

(12)

EUROPEAN PATENT APPLICATION

(21) Application number: 82102741.4

(51) Int. Cl.³: **E 21 B 43/24**
E 21 B 43/00, E 21 B 36/00
F 04 B 47/00

(22) Date of filing: 31.03.82

(30) Priority: 13.07.81 US 282488

(43) Date of publication of application:
19.01.83 Bulletin 83/3

(84) Designated Contracting States:
BE CH DE FR GB IT LI NL SE

(71) Applicant: Rockwell International Corporation
2230 East Imperial Highway
El Segundo, California 90245(US)

(72) Inventor: Tuttle, Gary Edward
22023 Bryant Street
Canoga Park California 91304(US)

(74) Representative: Wächtershäuser, Günter, Dr.
Tal 29
D-8000 München 2(DE)

(54) **Secondary oil recovery system.**

(57) A method and apparatus for oil recovery wherein a downhole steam generator 16 and a pump 32 are secured substantially parallel with each other to permit simultaneous positioning in the borehole and are operated independently whereby said pump 32 can be operated sequentially or simultaneously with said generator 16.

SECONDARY OIL RECOVERY
SYSTEM

Gary E. Tuttle

Background of the Invention1. Field of the Invention

5 This invention relates to secondary oil recovery systems and is particularly directed to means for generating steam within a borehole and recovering oil stimulated by said steam.

2. Description of the Prior Art

10 The use of steam for enhancing secondary oil recovery began in the United States around 1960. Originally, the process called for a steam generator located at the surface with the steam being injected into the treated well. Over the next twenty years, steam stimulation has gained wide acceptance and downhole steam generators have been developed, which are lowered into the borehole to generate steam in situ. Typical of these
15 downhole steam generators is that disclosed in the copending application of William R. Wagner et al, Ser. No. 202,990, filed 11-3-80, assigned to the present assignee.

20 The Wagner device is a vast improvement over previous steam generators. However, there has still been considerable room for further improvement. With the steam generators of the Wagner type, the generator is lowered down the borehole to the level of the formation to be treated, where it generates steam and injects the steam into the formation. After a desired period of time, the steam generator is withdrawn from the borehole and is replaced by a pump which serves to produce the oil which was re-
25 leased by the steam. Obviously a substantial period of time is required to accomplish this transfer and the steam-treated formation will be cooling down during this period. Consequently, much of the effect of the steam

treatment is wasted. Moreover, the operations involved in lowering the steam generator into the borehole, subsequently removing it, and lowering the pump, require much labor and downtime, which add substantially to the cost of the process.

5 Brief Summary and Objects of the Invention

These disadvantages of the prior art are overcome with the present invention and a method and apparatus are provided which eliminate the losses associated with equipment transfers and which permit steam treatment and production to occur without intermediate equipment transfers and, in fact, permit production to occur simultaneously with the steam treatment.

The advantages of the present invention are preferably attained by providing a secondary oil recovery system having a downhole steam generator and pump mounted substantially in parallel with each other so as to permit simultaneous positioning in the borehole and to permit independent operation of the steam generator and pump, so that the pump may be operated sequentially or simultaneously with the steam generator.

Accordingly, it is an object of the present invention to provide an improved system for secondary oil recovery.

Another object of the present invention is to provide an improved method and apparatus for steam treating subterranean formations and recovering oil released from the formations by the treatment.

An additional object of the present invention is to provide apparatus for steam treating borehole formations and recovering oil released by the treatment without requiring intermediate transfer of apparatus into and out of the borehole.

A specific object of the present invention is to provide a secondary oil recovery system comprising a downhole steam generator and a pump secured substantially parallel with each other to permit simultaneous positioning in the borehole and means for operating the pump independently of the steam generator to permit the pump to be operated sequentially or

simultaneously with the steam generator.

These and other objects and features of the present invention will be apparent from the following detailed description, taken with reference to the accompanying drawing.

Brief Description of the Drawings

5 In the drawings:

FIG. 1 is a diagrammatic representation of a secondary oil recovery system embodying the present invention;

FIG. 2 is a transverse section through the system of FIG. 1, taken on the line 2 - - 2 thereof; and FIG. 3 is a diagrammatic representation of an alternative form of the oil recovery system of FIG. 1.

Detailed Description of the Invention

In that form of the present invention chosen for purposes of illustration in the drawing, FIG. 1 shows a secondary oil recovery system, indicated generally at 2, located in a borehole 4 which penetrates a plurality of formations, as indicated at 6, 8, 10, and 12. If desired, the borehole 4 may be enclosed by casing 14 along part of its length. Obviously, however, the formation 10 to be treated must either be increased or, if cased, the casing must be perforated.

The oil recovery system 2 comprises a steam generator unit 16, which may be similar to that of Wagner et al, cited above. A water line 18, a fuel line 20 and an air line 22 connect the steam generator unit 16 with suitable supply sources, not shown, at the surface. The output of the steam generator unit 16 is delivered through conduit 24, check valve 26, conduit 28, and exhaust nozzle 30 into the borehole 4 and the formation 10 to be treated. A suitable pump 32 is mounted adjacent conduit 28 and is actuated from the surface by suitable means, such as sucker rod 34. The pump 32 draws oil from the borehole 4 through inlet 36 and conduit 38, and delivers the oil to the surface through conduit 40. A suitable packer 42 secures conduits 28 and 38 together and serves to maintain the recovery

system 2 at a desired location in the borehole 4 and to seal the borehole 4 so as to drive the steam into the formation 10 to be treated. Additional coupling means 44 serve to secure the components together to form an integral unit.

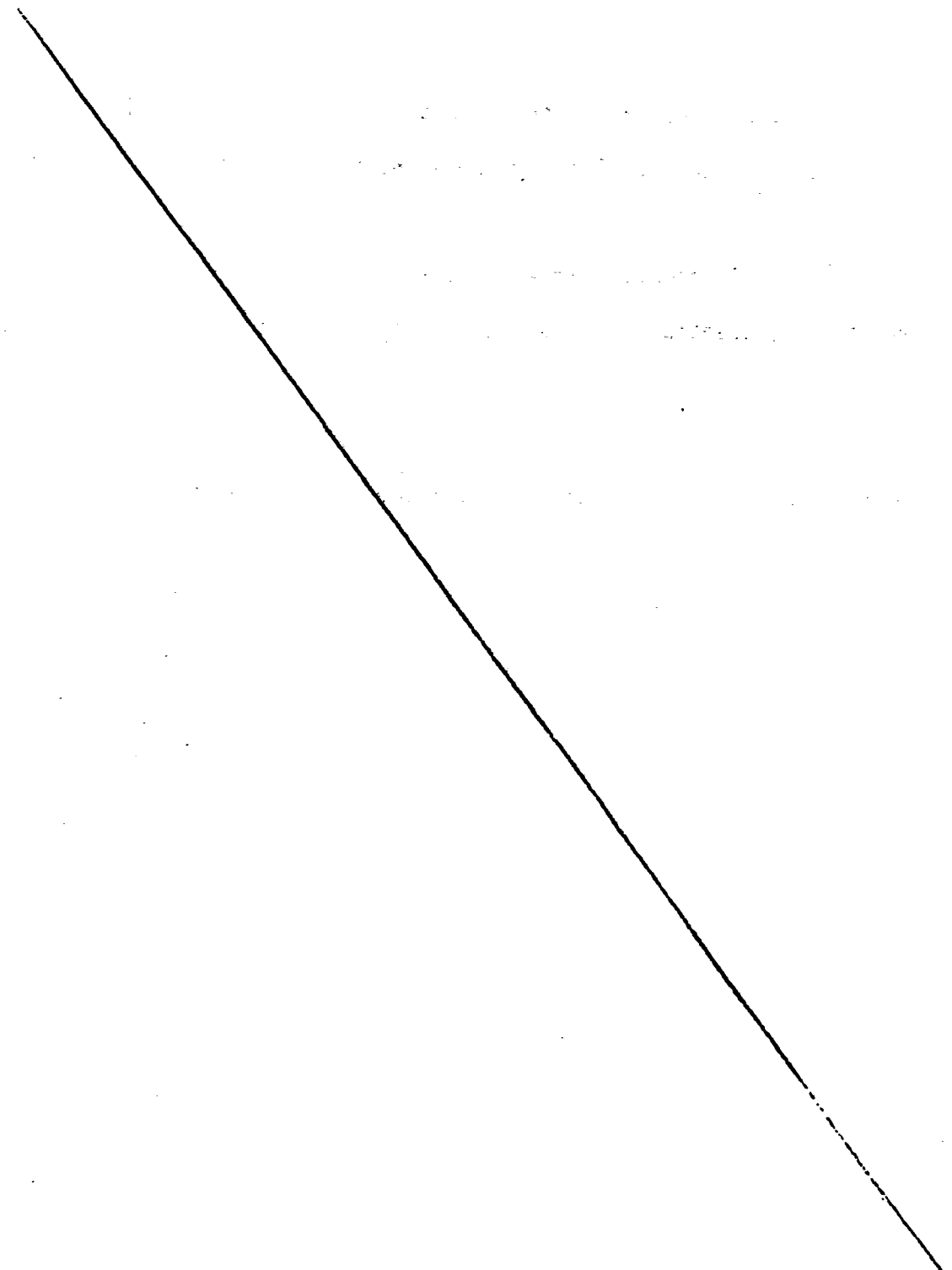
5 As shown, the pump inlet 36 is positioned immediately adjacent the steam nozzle 30. This arrangement is preferred for what is called "huff and puff" operation, wherein the steam generator 16 and pump 32 are actuated sequentially. With this arrangement, the pressure developed by the steam will drive oil out of the borehole 4 and, hence, will preclude simultaneous pumping while the steam generator 16 is operating. However, pump 32 can be actuated in the same instant that the steam generator 16 stops. Thus, production can be initiated while the formation 10 is at its hottest temperature and the oil is at its lowest viscosity. Thus, a substantial quantity of oil can be pumped during the time heretofore required for transfer of equipment. Moreover, since no equipment transfer is needed, it becomes feasible to operate the steam generator 16 and pump 32 on alternating schedules, such as four hours of steam treatment followed by four hours of pumping.

10 FIG. 3 shows an oil recovery system 2 which is similar to that of FIG. 1 except that the pump inlet conduit 38 is elongated so as to position the pump inlet 36 a substantial distance below the steam exhaust nozzle 30. With this arrangement, oil that is released from the formation 10 by the steam treatment will drain into the borehole 4 adjacent the pump inlet 36 with the result that steam generator 16 and pump 32 can be operated simultaneously. This permits recovery from extremely difficult formations which would not yield to prior art methods of production.

Obviously, numerous other variations and modification can be made without departing from the present invention. Accordingly, it should be clearly understood that the forms of the present invention described above and shown in the accompanying drawing are illustrative only and are not intended to limit the scope of this invention.

5

What is claimed is:



1 1. An oil recovery system comprising:
2 a downhole steam generator;
3 a pump secured substantially parallel with said steam generator to
4 permit simultaneous positioning of said pump and said generator in a borehole;
5 and
6 means for operating said pump and said generator independently of
7 each other.

1 2. The oil recovery system of Claim 1 wherein the intake for said pump is
2 located adjacent to and slightly above the outlet nozzle of said steam generator.

1 3. The oil recovery system of Claim 1 wherein the intake for said pump is
2 located a substantial distance below the outlet nozzle of said steam generator.

1 4. The oil recovery system of Claim 1 wherein said means for operating
2 permits simultaneous operation of said pump and said steam generator.

1 5. The method of oil recovery comprising the steps of:
2 generating steam in situ at a location within a borehole;
3 injecting said steam into the formations adjacent said borehole to
4 release oil from said formations; and
5 pumping said oil to the surface without removing said steam generator.

1 6. The method of Claim 5 wherein said pumping step is performed simul-
2 taneous with said generating step.

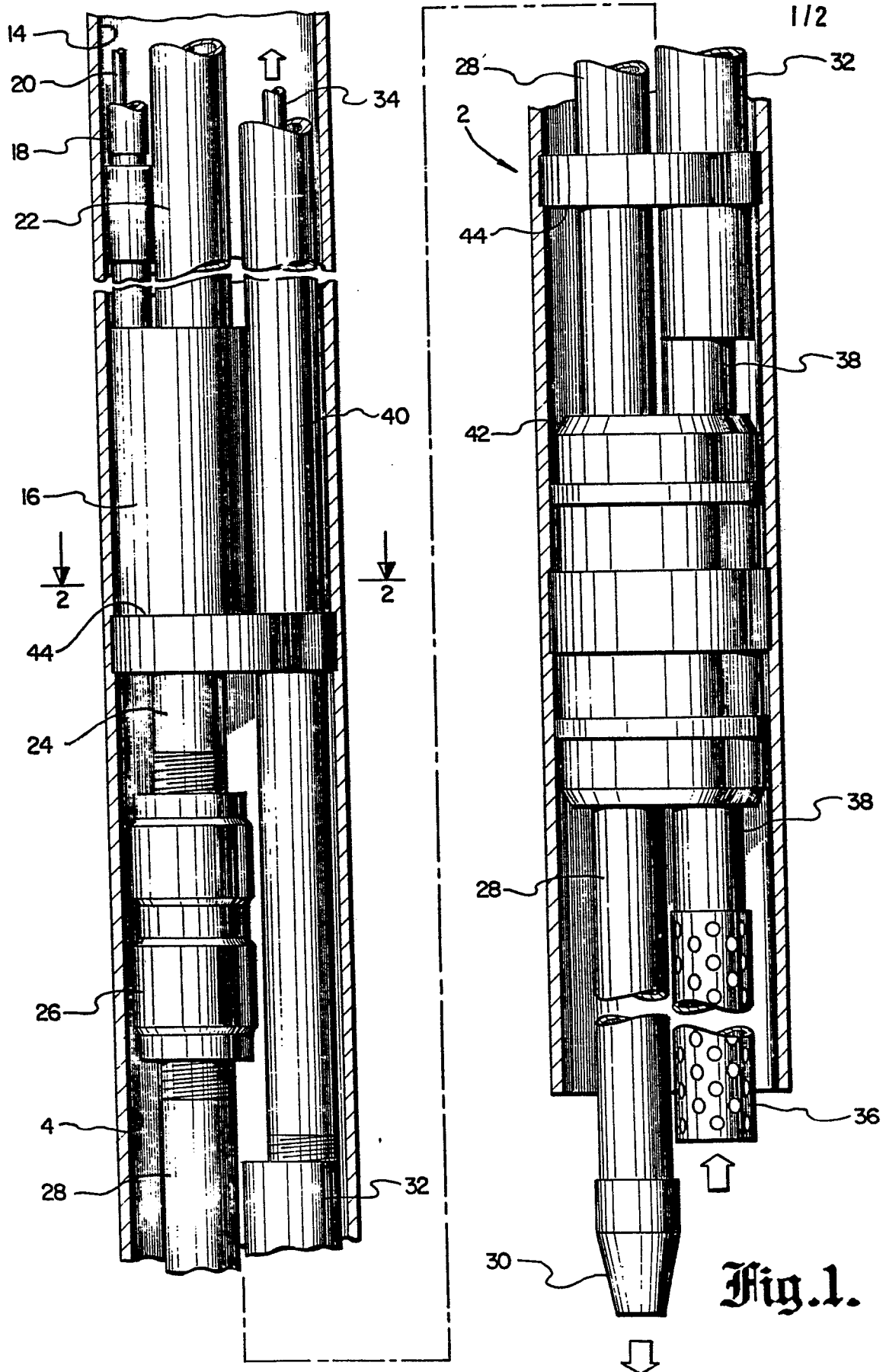


Fig. 1.

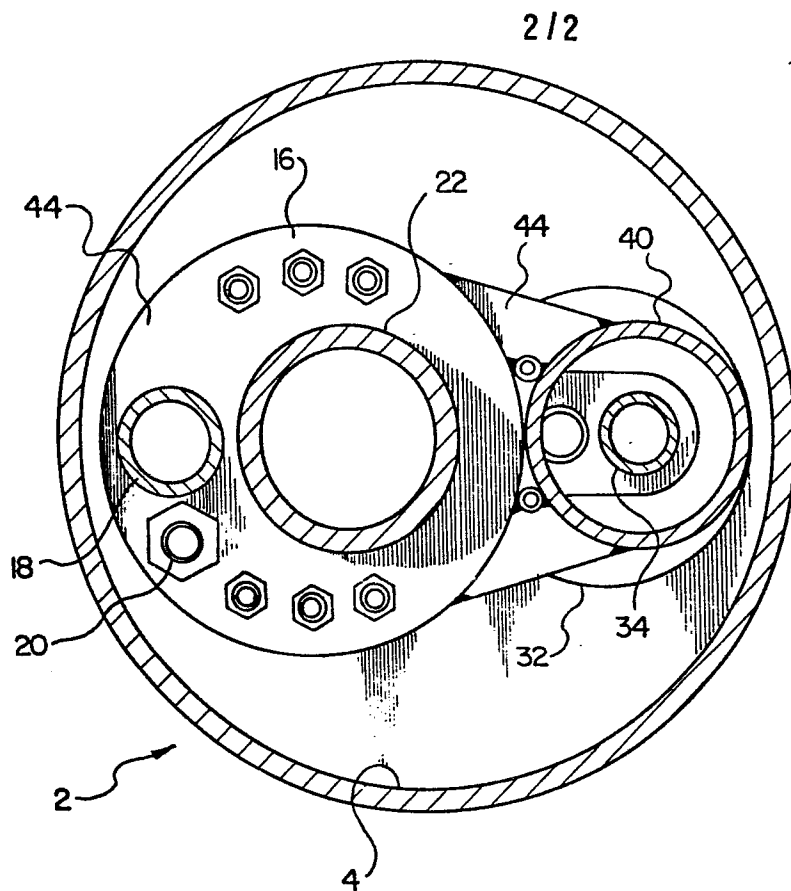


Fig. 2.

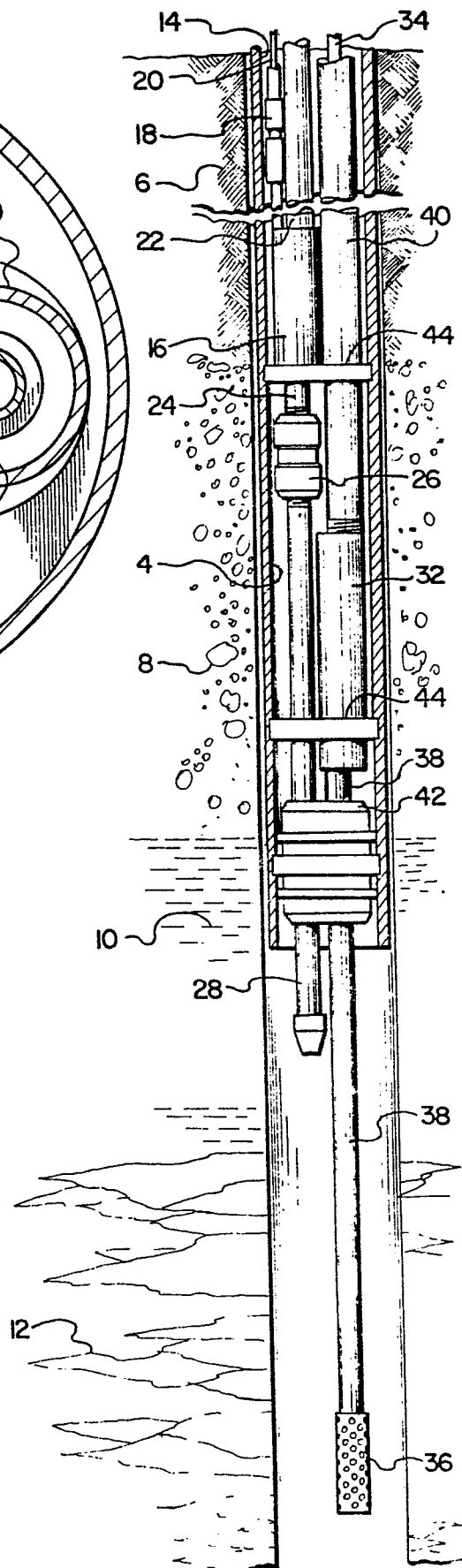


Fig. 3.