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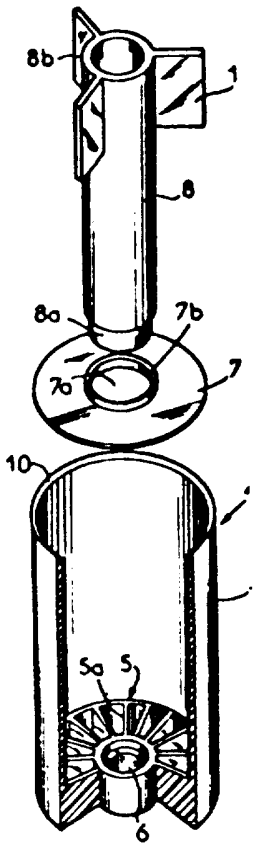
(54) **Title: PUMPING APPARATUS WITH A PLURALITY OF PISTONS AND A PISTON FOR SUCH APPARATUS**

(57) **Abstract:**

Pumping apparatus comprising a set of rods (2) driven in a reciprocating movement within a pumping column (3), and a plurality of pistons (4) spaced at equal distances from each other along the set of rods (2).

Each piston (4) comprises a cylindrical piston body (4a) secured to the set of rods (2) whose end facing downwards of the pumping column (3) comprises a perforate structure (5) comprising an axial orifice (6) accommodating the set of rods (2), a delivery valve (7) being pressed against the perforate structure (5) by a tubular member (8) extending within the piston body (4a) and through which passes the set of rods (2) to which it is also secured.

The pumping apparatus is applicable to manual pumping of water or oil or other liquids.



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(56) **Documents cited:** NONE

TITLE : PUMPING APPARATUS WITH A PLURALITY OF PISTONS AND A PISTON FOR SUCH APPARATUS

BACKGROUND OF THE INVENTION

The present invention concerns pumping apparatus of the multi-piston pump kind, that is to say a pumping apparatus comprising a set of rods driven in a reciprocating movement within a pumping column, and a plurality of pistons secured along the set of rods.

The invention also relates to pistons for use in such a pumping apparatus.

DESCRIPTION OF THE PRIOR ART

Patent No. 56772 and its Certificate of Addition No. 56773 filed on 23-3-1979 at the OAPI (Organisation Africaine de la Propriété Industrielle) describe a multi-piston pumping apparatus of the above kind.

A major disadvantage of the pumping apparatus described in the above documents resides in the design of the pistons therein.

In those pistons, a delivery valve is secured to the set of rods and is movable relative to the piston body which is floating, so that relative movement of these two parts during operation of the pump produces friction between the immersed parts of the pump and the pumping column, which generates a certain resistance to pumping and wear of the above parts. Moreover, the piston seal is also liable to wear rapidly, so that it has to be charged fairly frequently.

OBJECTS OF THE PRESENT INVENTION

An object of the present invention is to provide a pumping apparatus of the kind refered to above whose pistons do not include a sliding seal nor any parts moving relative to each other, so that its maintenance is reduced and it presents a smaller resistance to pumping.

BRIEF DESCRIPTION OF THE INVENTION

One aspect of the present invention provides a pumping apparatus of the kind comprising a set of rods driven in a reciprocating movement within a pumping column, and a plurality of pistons mounted along the set of rods, characterized in that each piston comprises a cylindrical piston body secured to the set of rods, the end of the piston body facing downwards of the pumping column comprising a perforate structure defining an axial orifice for accomodating the set of rods and perforations for the passage of the liquid being pumped, and a delivery valve pressed against said perforate structure by a tubular member extending within the body of the piston and through which pass the set of rods to which it is also secured.

According to an advantageous feature of the invention, the delivery valve comprises a circular diaphragm of flexible plastics material whose diameter is substantially equal to the inner diameter of the piston body and comprising an axial opening for the passage of the set of rods.

The absence of a seal and of moving parts other than the diaphragm acting as valve give the above pumping apparatus particular strength and efficiency enabling exceptional flow rates to be obtained while practically eliminating the risk of wear and the need for maintenance, which designates the pumping apparatus described especially for use in countries where the search for water is a constraint, such as the Sahel countries.

In a preferred embodiment of the invention, the edge of the end of the piston body opposite to the perforate structure is bevelled so as to direct inwards any grains of sand which may be disposed at the periphery of the piston body in cases where the water being pumped is particularly sandy, the grains of sand

being thus eliminated instead of collecting between the walls of the piston and of the pumping column.

Preferably, the outer diameter of each piston body is substantially less that the inner diameter o the pumping column. This gives a very substantial reduction in friction between the immersed parts and the pumping tube, as well as reduced pumping resistence.

In a advantageous embodiment of the invention, the pumping column also acts as drill casing. In this case, a single tubing is used, reinforced relative to that used just for the pump, eliminating the intermediate casing tube normally used between the drill hole and the pumping column of the pump, which gives a substantial reduction in the cost of the furbished well.

DESCRIPTION OF THE DRAWINGS

Other features and avantages of the invention will appear from the following description, given by way of example with reference to the accompanying drawings, in which :

- Fig. 1 is a simplified general view of pumping apparatus in accordance with an embodiment of the present invention,

- Fig. 2 is an exploded perspective view of a piston in accordance with an embodiment of the present invention,

- Fig. 3 is a top view of the piston,

- Fig. 4 is an underneath view of the piston of Fig. 3, and

- Fig. 5 is a sectional view of an immersed part of the pumping apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The pumping apparatus shwon diagrammatically in Fig. 1 comprises an external superstructure which is not specific to the present invention. This

superstructure of the rocking head kind will not be described in detail as its description is given on the OAPI Patent No. 56 772 referred to above.

As shown in Fig. 1, the pumping apparatus of this embodiment of the invention is of the kind comprising a set of rods 2 which are driven in a reciprocating movement within a pumping column or body 3, which may comprise a tube of PVC or similar material for example, a plurality of pistons 4 being fixed at equal distances along the set of rods in a manner which is described below. In accordance with a preferred feature of this embodiment, the pistons 4 are spaced by a distance of about 3m.

The pumping column 3 also comprises steel coupling sleeves 3a which enable the tubular elements forming the pumping column to be assembled together (see Figs. 1 and 5), and a bottom valve 9 which is not specific to the present invention. In a manner which is also not specific to the present invention, the set of rods 2 comprises drawn rods of diameter 14mm in lengths of 3 metres, assembled using screw threads thereon by means of hexagonal steel sleeves 2a of size 21mm across the flats (see Fig. 5) each such hexagonal sleeve being screwed and welded onto the upper end of each rod. A lock-nut 2b avoids the sleeves 2a coming unscrewed. Each of the sleeves 2a is protected by a flexible PVC hood (not shown).

In accordance with this embodiment of the invention (see Figs. 2 to 4) each of the pistons 4 comprises a cylindrical piston body 4a which is secured to the set of rods 2 by means described below, its end facing downwards of the pumping column 3 comprising (see Figs. 2 to 4) a honeycomb structure 5 comprising an axial orifice 6 for accommodating the set of rods 2. A delivery valve 7 (see Figs. 2 and 3) which comprises a circular diaphragm of flexible plastics material is

pressed against the honeycomb structure 5 referred to above by a tubular member 8 which extends within the piston body 4a and through which passes the set of rods 2, to which is also secured.

The diaphragm 7 mentioned above forming the delivery valve, whose diameter is substantially equal to the inner diameter of the piston body 4, and which comprises an axial opening 7a for the passage of the set of rods 2, presents a flange 7b on the side opposite to the honeycomb structure 5, the flange 7b enabling the diaphragm to be fitted over the end 8a of the tubular member 8 adjacent to the honeycomb structure 5. The end 8a of the member 8 referred to above comprises a section of the tubukar member of reduced diameter relative to the section extending through the piston body 4a, the diameter of the section being defined so that the end 8a of the tubular member 8 can be accommodated in the axial orifice 6 of the honeycomb structure 5. The penetration of the end 8a of the tubular member 8 into the orifice 6 of the body of the honeycomb structure 5 which is solid with the piston body 4a ensures self-centering of the tubular member 8 within the piston body 4a and, consequently, self-centering of the diaphragm 7 forming the delivery valve and also secures together the three members forming the piston 4, that is to say the tubular member 8, the diaphragm 7 and the piston body 4a.

In accordance with another preferred feature of this embodiment of the invention, the edge 10 of the end of this piston body 4a opposite to the honeycomb structure 5 described above is bevelled at 45° so as to direct inwards of the piston body 4a any grains of sand which might be disposed at the periphery of the piston body or column 3 in cases where the water being pumped is particularly sandy, the grains of sand being thus

eliminated instead of collecting between the walls of the pistons 4 and of the pumping column 3.

In accordance with another preferred feature of this embodiment of the invention, the tubular member 8 has centering fins 11 at its end 8b opposite to the delivery valve 7, there being three fins spaced angular by 120° relative to each other in the example shown, and the fins extending radially between the outer surface of the tubular member 8 and the inner surface 4c of the piston body 4a.

The centring fins 11 ensure self-centering of the pistons 4 within the pumping column 3 during use of the pumping apparatus.

Additionally, the honeycomb struture 5 referred to above comprises (see Figs. 2 and 4) a plurality of arms 5a which extend radially between the wall of the piston body 4a and the orifice 6 through which passes the set of rods 2. The arms 5a present a height in the direction of the generatrixes of the piston body 4a which is non-negligeable relative to the length of the piston body 4a and, together with the body 6a of the orifice 6 which is of the same height, the arms form a suitable support for the diaphragm 7 forming the delivery valve while presenting a honeycomb structure which rigidifies the piston body 4a and enables water to pass through during the delivery phase in use of the pumping apparatus.

As shown in Fig. 5, the outer diameter of each of the piston bodies 4a is substantially less than the inner diameter of the pumping body or column 3. This gives a very substantial reduction in the friction between the immersed parts of the pump and the pumping column 3 and also lower resistance to pumping.

The pistons 4 are spaced and secured along the whole length of the set of rods 2 at equal distances from each other in the following manner. A

steel washer 12 is welded to the rod 2 (see Fig. 5) at a position juxtaposed with the end of the tubular member 8 presenting the fins 11. The piston 4 is pressed into abutment against the steel washer 12 by a nut-lock nut pair 13 which is screwed onto the rod 2 to press against the end of the piston body 4a opposite to the fins 11.

Another advantage of this embodiment of the invention consists of the possibility to use the pumping column or body 3 as a drill casing. For this purpose, a single tube 3 is used whose thickness is reinforced relative to the casing used merely for the pump, which enables the intermediate casing tube usually used between the drill hole and the pumping column 3 to be eliminated. This arrangement gives a substantial reduction in the cost of the furbished drill hole.

It will be noted that the pistons 4 described are free from any seal. The latter would have been needed in the case where a single piston was used to ensure sufficient sealing but its wear is often rapid and leads unavoidably to the breakdown of the pumping apparatus ; however, it becomes unnecessary when a plurality of pistons are used.

The absence of a seal and of moving parts other than the diaphragm 7 functioning as valve, and the materials chosen to make the pistons 4 which present a high level of corrosion resistance, give particular strength and efficiency enabling exceptional flow rates to be obtained while practically eliminating the risk of wear and the need for maintenance, which designates the pumping apparatus described especially for use in countries where the search for water is a constraint, such as the Sahel countries.

The diameters of the pumping column 3 and the pistons 4 may vary according to the drilling depth, the

flow rate and water requirements of the users, from 50mm (outer diameter of the pumping column 3) to 160mm or even more in the case of a motorised deep-level pump.

One feature of this type of pumping apparatus is in fact the possibility to obtain high flow rates at great depths, the multiplicity of pistons ensuring a constant pressure per piston irrespective of the depth.

The characteristics of the casing tube-pumping column 3 (identical over the whole drilling depth), the set of rods 2, the pistons 4 spaced as indicated above and the check valve 9 disposed at the bottom of the pump enable it to be installed in a drill-hole to a sufficient depth to reach the water bearing zone at whatever depth it occurs while maintaining the maximum output of the pump. It is important just to provide a special arrangement for the bottom check valve 9 disposed in the bottom part of the tube to be withdrawn as desired for examination as the casing tube-pumping column are now fixed. It is sufficient to provide the bottom valve 9 with a screw thread in its upper end enabling a corresponding thread on the lower end of the set of rods 2 to engage therewith to bring the valve up to the surface of the well.

The operation of the pumping apparatus described above is as follows. When the set of rods rises, it lifts up with it the piston 4. The diaphragm 7 of each piston 4 is pressed against the honeycomb structure 5 of the corresponding piston, so that the apparatus becomes relatively sealed and develops a partial vacuum beneath it, which lifts the bottom valve 9 so that water enters into the pumping body 3. When the set of rods is lowered, it lowers the pistons 4 with it. The water contained in the bottom of the pumping column flows upwards within the pumping body

through the perforations of the honeycomb structures 5 of the pistons 4, by lifting the diaphragms 7 of the pistons. The water in the pistons is then lifted on the next upward stroke of the set of rods 2.

The pumping apparatus of the invention can be adapted to various superstructures, according to whether it is actuated by a simple manual operating lever intended for 1 to 4 persons (a woman or a child can actuate it without undue effort for the requirements of a family) or by animal daught by means of a turntable, or an engine of any kind with a transmission mechanism providing the reciprocating movement of the piston 4. Several pumps may be installed in the same system, moreover.

A pumping apparatus in accordance with the invention may also be used for the extraction of oil. In this case, it will just be necessary to adapt the materials used for the pumping column and the pistons. They may be made of metal, for example, since the viscosity of oil products will protect them from the isles of seizure which would occur rapidly in the case of extraction of sandy and sometimes brackish water.

It will be appreciated that the invention is not limited to the specific example described and illustrated. For example, the guide fins 11 of each piston 4 could be helicoidal so that the water would be caused to whirl one way or the other, carrying the sand towards the center of the pumping column.

SAVING NOW PARTICULARLY DESCRIBED AND ASCERTAINED MY/OUR SAID INVENTION AND IN WHAT MANNER THE SAME IS TO BE PERFORMED, I/WE DECLARE THAT I/WE CLAIM IS:-

CLAIMS

1. Pumping apparatus of the kind comprising a set of rods (2) driven in a reciprocating movement within a pumping column (3), and a plurality of pistons (4) mounted along the set of rods (2), characterized in that each piston (4) comprises a cylindrical piston body (4a) secured to the set of rods (2), the end of the piston body facing downwards of the pumping column (3) comprising a perforated structure (5) defining an axial orifice (6) for accommodating the set of rods (2) and perforations for the passage of the liquid being pumped, and a delivery valve (7) pressed against said perforate structure (5) by a tubular member (8) extending within the body (4a) of the piston (4) and through which passes the set of rods (2) to which it is also secured.

2. Pumping apparatus as claimed in claim 1, characterized in that the delivery valve comprises a circular diaphragm (7) of flexible plastics material whose diameter is substantially equal to the inner diameter of the piston body (4a) and comprising an axial opening (7a) for the passage of the set of rods (2).

3. Pumping apparatus as claimed in claim 2, characterized in that the diaphragm (7) presents a flange (7b) which fits onto an end (8a) of the tubular member (8) adjacent to the perforate structure (5).

4. Pumping apparatus as claimed in any of the preceding claims, characterized in that the tubular member (8) presents at its ends (8b) opposite to the delivery valve (7) centering fins (11) extending radially between the surface of the tubular member (8) and the inner surface of the piston body (4a).

5. Pumping apparatus as claimed in any of the preceding claims, characterized in that the edge (10)

of the end (8a) of the piston body (4a) opposite to the perforate structure (5) is beveelled.

6. Pumping apparatus as claimed in any of the preceding claims, characterized in that the perforate structure (5) comprises a plurality of arms (5a) which extend radially between the wall of the piston body (4a) and the orifice (6) accommodating the set of rods (2).

7. Pumping apparatus as claimed in any of the preceding claims, characterized in that the outer diameter of each piston body (4a) is substantially less that the inner diameter of the pumping column (3).

8. Pumping apparatus as claimed in any of the preceding claims, characterized in that the pistons (4) are spaced and fixed over the whole length of the set of rods (2) at equal distance from each other.

9. Pumping apparatus as claimed in any of the preceding claims, characterized in that the pumping column (3) also forms a drill casing.

10. A piston (4) for pumping apparatus as claimed in any of the preceding claims, characterized in that it comprises a cylindrical body (4a) secured to the set of rods (2), the end of the piston body facing downwards of the pumping column comprising a perforate structure (5) defining an axial orifice (6) for accommodating the set of rods (2), and a delivery valve (7) pressed against said perforate structure (5) by a tubular member (8) extending within the body (4a) of the piston (4) through which passes the set of rods (2) to which it is also secured.

DATED THIS 12th DAY OF July 19 89

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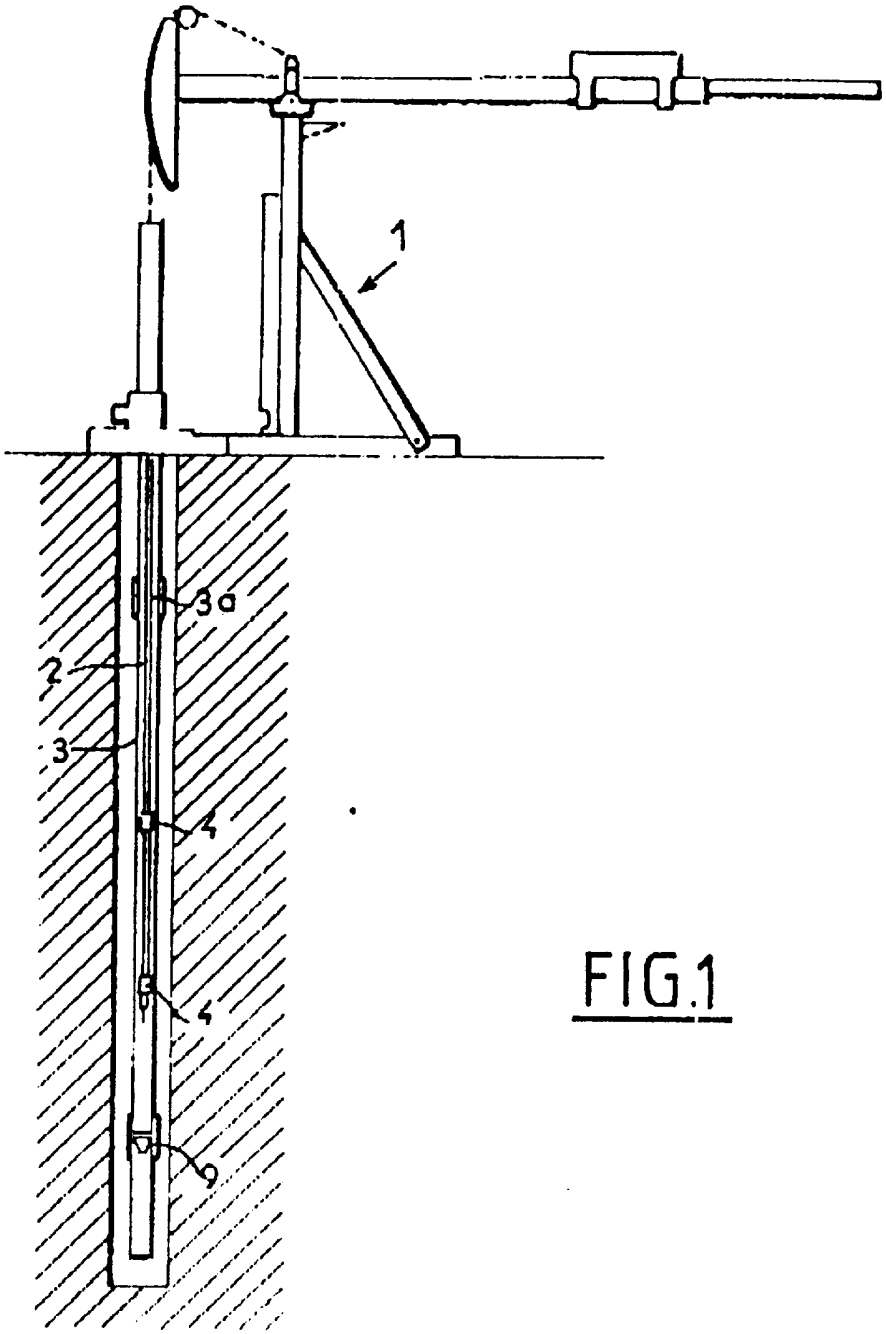

FIG.1

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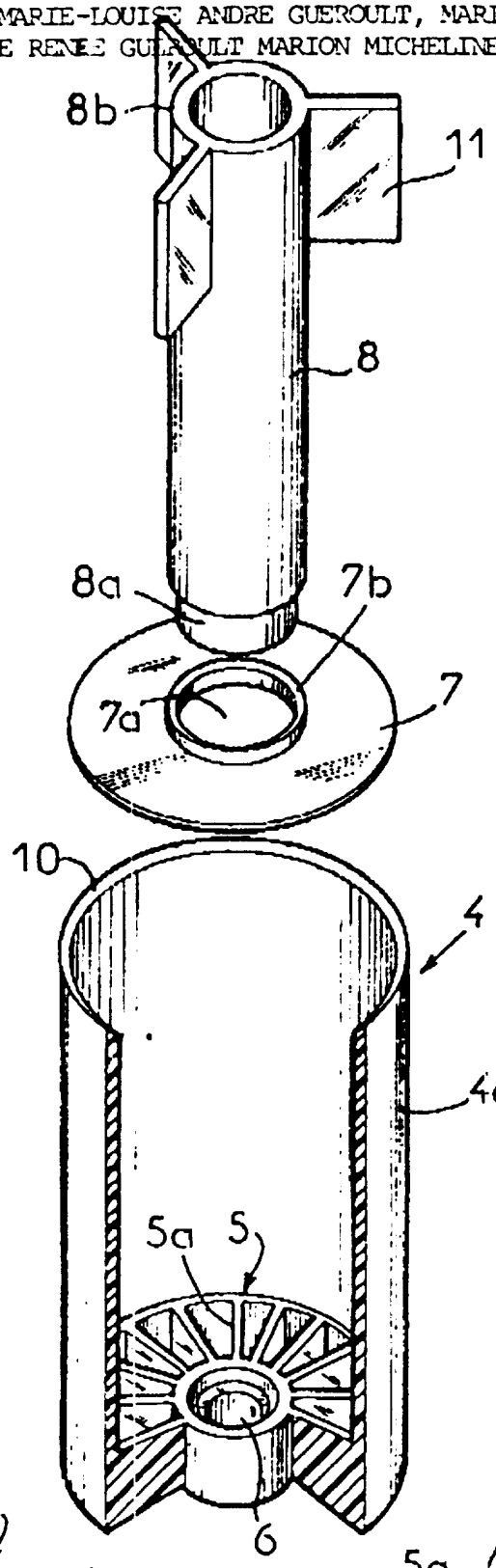

FIG.2

FIG.3

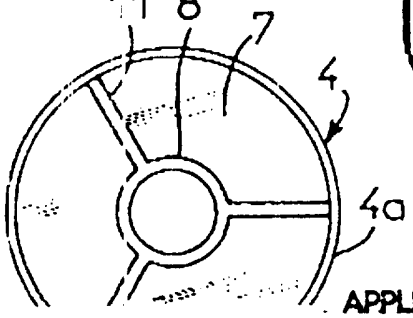

FIG.4

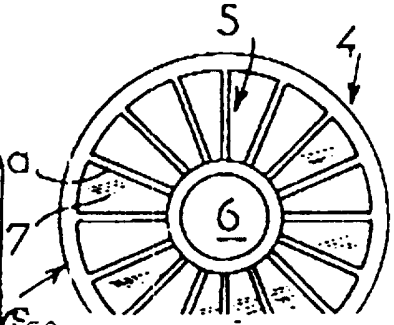

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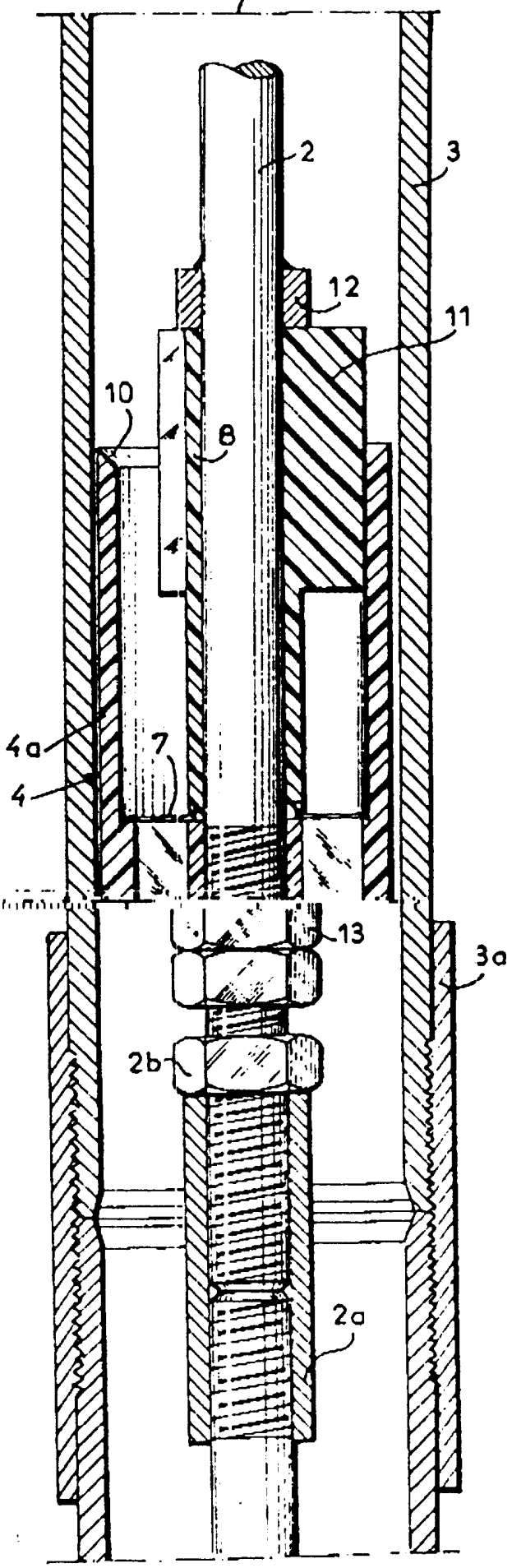
FIG.5



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