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(12) # EUROPEAN PATENT APPLICATION

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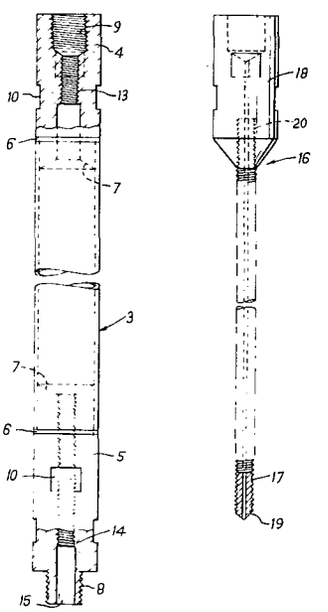
(54) **Apparatus and method for recovering ground drilling equipment in a borehole.**

(57) Drilling tubes 3 are provided with a threaded central bore 14 in coupling fittings 4, 15. An extractor 16 is provided with a complementarily thread elongate member 17 which is engageable in the bores 14 for recovery of the tubes in the event of them becoming lost under ground during drilling.



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RECOVERY OF GROUND DRILLING EQUIPMENT

The present invention relates to recovery of equipment lost underground during drilling such as rock drilling, water-well drilling and oil well drilling. Herein this equipment is referred to as "ground drilling equipment".

Ground drilling equipment includes, for a typical 4" (102 mm) diameter bore hole, a "down the hole" drilling hammer with a 4" (102 mm) diameter bit and a string of 2¾" (70 mm) diameter drilling tubes extending down from a drilling platform to the hammer. Individual drilling tubes may be 9 ft. (2750 mm) long and consist of ⅛" (3 mm) wall thickness tubing having male screw-coupling fittings at one end and female fittings at the other end. From time to time the string breaks, generally at a weld between a fitting and the tubing, or less frequently in the middle of the tubing of a tube.

Extractors exist for recovering the equipment left down the bore hole in the event of a breakage. Conventional extractors consist of a stepped cone having a screw thread on both conical portions as may be seen in Figure 1 which is a side view of a conventional extractor. When the breakage has occurred at the bottom of one drilling tube, where its tubing is welded to a fitting, the smaller conical portion 1a engages in a central bore provided in the fitting, provided for the supply of compressed air to the hammer. Although the extractor is hardened, its conical thread often fails to cut a thread in the fitting's cental bore since the fitting is itself hardened to lengthen the life of its own thread. If the fitting is successfully

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threaded, the new thread is unlikely to extend for more than two threads on account of the taper. This length of thread may well prove insufficient to lift the weight of the lost equipment.

If the breakage has occurred at the top of a tube or in the middle, the larger diameter conical portion 1b of the extractor will engage the tubing. There should be no problem with hardness here, but again only two threads may be cut, the tube being typically only approximately $\frac{1}{8}$" (3 mm) thick for $2\frac{3}{4}$" (70 mm) tubing.

The object of the invention is to improve the chances of recovering lost equipment.

According to one aspect of the invention there is provided ground drilling equipment having at least one rotatably engageable adaption which is not utilized during normal use of the equipment and which is arranged to co-operate with a complementary rotatably-engageable extractor for recovery of the equipment in the event of loss of the equipment.

According to a second aspect of the invention there is provided an extractor for recovering ground drilling equipment in accordance with the first aspect of the invention, the extractor having a rotatably engageable adaption complementary to the adaption of the drilling equipment and means including a boss for coupling the extractor to a string of drilling tubes.

According to a third aspect of the invention there is provided a method of recovering ground drilling equipment consisting in feeding an extractor of the second aspect of the invention to lost drilling equipment of the first aspect, the extractor being coupled to a recovery string of drilling tubes, engaging the rotatably engageable adaption of the lost drilling equipment with the complementary rotatably-engageable adaption of the extractor and withdrawing the recovery string of drilling tubes, the extractor and the lost drilling equipment.

For recovering a string of drilling tubes, the extractor comprises an elongate screw threaded member and a boss from which the threaded member extends. Preferably, the boss is adapted to be connected to a recovery string by means of a female thread.

For recovery with this extractor, the drilling tubes are provided with a female thread in the central bores of the fittings, the thread being complementary to that of the elongate threaded member. Although it is possible for the thread to be included in only one of the male and female fittings, the other being bored out to pass the elongate member of the extractor, it is preferred that both fittings of a drilling tube are provided with the female thread. Further, it is preferred that the male fittings are counter-bored along the axial extent of their male threads, to allow engagement of the extractor in an adjacent female fitting where a male thread has broken off.

Preferably the elongate member is of sufficient length to pass through the full length of one tube. This enables the fitting at the far end of a broken tube to be engaged when the fitting at the near end has broken off.

The end of the elongate member remote from the boss is preferably pointed to provide self-centring when a fitting is engaged. Preferably the elongate member has an axial compressed air bore. An indication of whether the extractor has engaged the lost equipment can be gained by passing air through the extractor. If it has engaged, the hammer will start operating.

To further improve the drilling tube fittings and the extractor, it is proposed that the spanner flats thereon should be shallower than the presently used flats which are machined to the extent of defining a square which is continuous in cross-section across the fittings, see flats 2 on conventional extractor shown in Figure 1. Further it is proposed that the flats at right angles to each other should be longitudinally spaced. However, conventional square section flats may be used.

It is envisaged that normally the invention will be employed in respect of drilling tubes in the range of diameters 2½" (64 mm) to 5½" (1285 mm) but it may also be employed for a larger range of drilling tubes for example 1½" (38 mm) to 8" (2040 mm).

Another equipment breakage which can occur is failure of the shock absorber in the hammer. The shock absorber connects the hammer to the drilling string with the result that the hammer is lost down the hole if the shock absorber breaks.

For recovery of the hammer, it is preferably provided with a pair of bayonet fitting slots and an extractor is provided with a complementary pair of bayonet fitting dogs.

Preferably the bayonet slots are directed in the normal direction of rotation i.e. clockwise, and the trailing edges of the slots are chamfered to keep the slots clear of drilling debris.

To help understanding of the invention, various embodiments thereof will now be described with reference to the accompanying drawings in which:

Figure 1 is a side view of a conventional extractor;

Figure 2 is a side view - partly sectioned - of a drilling tube in accordance with the invention;

Figure 3 is a side view of a drilling tube extractor in accordance with the invention;

Figure 4 is a side view of a hammer having a broken shock absorber and of a hammer extractor in accordance with the invention; and

Figure 5 is a plan view on line V-V in Figure 4.

The drilling tube 3 shown in Figure 2 has an upper female screw-coupling fitting 4 and a lower male screw-coupling fitting 5, both fittings being welded to tubing at weld 6 and having spigots 7 that extend into the tubing. It is at either of the welds 6 that the tube is most likely to fail. The male fitting 4 has a male screw threaded end 8 adapted to screw into the female screw threaded socket 9 of another tube. The fittings are hardened to prolong

the life of the threads at 8,9. The threads may be of standard Whitworth profile or rope threads for example and may be tapered. To facilitate unscrewing of joined male and female fittings they are provided with spanner flats 10 which do not extend across as much of the width of the fittings as they might to obviate the risk of jamming against a loose rock in a bored hole.

The fittings are provided with screw threaded bores 13, 14 for engagement by the extractor 15 described below with reference to Figure 3. The bore 14 in the male fitting 5 is counter-bored at 15 to ensure that should all or part of the male end 8 break away from the fitting 5, the extractor can engage in an adequate length of thread 13 in a female fitting into which the male end 8 is screwed without interference from an out of true thread in the fractured male end. As shown the thread in the female fitting 5 does not extend into the spigot 7.

As shown in Figure 3, the extractor 15 has an elongate threaded member 17 attached to a boss 18 similar to the male fitting 4 whereby the extractor may be fitted to the end of a recovery string of drilling tubes for feeding through a hole to a lost string of other drilling tubes. The member 17 may be integral with the boss 18 but is preferably threaded and possibly pinned or otherwise fitted thereto. The elongate member is of sufficient length to pass through the tube 3 to engage the thread 14 in the female fitting 5 should the male fitting come away from the tube at its weld 6. For use with 2¾" (70 mm)

diameter, 9 ft (2750 mm) long drilling tubes, the extractor is 11 ft (3355 mm) long and its elongate member is $1\frac{3}{8}$" (35 mm) in diameter. The forward end of the elongate member of the extractor is pointed at 19 to guide the tool towards the axis of a broken drilling tube in the event of the extractor reaching the tube eccentrically. A bore 20 extends along the length of the elongate member 17 to pass compressed air into the recovered string of drilling tubes. An indication of engagement of the elongate member in a thread 13, 14 of the lost equipment is provided by the compressed air working the lost drilling hammer at the far end of the lost string.

Figures 4 and 5 show a drilling hammer 21 which has been lost following fracture of its shock absorber 22 at 23, the shock absorber normally connecting the hammer to its drill string. In accordance with the invention the hammer has a pair of diametrically opposite bayonet-fitting slots 24 which are complementary to a pair of dogs 25 provided on an extractor 26. To retrieve the hammer, the tool 26 is brought into contact with the hammer and rotated until the dogs 25 engage in the slots 24. A counter bore 27 is provided in a boss of the extractor to accommodate the shock absorber. As may be seen in Figure 5 the trailing edges 28 of the slots are chamfered to obviate the accumulation of drilling debris in the slots. For the same reason the slots are directed in the direction of normal hammer rotation so that debris does not accumulate at the forward end 29 of the foot of the slots.

CLAIMS

1. Ground drilling equipment having at least one rotatably engageable adaption which is not utilized during normal use of the equipment and which is arranged to co-operate with a complementary rotatably-engageable extractor for recovery of the equipment in the event of loss of the equipment.

2. Ground drilling equipment as claimed in claim 1 wherein the equipment is a drilling tube and the rotatably engageable adaption is a screw threaded bore extending along the central axis of the tube.

3. Ground drilling equipment as claimed in claim 2 wherein the screw threaded bore is provided in a female screw-coupling fitting provided at one end of the tube.

4. Ground drilling equipment as claimed in claim 2 or claim 3 wherein the screw threaded bore is provided in a male screw-coupling fitting provided at the other end of the tube.

5. Ground drilling equipment as claimed in claim 4 wherein the screw threaded bore in the male screw-coupling fitting is counter-bored along the axial extent of the male thread of the male fitting.

6. Ground drilling equipment as claimed in any one of claims 3 to 5 wherein the or each screw-coupling fitting is provided with two pairs of spanner flats, one pair being axially spaced and set at right angles from the other pair.

7. Ground drilling equipment as claimed in claim 1 wherein the equipment is a drilling hammer and the rotatably engageable adaption is a pair of bayonet-fitting slots.

8. An extractor for recovering ground drilling equipment as claimed in any preceding claim, the extractor having a rotatably engageable adaption complementary to the adaption of the drilling equipment and means including a boss for coupling the extractor to a string of drilling tubes.

9. An extractor as claimed in claim 8 for recovering ground drilling equipment as claimed in any one of claims 2 to 6, the drilling equipment being a drilling tube, the complementary adaption of the extractor comprising an elongate member having a male screw engageable in the screw threaded bore of the drilling tube.

10. An extractor as claimed in claim 9 wherein the elongate member has an axial bore for passing compressed air.

11. An extractor as claimed in claim 8 for recovering ground drilling equipment as claimed in claim 7, the drilling equipment being a drilling hammer, the complementary adaption of the extractor comprising a pair of bayonet-fitting dogs for engaging the bayonet-fitting slots of the hammer.

12. A method of recovering ground drilling equipment consisting in feeding an extractor as claimed in claims 8 to 10 or claim 11 to lost drilling equipment as claimed in any one of claims 1 to 6 or claim 8 respectively, the extractor being coupled to a recovery string of drilling tubes, engaging the rotatably engageable adaption of the lost drilling equipment with the complementary rotatably-engageable adaption of the extractor and withdrawing the recovery string of drilling tubes, the extractor and the lost drilling equipment.

FIG. 4

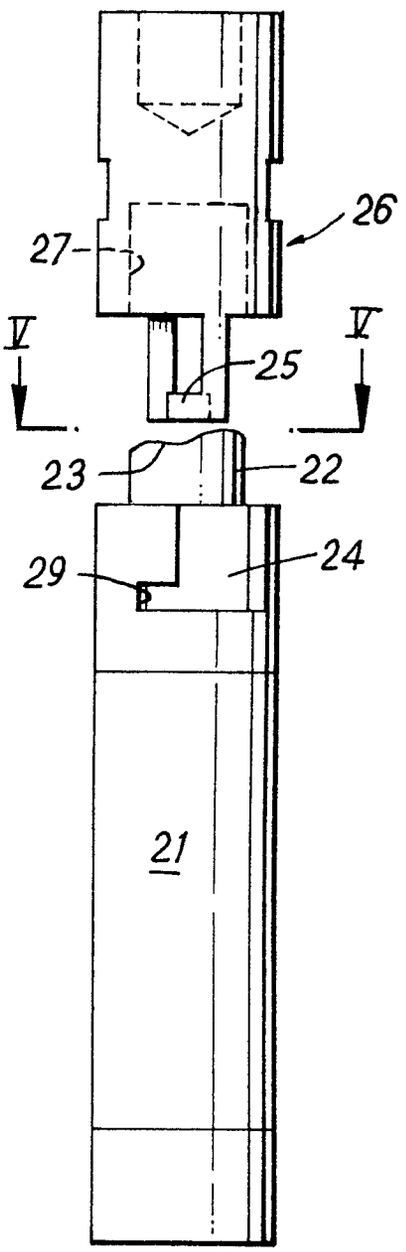


FIG. 1

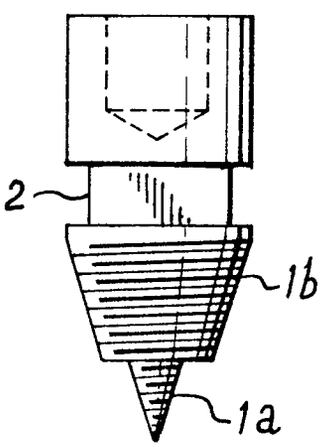
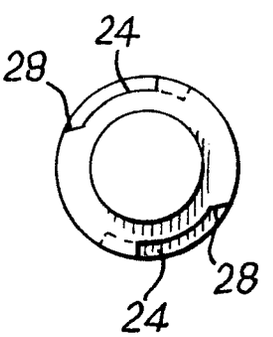


FIG. 5



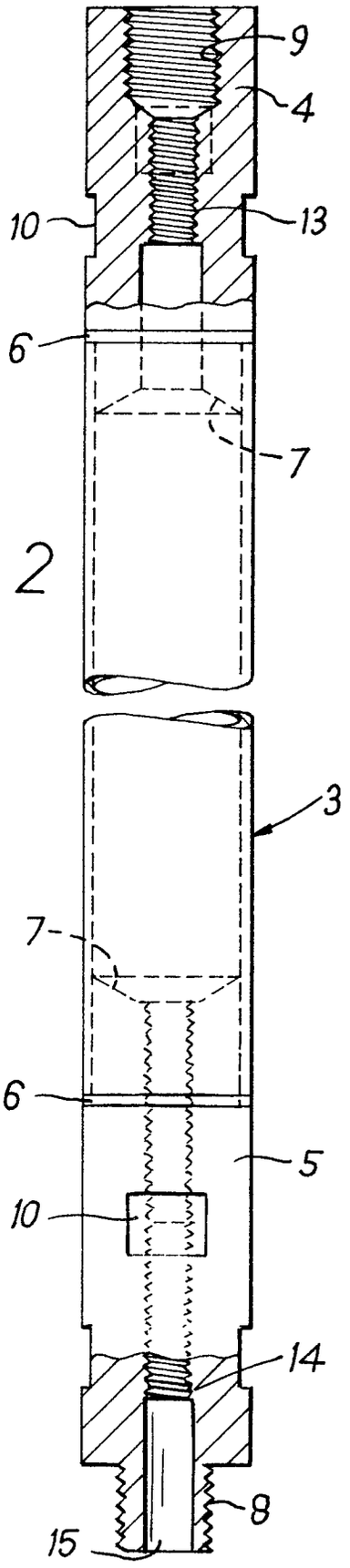


FIG. 2

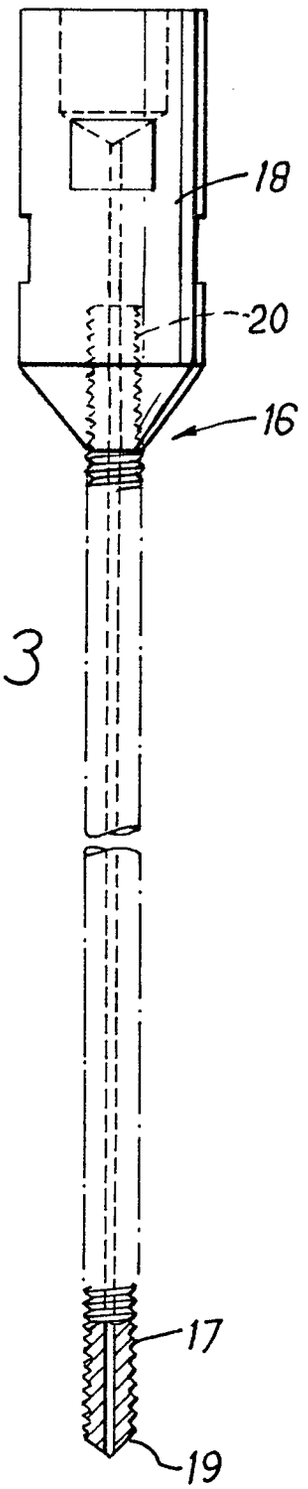


FIG. 3

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EUROPEAN SEARCH REPORT

0025650
Application number
EP 80 30 2905

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 3 667 252 (NELSON) * In its entirety *	7,11
	US - A - 3 737 189 (DARBY) * Column 2, lines 34-56 *	1-4,8-10,12
	US - A - 3 211 484 (KARLSSON) * Column 2, lines 12-17 *	6
	US - A - 1 521 482 (STEELE) * Figures 3,5; page 1, line 85 - page 2, line 35 *	1-4
	US - A - 1 469 493 (BROWN) * Claim 1 *	1,8,12
X	US - A - 2 751 019 (BAKER) * Column 3, lines 28-70 *	1,2,8,9,12
A	US - A - 2 647 008 (STEWARD)	
A	US - A - 2 947 362 (SMITH)	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

E 21 B 31/20
17/042
17/046

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

E 21 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17-12-1980	SOGNO

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