modular part (2) is pivoted, which launches the second dart (12) which then is propelled by the fluid since the surfaces (29) prevent any fluid diversion towards or through annuli (16, 18). At the outlet of tube (19), the dart passing can be magnetically detected.

Fig. 7 and Fig. 8 represent the second dart acting on the sub-sea tool: the pressure accumulated behind the dart (12) causes the rupture of means (32) and thus a second downward movement of piston (24), which expels plug (28) and, at finally, the radial openings (23) will be freed. The pumped fluid then passes through annulus (33) and propels plug (28) towards the well bottom.

The invention thus proposes a dart launching system for a sub-sea cementing head which, de-

spite the operational complexity and the imperatives resulting from the necessity of 100% insuring the launching of a given dart at a given time, and the need of precluding, for instance, a simultaneous launching of both darts, still provides a much easier handling than in the previous art and includes a remote control from the drilling floor, which improves the safety of both the operators and the operation.

Other advantages are the balancing in relation with the vertical axis, the compatibility with the top drive system and the possibilities of rotating and up and down reciprocating movements, as well as a capacity for a very high pressure and a very high lifted weight (about 250 t; 500,000 lbs).

Compatibility with top drive/rotary table

Two heads versions can be made available:
1st version: with right hand thread connections.
2nd version: with left hand thread connections.

The first version allows:

- rotation and/or reciprocation of the system with a top drive;
- reciprocation only with a rotary table (rotation would tend to loosen the threads).

The second version allows:

- reciprocation only with a top drive (rotation would tend to loosen the left hand threads).
- rotation and/or reciprocation with a rotary table.

Finally, its modular aspect and the resulting possibility of launching more than two darts is capital for the considered industry.

Claims

1. Dart launching system for cooperating with a sub-sea tool or a sub-sea cementing head in an oil, gas and similar well, of the type in which darts originally are mechanically held in a launching position in a "high pressure" ram, then launched and propelled according to a predetermined sequence towards the well bottom by the fluid to be pumped into the well, characterized in that:
   - the "high pressure" ram (1, 2, 3) includes a fluid inlet (4) in its top part (3);
   - the dart or darts (12) are located in individual baskets open at both ends, which themselves are positioned in the center and aligned with the longitudinal axis of said body, in the generally cylindrical cavity (14, 15, 16, 18) formed in said ram;
   - those baskets are located between the top fluid inlet (4) and the bottom fluid outlet (19) leading to the drilling pipe; and that
   - a mechanical and movable holding means (7) is located substantially immediately under each basket and opposes, in a position, the downward passing of a dart, but does not oppose the passing of the fluid and, in another position, does not oppose the downward passing of a dart but opposes the passing of the fluid.

2. System according to claim 1, characterized in that said holding means (7) consist of a cock (7) transversally positioned in relation with the common longitudinal, system and dart axis, pivotably mounted around an also transversal axis, and including an opening (8) centered in the longitudinal, system and darts axis, with a large enough diameter to allow the darts passing, which cock:
   - in a vertical position opposes the passing of the dart through its part (a) but allows the passing of the fluid through the grooves (b);
   - in a horizontal position (reached by a quarter of a turn pivoting) allows the passing of the darts through opening (8) but opposes the passing of the fluid by its surface (29).

3. System according to claim 1 or 2 characterized in that said holding means (7) are mechanically controlled by a system acting through the wall of the body (1, 2, 3); preferably by a remote control electric motor or hydraulic or pneumatic system.

4. System according to any of claims 1 to 3 characterized in that the darts (12) are slightly spring prestressed in the basket (13).

5. System according to any of claims 1 to 4 characterized in that the top part (3) consits of a revolving joint with one or several lateral fluid inlets.

6. Use of the system according to any of the previous claims in the fields of oil or related, geothermic, water, gas or similar drillings.

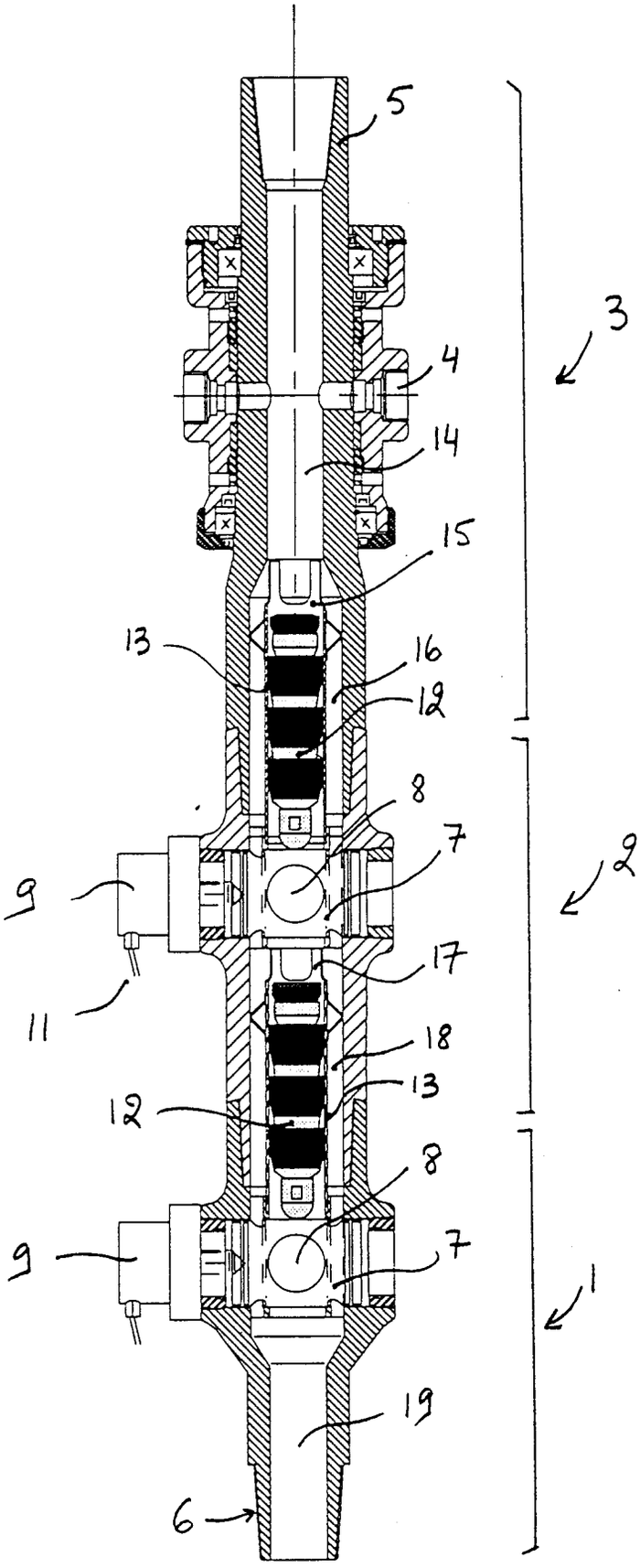

Fig. 1

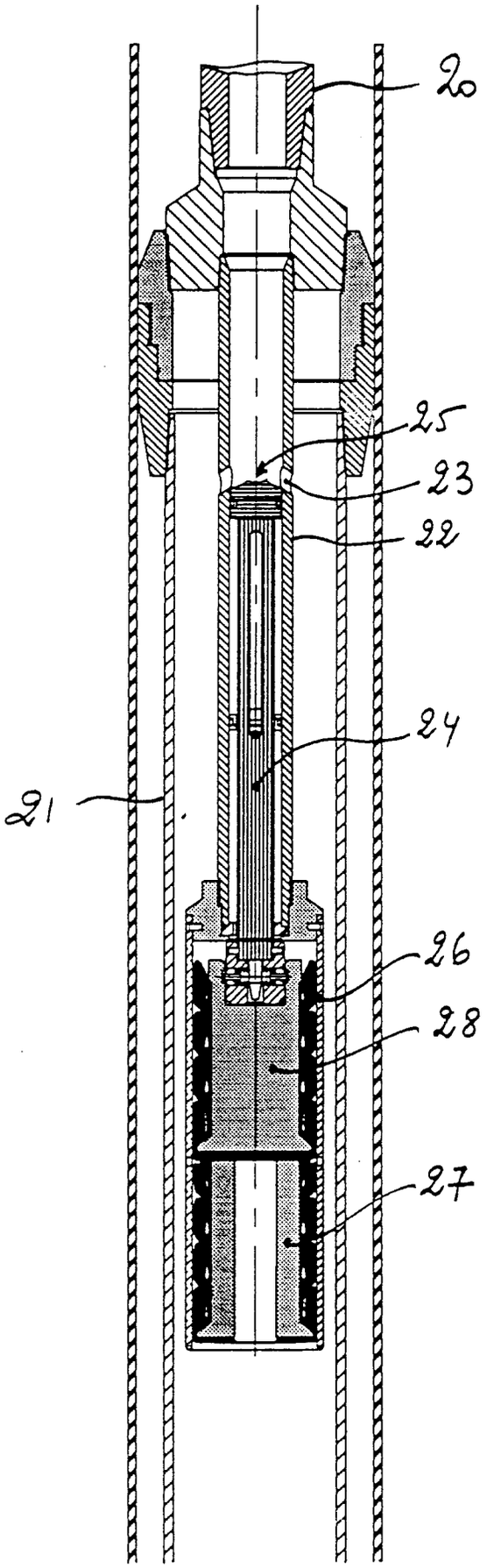

Fig. 2

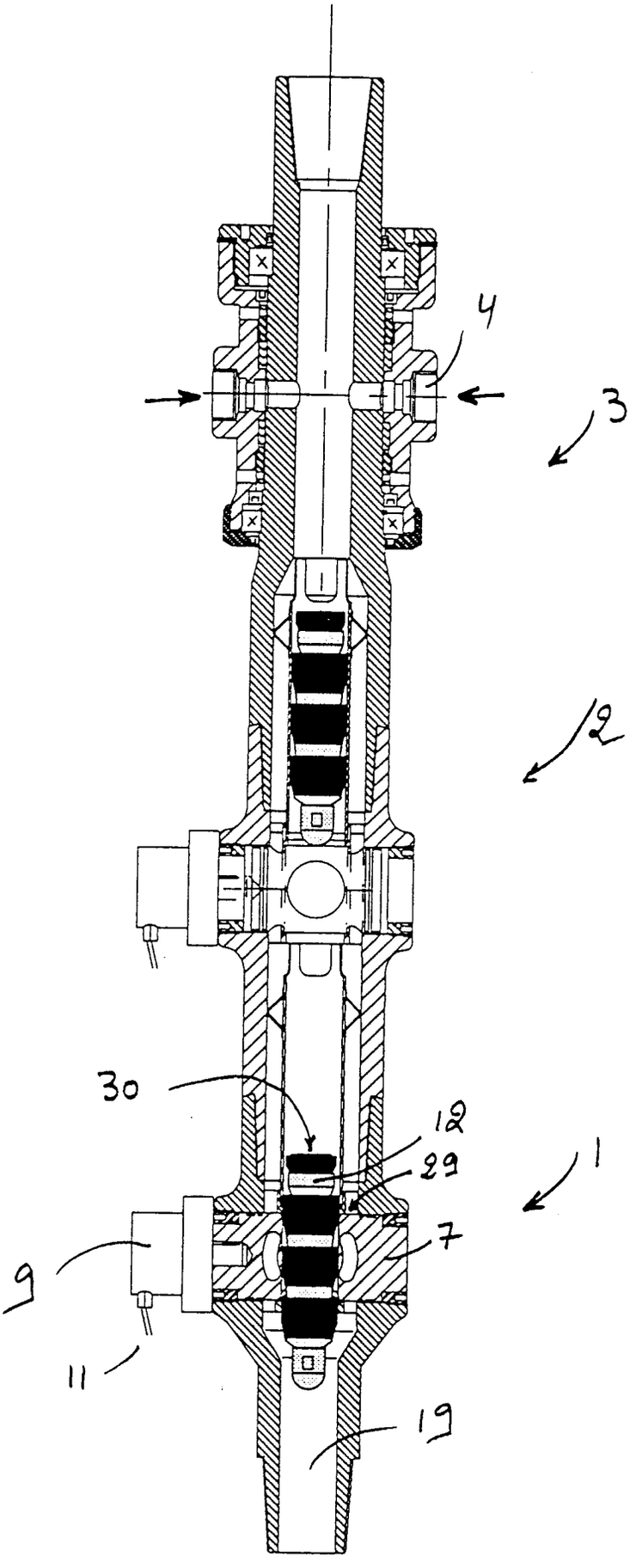

Fig.3

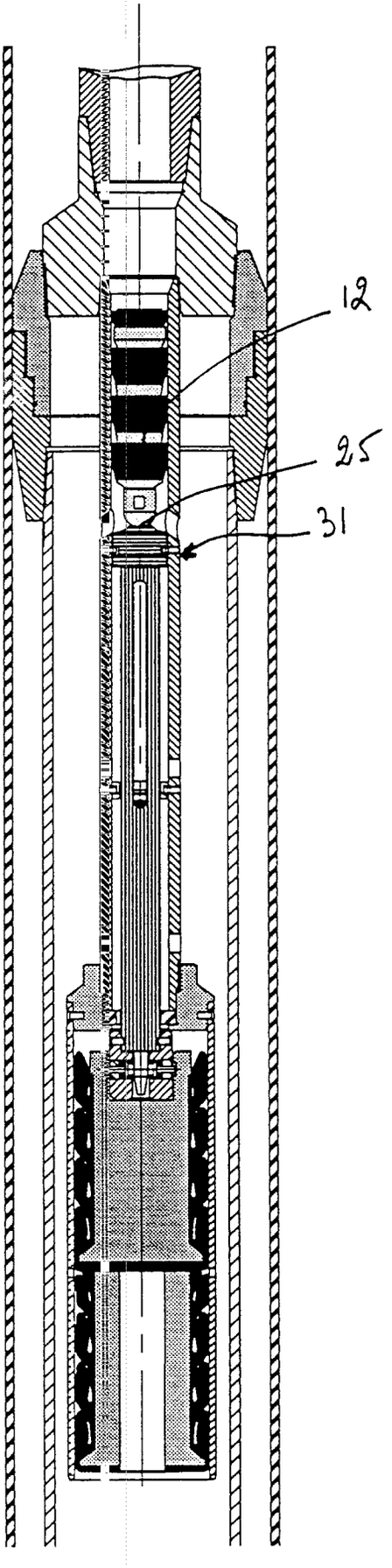

Fig. 4

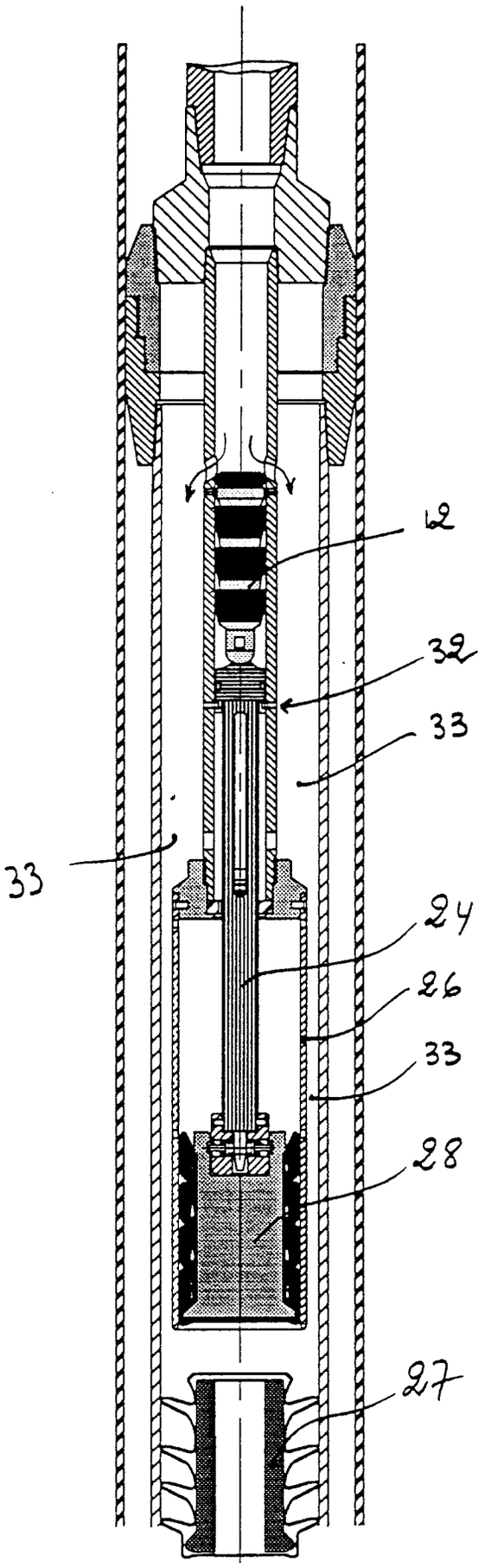

Fig. 5

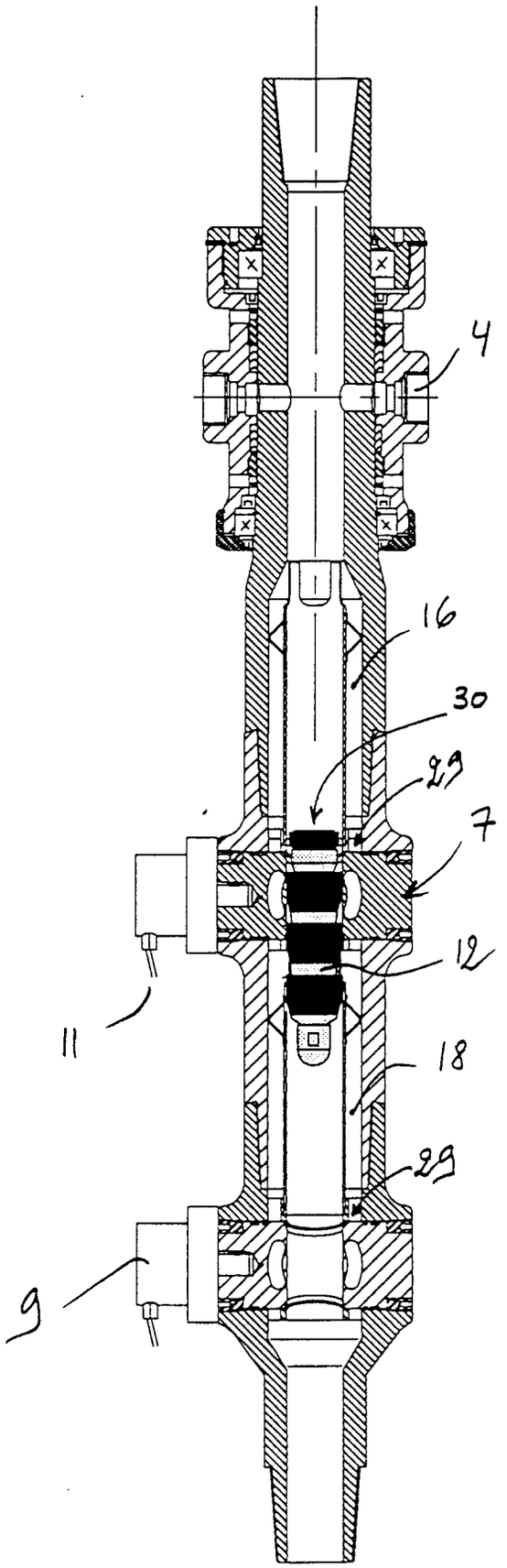

Fig. 6

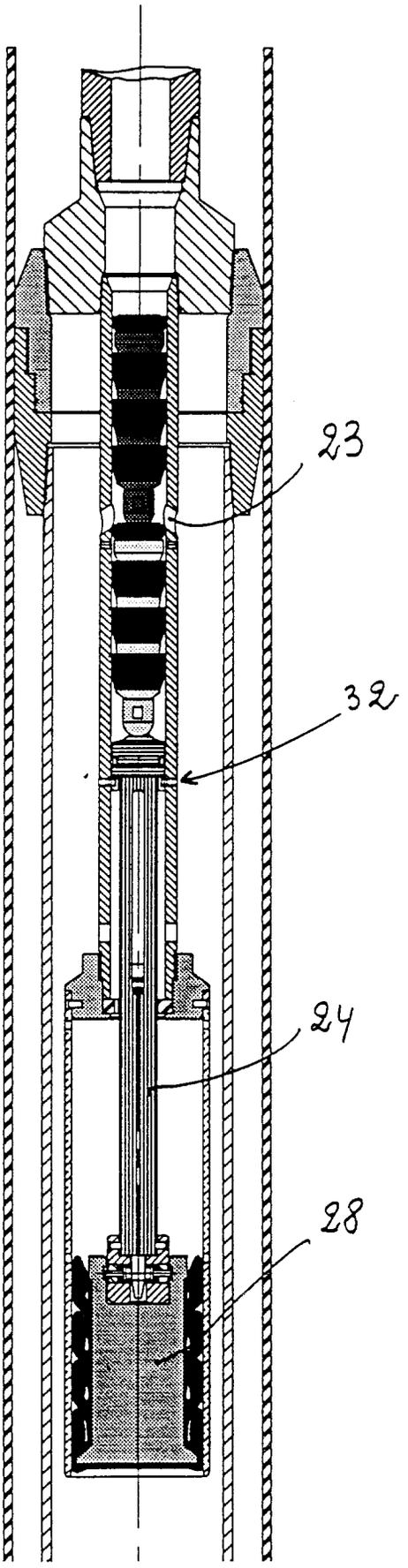

Fig. 7

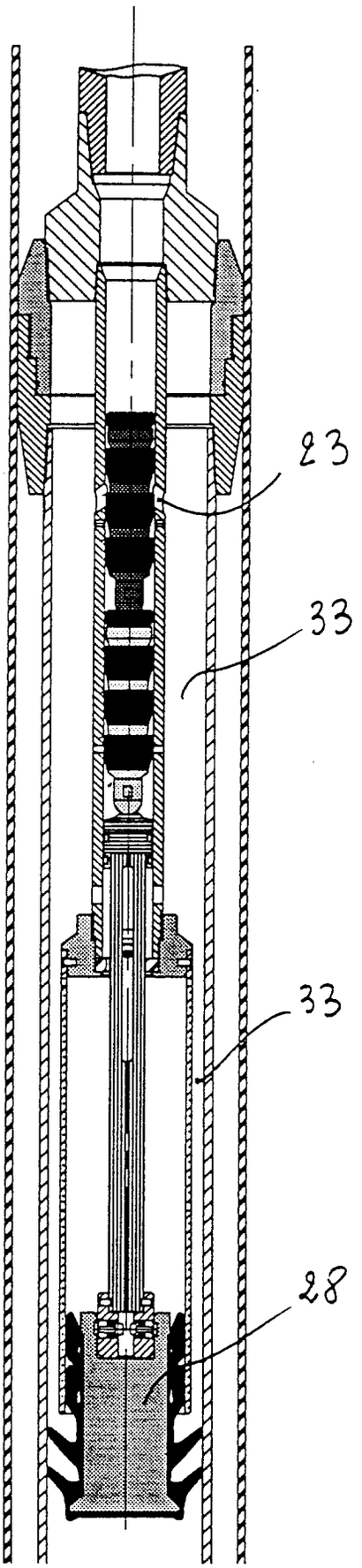

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number

EP 92 20 0360

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)
A	US-A-3 076 509 (BURNS) * column 4, line 31 - column 5, line 53; figures 1-5 *	1,2,3,6	E21B33/05 E21B33/076
A	US-A-4 042 014 (BURNELL SCOTT) * column 13, line 4 - column 16, line 4; figures 1-10 *	1	
P,A	EP-A-0 430 523 (HALLIBURTON) * column 12, line 15 - line 22; figures 1-3 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 MAY 1992	FONSECA Y FERNANDEZ

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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