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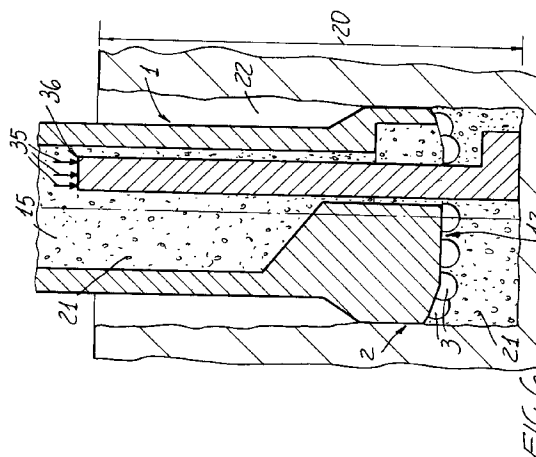
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**Method for consolidating soil and piercing bit for performing the method.**

The invention provides a method for consolidating soil comprising a soil perforating step in which the soil is perforated by a piercing bit (1), this step being preceded by a preparing step consisting of arranging inside the piercing bit (1) a reinforcing body (6), and being followed by an injection step in which into the made hole (22) there is injected a cementing mixture (21) conveyed from the inside of the piercing bit (1).

The piercing bit (1) for performing the method comprises a piercing head (2) in which there are formed one or more seats (40), by means of each of which to the piercing bit (1) there is connected a reinforcement body (6) which is released into the perforated hole (22) as the cementing mixture (21) is introduced into this hole (22).



## BACKGROUND OF THE INVENTION

The present invention relates to a method for consolidating soil and a piercing bit for performing the method.

As is known, a soil consolidation method usually comprises a step of forming, in the soil region to be consolidated, a plurality of holes, and a step of filling these holes by injecting into said holes a cementing mixture after having introduced into the hole a respective reinforcement body.

More specifically, by means of a piercing bit including a piercing or perforating head comprising a plurality of disgregating elements and arranged at one end of a tubular body connected to a mechanical drive assembly for rotatively driving the head, in the region to be consolidated there are made a plurality of holes having a set length.

If the perforating operation is performed through a comparatively compact soil, thereby the hole walls do not require supporting elements, after having performed the hole, the piercing bit is withdrawn, a reinforcement body is introduced into the hole, and then the hole is filled by injecting into said hole a suitable cementing mixture.

In other cases, the reinforcement body can be introduced into the hole after having poured into said hole the cementing mixture.

If the piercing or perforating operation, however, is performed through a crumbly soil, in order to prevent the hole wall from collapsing as the piercing bit is withdrawn from the hole, as the piercing bit is caused to advance through the hole being formed, into the latter there is also introduced a reinforcement pipe, adapted to prevent the hole wall from collapsing as the piercing bit is withdrawn.

After having made the hole and withdrawn the piercing bit, the hole is reinforced and into its inside there is poured the cementing mixture, and the hole wall supporting pipe is removed.

It should be apparent that the above disclosed method requires a lot of operating steps and, moreover, a very long time.

In order to simplify the above disclosed soil consolidating operations, there has been moreover designed an alternative, quicker, method providing for the use of a reinforcement body including a piercing bit which, in piercing a hole, simultaneously introduces into said hole a reinforcement body.

This method is actually simpler than the above disclosed method, but it has the drawback that the piercing bit is held engaged in the soil after having completed the hole and, accordingly, remains embedded in the hole upon injecting the cementing mixture and, accordingly, for each hole there is used a disposable piercing bit.

## SUMMARY OF THE INVENTION

Accordingly, the aim of the present invention is to provide a soil consolidating method and a piercing bit therefor, which allows to consolidate the soil in a very quick manner, by using a single piercing bit and introducing the reinforcement body into the hole as the latter is made.

According to one aspect of the present invention, the above aim is achieved by a method for consolidating soil which, as disclosed in the main claim, comprises a soil perforating step in which the soil is perforated by a perforating bit driven with a rotary perforating movement or a rotary-percussion perforating movement, the method being characterized in that the perforating step is preceded by a soil preparing step including arranging inside the piercing bit a reinforcement body, and being followed by an injection step in which into a made hole there is introduced from the inside of the piercing bit a cementing mixture, wherein, during the injection step, the reinforcement body is released inside the hole, by exploiting the pressure of the cementing mixture on said reinforcement body, as the piercing bit is withdrawn from said hole.

The piercing bit for performing the disclosed method comprises a piercing head, including disgregating elements, arranged at one end of a tubular body including clutch means for connecting said tubular body to a mechanical assembly for rotatively driving said tubular body, or for connecting said body to a rotary percussion driving assembly, and being characterized in that in said piercing head of said piercing bit there are formed one or more seats, each of which communicates with the inside of said tubular body, each said seat allowing a reinforcement body to be slidably coupled in said tubular body, said reinforcement body comprising an element extending in the length direction of said reinforcement body and being provided with a contoured end portion, said contoured end portion being adapted to be engaged in said seat so as to make said reinforcement body rigid with said piercing bit as said piercing bit is caused to advance along the hole being pierced thereby.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be disclosed in amore detailed way hereinafter with reference to the accompanying drawings, where:

Figure 1 is a longitudinal cross-sectional view illustrating the piercing bit according to the invention;

Figure 2 is a top plan view illustrating the bottom portion of the piercing bit shown in Figure 1;

Figure 3 illustrates the piercing bit of Figure 1 with a reinforcement element or body being introduced;

Figure 4 illustrates the piercing bit of Figure 3 with the reinforcement element in a fully introduced condition and arranged at a position assumed at the start of the perforating or piercing operation; Figure 5 illustrates the piercing bit of Figure 4 during its hole making operation; and Figure 6 illustrates the piercing bit of Figure 5 upon having completed a hole and at the start of the cementing mixture injection step.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in Figure 1, the piercing bit according to the present invention, which has been generally indicated at the reference number 1, comprises a piercing head 2 including a plurality of disgregating elements 3, including, for example, hard metal elements or widia or other suitable material small bars, said head being arranged at one end of a tubular body 4 which comprises clutch means for connecting said tubular body 4 to a rotary or rotary-percussion driving mechanical assembly, where, for simplifying the drawing, the clutch means and driving assembly have not been shown since they would be well known to one skilled in the art.

In the piercing head 2 of the piercing bit 1 there is formed a seat or recess, generally indicated at the reference number 40, and also shown in Figure 2, which communicates with the inside 5 of the tubular body 4 and in said seat, as is clearly shown in Figures 3 and 4, there is slidably engaged, inside said tubular body 4, a reinforcement body 6 comprising an extended element 7 including a contoured end portion 8.

Said contoured end portion 8, with the reinforcement body 6 being fully introduced into the piercing bit, and as is shown in Figure 9, is engaged in the seat or recess 40 and abuts against a shoulder 19 formed on the bottom of said seat 40 so as to hold the reinforcement body 6 in a set position as the soil is perforated.

Moreover, the axial length 9 of said contoured end portion 8 is less than the depth 10 of the seat 40, thereby the bottom face 11 of the reinforcement body 6, as is shown in Figure 4, does not project from the top part 12 of the piercing head 2, thereon there are applied the disgregating elements 3, thereby said top does not perform any disgregating work.

From the already mentioned figures, it should be apparent that the connection of the reinforcement body 6 in the piercing bit is a free type of connection, as it should be apparent by observing the clearance 13 between the reinforcement body 6 and the inner regions of the piercing bit in which it is engaged.

The provision of such a clearance 13 is very important since, as a hole is made, into the inside region 15 of the tubular body 4 not occupied by the reinforcement body 6 is introduced a pressurized bleeding fluid,

for example air or water, or bentonite or the like, which, by flowing through the clearance 13, in the direction 30, will arrive at the bottom of the hole 22 being formed, as shown in Figure 5, so as to facilitate the disgregating operation of the disgregating elements 3.

Sometimes the piercing operation can also be performed without using any bleeding fluid.

It should be pointed out that, during its working step, the piercing bit 1 is rotated for example in the direction shown by the arrow 14 and, possibly, being also impacted in the axial direction 31 by the above mentioned driving assembly to which the piercing bit is connected, and being simultaneously caused to descend in the vertical direction 16, whereas the material removed by the disgregating elements 3 and entrained away by the bleeding fluid, is brought to the soil surface in the direction 17 by said bleeding fluid introduced into the inner space 15 in the direction 30.

Simultaneously, during its advancement in the direction 16, the piercing bit 1 also drives the reinforcement body 6 which will follow it.

In fact, during the rotary movement of the piercing head 1, the reinforcement body 6 is also caused to turn about the axis 18 because of the abutment of its contoured end portion 8 against the side wall of the seat 40, and simultaneously said reinforcement body 6 being also downwardly urged in the direction 10 because of the abutment of the shoulder 19 of said seat against said contoured end portion 8.

As the piercing bit is arrived at the desired depth 20, as shown in Figure 6, into the free region 15 inside the tubular body 4 there is injected under pressure a cementing mixture 21 which, likewise the bleeding fluid, will flow through the clearance 13 so as to arrive at the bottom of the hole 22.

The cementing mixture 21 will provide on the head 35 of the reinforcement body 6 a pressure 36 facilitating the ejection of the reinforcement body 6 from the piercing bit 1.

Moreover such an ejection is also facilitated by the friction against the walls of the reinforcement body 6 and due to the viscosity of the cementing mixture as the latter flows through the clearance 13.

Accordingly, during the injection of the cementing mixture 21, while the reinforcement body 6 is held engaged in the hole 22 being filled with the cementing mixture, the piercing bit 6 will be withdrawn from said hole 22.

After having withdrawn the piercing bit, the hole 22 will be reinforced and filled by the cementing mixture.

To the piercing bit 1 a new reinforcement body 6 will be then connected, and the process will be repeated as desired by the user.

From the above disclosure it should be apparent that the piercing or perforating method and piercing bit according to the present invention allows to greatly

reduce the perforating time and moreover to greatly simplify the perforating work.

It should be apparent that the shape and size of the piercing bit, as well as of the seat housing the contoured end portion of the reinforcement body, can assume any desired suitable value and can be made as required.

In particular, the seat housing the contoured end portion of the reinforcement body can comprise a plurality of seats, so as to afford the possibility of simultaneously engaging in the piercing bit a lot of reinforcement bodies.

Moreover, each seat can also have an open profile instead of a closed profile as shown in the drawings.

Finally, with respect to the making direction of the holes, these holes can be oriented according to any desired directions, since the piercing bit according to the invention can make them according to any required directions.

Moreover, it should be also apparent that the reinforcement body can have any desired length, size and shape.

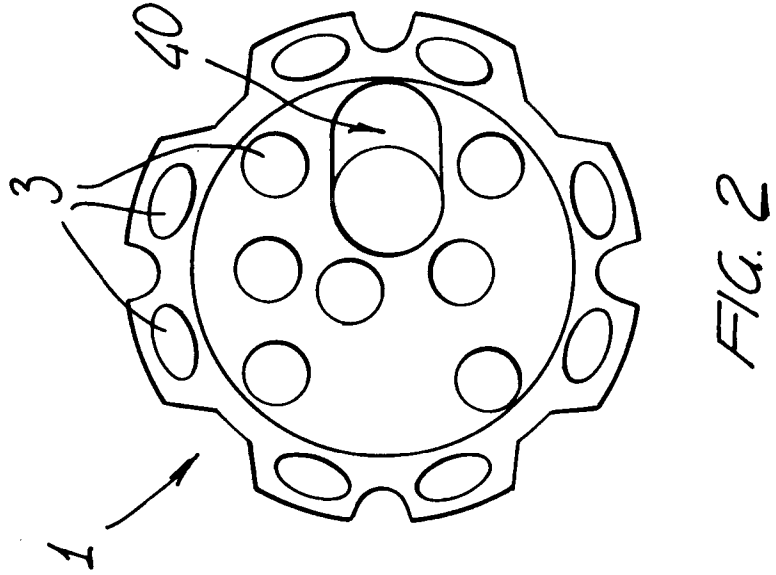
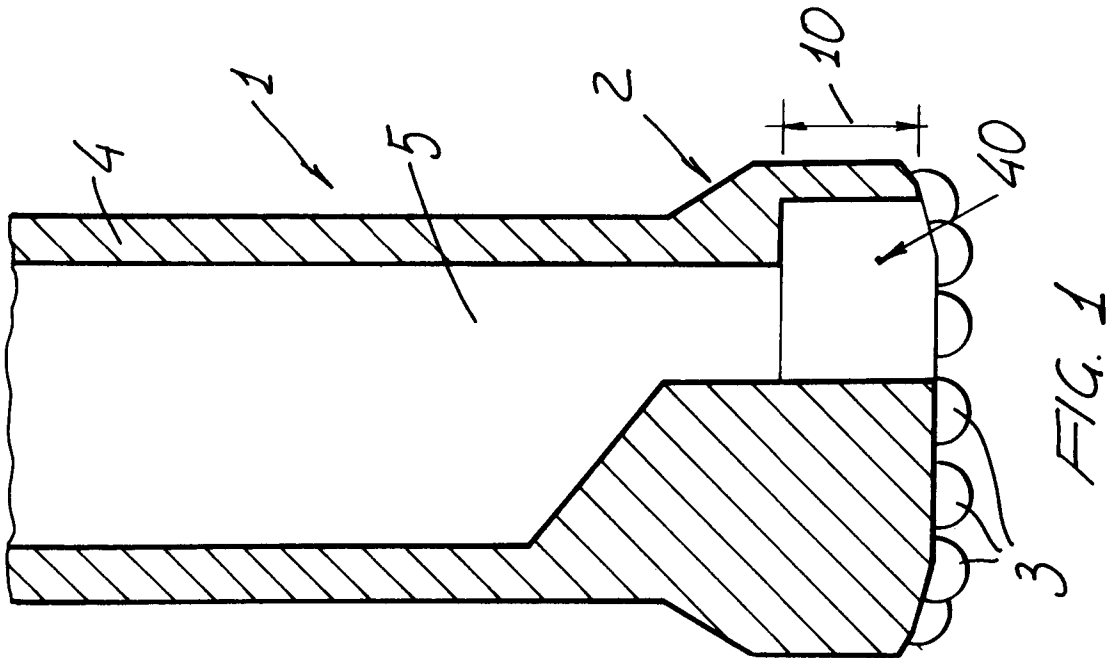
Possible constructional variations and modifications will come within the spirit and scope of the present invention.

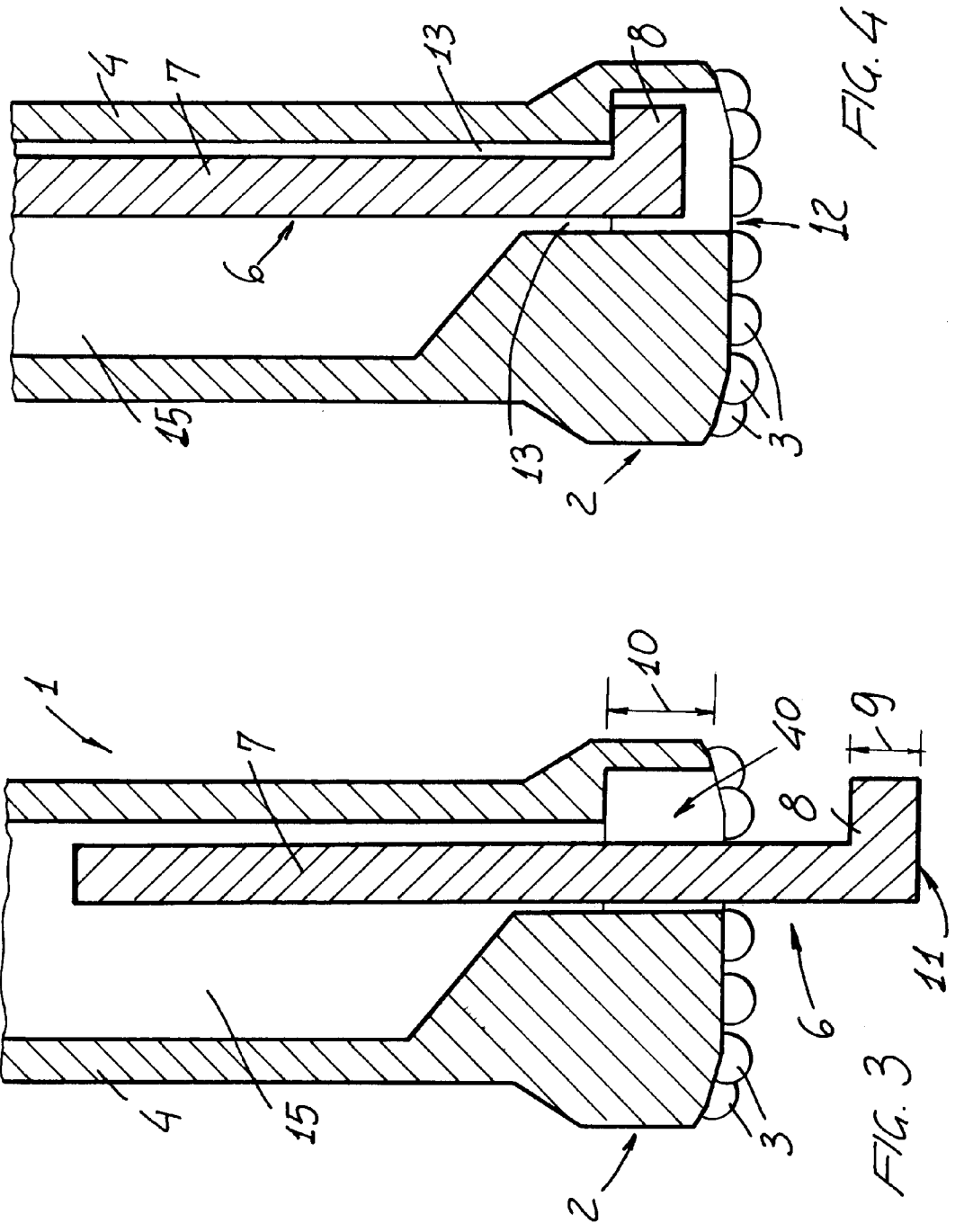
## Claims

1. A method for consolidating soil comprising a soil perforating step in which the soil is perforated by means of a piercing bit (1) driven with a rotary or rotary-percussion piercing movement, characterized in that said perforating step is preceded by a preparing step comprising arranging inside said piercing bit (1) a reinforcement body (6) and being followed by an injection step in which into a made hole (22) a cementing mixture is introduced from the inside of said piercing bit, wherein, during said injection step, said reinforcement body (6) is released into said hole (22), under the pressure of the cementing mixture on said reinforcement body (6) as the piercing bit (1) is withdrawn from said hole (22).
2. A piercing bit for carrying out the method according to Claim 1, comprising a piercing head (2) including a plurality of disgregating elements (3), arranged at an end portion of a tubular body (4) provided with connecting means for connecting said tubular body (4) to a rotary or rotary-percussion driving mechanical assembly, characterized in that in said piercing head (2) of said piercing bit (1) there are formed one or more seats (40), each of which communicates with the inside (5) of said tubular body (4), and by means of each said seat in said tubular body (4) there being slid-

ably connected a reinforcement body (6) including an extending element (7) having a contoured end portion (8), said contoured end portion (8) being provided for engaging in a said seat (40) so as to make said reinforcement body (6) rigid with said piercing bit (1) as said piercing bit is caused to advance along the hole being made.

3. A piercing bit according to Claim 2, characterized in that said contoured end portion (8) of said reinforcement body (8), as it is engaged in its corresponding seat (4), abuts against a shoulder (8) formed on the bottom of said seat (40).
4. A piercing bit according to Claim 2, characterized in that the height (10) of each seat (40) is greater than the height (9) of the contoured end portion (8) of the reinforcement body (6).
5. A piercing bit according to Claim 2, characterized in that said extending element (7) forming said reinforcement body (6) is a tubular element.





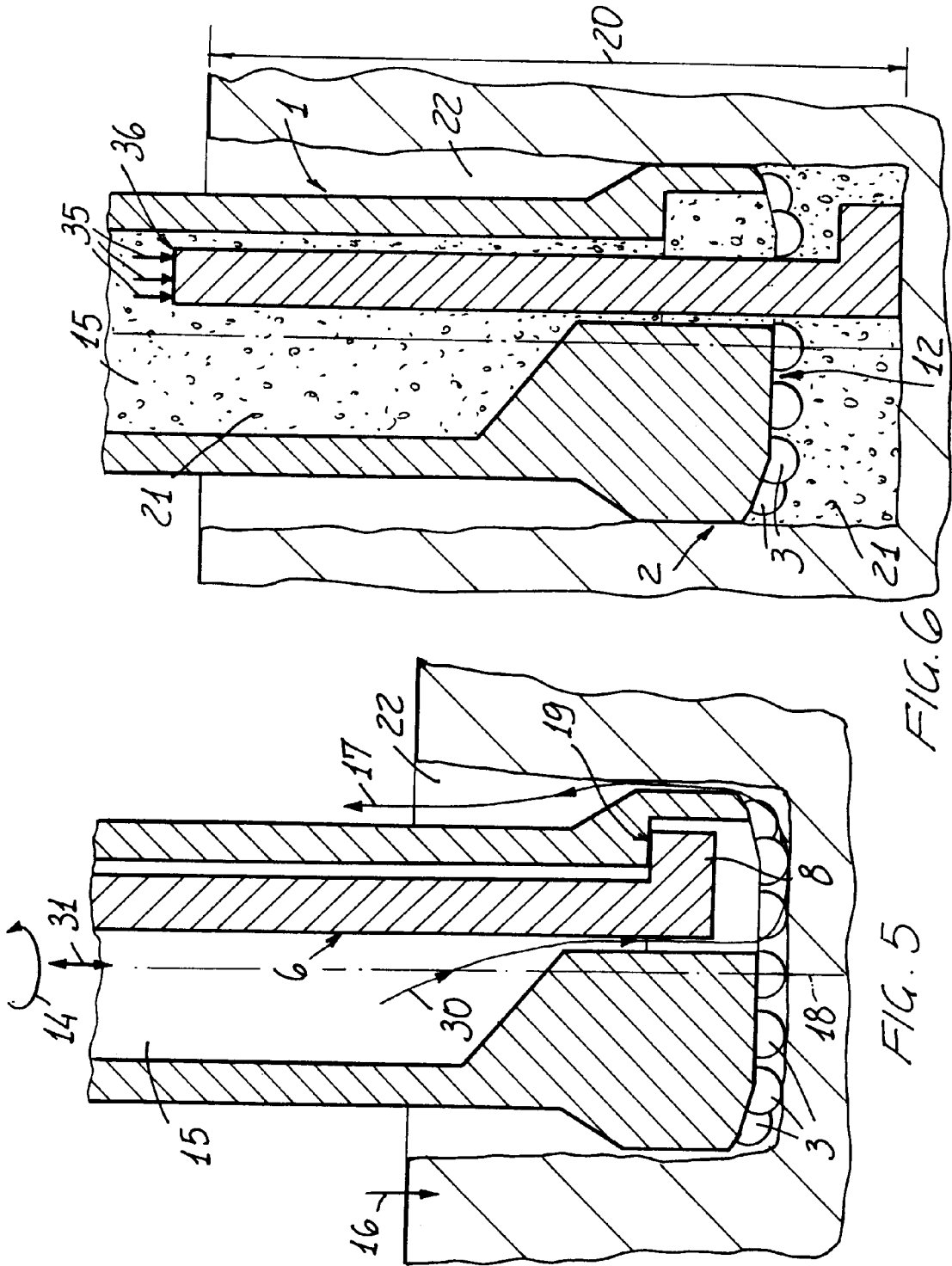


FIG. 5

FIG. 6



European Patent  
Office

EUROPEAN SEARCH REPORT

Application Number  
EP 93 83 0055

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)
X	EP-A-0 368 838 (G. SAUER) * column 3, line 26 - column 4, line 34; figures 1-3 *	1	E02D5/80 E21D21/00 E21D20/00
A	---	2,5	
X	DE-A-24 31 113 (TAKECHI KOUMUSHO) * page 5, paragraph 2 - page 6; figures 1-4 *	1	
A	---	5	
A	US-A-3 363 422 (L. TURZILLO) * the whole document *	1	
A	US-A-3 436 923 (G. LAGERSTRÖM) * abstract; figures 1,2 *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			E02D E21D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 5 November 1993	Examiner KRIEKOUKIS, S
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone                      Y : particularly relevant if combined with another document of the same category                      A : technological background                      O : non-written disclosure                      P : intermediate document</p> <p>T : theory or principle underlying the invention                      E : earlier patent document, but published on, or after the filing date                      D : document cited in the application                      L : document cited for other reasons                      &amp; : member of the same patent family, corresponding document</p>			

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