March 5, 1957 H. B. FEHLMANN 2,783,972

INSTALLATION FOR MAKING BORES IN A STRATUM

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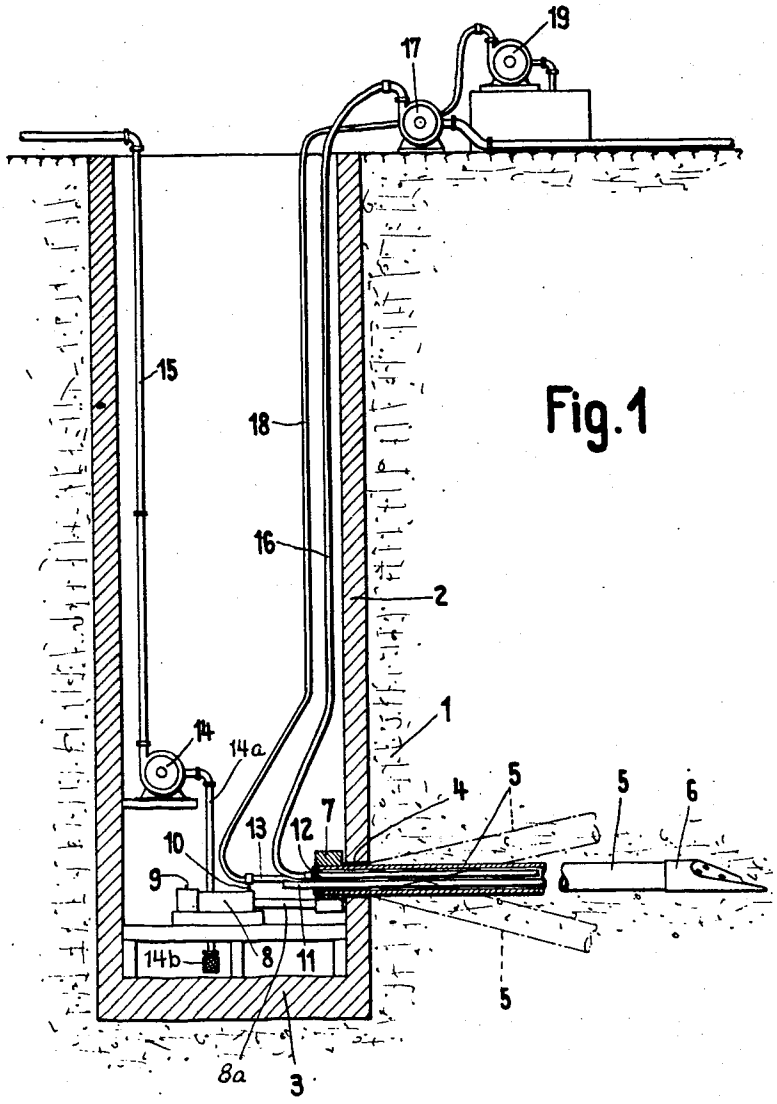


Fig.1

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Fig.2

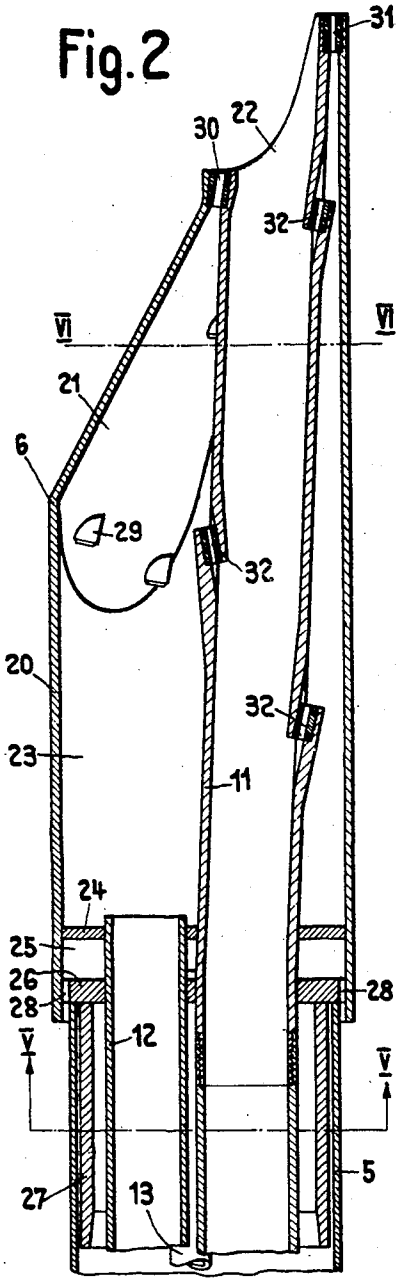


Fig.3

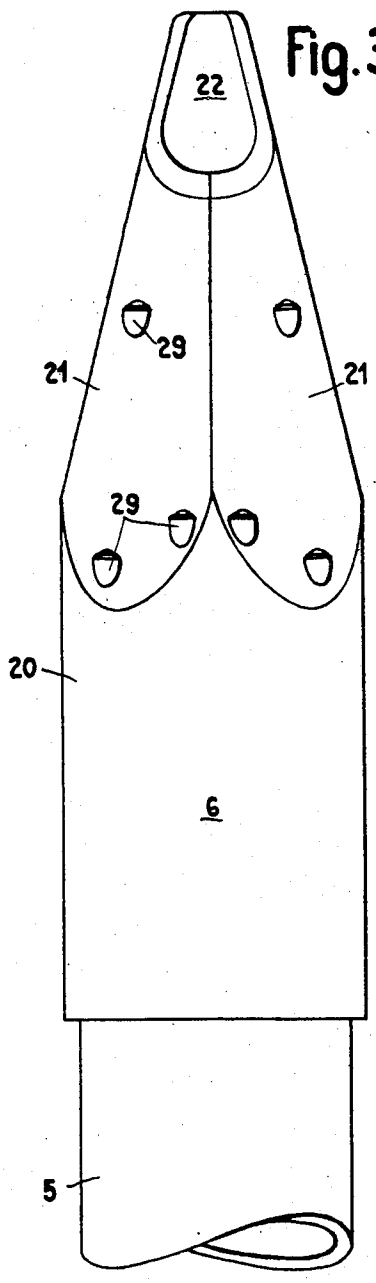


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Fig.4

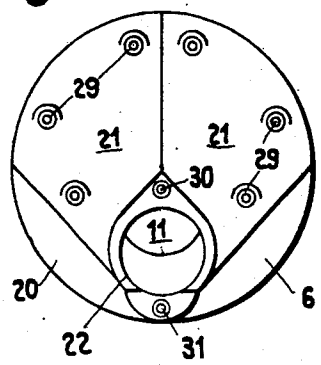


Fig.5

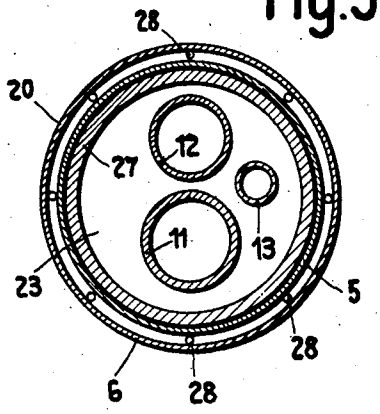


Fig.6

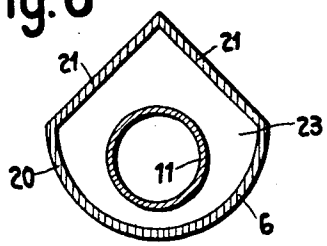


Fig.7

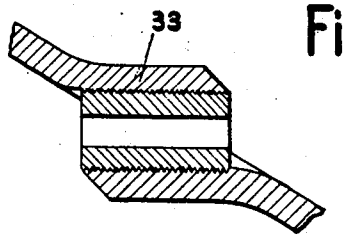


Fig.8



Fig.9

Fig.10


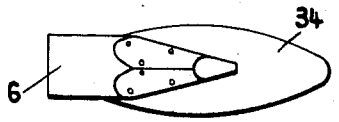


Fig.11

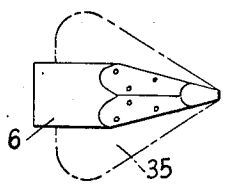


Fig.12

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2,783,972

# INSTALLATION FOR MAKING BORES IN A STRATUM

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Application February 24, 1954, Serial No. 412,343

6 Claims. (Cl. 255—24)

This invention relates to an installation for making bores in a stratum, preferably but not exclusively in a nonliquid-bearing stratum such as for instance clay, limestone and other strata of compact formation.

An object of my invention is to provide a borehole tube with a head at its fore-end to be advanced in the stratum and in which the stratum material to be removed is carried off through a scavenging pipe inside the borehole tube, and in which forwardly directed, pressure medium jets are discharged from the head.

Another object of my invention is to provide an installation for making horizontal or inclined bores in a stratum in which the stratum portion lying in front of the head and forming a compact formation is cut out and disintegrated by forwardly directed, pressure medium jets over a range corresponding to at least the larger portion of the largest cross section of the head and the head is afterwards advanced into the hollow space obtained by the cutting out and carrying away of the cut away and disintegrated stratum material.

A further object of my invention is to provide an installation for making bores in a stratum.

Another object is to provide an installation including a borehole tube, a head connected with the fore end of the borehole tube, a scavenging pipe in the borehole tube, forwardly directed jet nozzles on the head, some of these nozzles being arranged near the largest outer circumference of the head, and means in the scavenging pipe, such as for instance a backwardly directed jet nozzle or a worm conveyer for carrying off the disintegrated stratum material through the scavenging pipe.

Other objects and features will be apparent as the following description proceeds, reference being had to the accompanying drawings, illustrating by a non-restrictive way of example an installation in which

Fig. 1 is a schematic illustration of the installation,

Fig. 2 is an axial section through the head with the installation parts connected to it,

Fig. 3 is a top view of the parts shown in Fig. 2,

Fig. 4 is a front view of the head,

Fig. 5 is a section along the line V—V of Fig. 2,

Fig. 6 is a section along the line VI—VI of Fig. 2,

Fig. 7 is an axial section through a jet nozzle and through the adjacent parts of the head casing,

Figs. 8 and 9 show in a schematic way the directions of the pressure water jets emerging from the nozzles of the head,

Figs. 10, 11, and 12 illustrate modified constructions of the head.

Referring now to Fig. 1 of the drawings, a shaft 2 stands in the stratum 1 which may for instance consist of clay or limestone. Near to the shaft floor 3 the shaft wall has an opening 4 traversed by a borehole tube 5 having at its free end a head 6. The borehole tube 5 which lies horizontally but may also be inclined with regard to the axis of the shaft, is formulated of several component tubular pieces connected in a known manner by means of a schematically illustrated coupling 7 with



the piston rod 8*a* of a hydraulic press 8. The hydraulic supply lines (not shown) for the operation of the hydraulic press 8 are designated by the reference characters 9 and 10. This construction is well-known. The use of hydraulic presses is, for instance, described in U. S. Patent No. 2,550,408, where also the addition and advance of the component pieces of the borehole tube are explained. The tube 5 is made of component tubular pieces which are shorter than the diameter of the shaft 2, and, after a component piece has been advanced in the stratum, another component piece is attached in the shaft 2 to the previously advanced piece, as is well-known in the art, reference being had, for example, to U. S. Patents Nos. 2,550,408 and 2,383,496. Inside the borehole tube 5 there are a scavenging pipe 11, a pressure pipe 12 for the supply of pressure water to the head 6 and a line 13 for the supply of lubricating liquid. The scavening pipe 11 discharges into the shaft 2 and the boring sludge flowing through the pipe 11 into the shaft 2 is evacuated to the outside by the pump 14 through the pressure line 15 from a suction pipe 14*a* having a suction head 14*b*. The pressure pipe 12 is connected to a pump 17 by a conduit 16 and the tube 13 by a conduit 18 to a pump 19.

Referring to Figs. 2 to 7, the head 6 comprises a cast or welded casing 20. Above the scavenging pipe 11 the fore portion of the casing 20 has inclined intersecting surfaces 21 forming together a ridge approaching the longitudinal axis of the tube 5 towards their fore end. The fore end of the scavenging pipe 11 is welded or connected in any other way to the head casing 20, and the pipe 11 is provided with a screw coupling 11*a*. In front of the scavenging pipe 11 the head casing 20 has an intake port or scavenging opening 22 to the pipe 11. The pressure pipe 12 for the pressure water discharges into a pressure space 23 of the head 6, this space being closed at its hind end by a wall 24 traversed by scavenging pipe 11. The conduit 13 for the lubricating liquid discharges into a second pressure space 25 formed by the walls 24 and 26. A tube 27 guiding the borehole tube 5 is fixed to the wall 26 having outlet orifices 28 discharging from the pressure space 25 along the outer circumference of the borehole tube 5. The borehole tube 5 is not positively connected with the head 6 but is only applied to the head by the drive force imparted to the tube 5 during the advance of the head 6, so that on withdrawing the tube 5 the head 6 stays behind. The tubes 13, 12 and 11 are also withdrawn after having been disconnected from head 12 in a manner well-known to those skilled in the art, for instance, tubes 13 and 12 are pulled from frictional engagement with the walls of the openings in walls 24 and 26, while pipe 11 may be removed by unscrewing it from its coupling 11*a*.

On the roof surfaces 21 of the intermediate portion of the head 6 several forwardly directed jet nozzles 29 are provided in such a way that the forwardly discharged jets meet one another in one point 36 (Figs. 8 and 9) in order to increase the blast or jet effect. In the drawings (Figs. 3 and 4) three nozzles 29 are shown on each surface 21 but there may be less or more than three. Another forwardly discharging jet nozzle 30 is provided at the fore end of the ridge formed by the intersecting surfaces and still another forwardly discharging jet nozzle 31 is arranged at the tip of the head 6 beneath the scavenging pipe 11. Three nozzles 32 are mounted on the wall of the scavenging pipe 11, discharging into the pipe 11 in backward direction. There may, however, also be less or more than three nozzles 32. As shown in Fig. 7, all the nozzles 29 and 32 are screwed into eyes 33 of the head casing 20 and of the scavenging pipe wall respectively, so that they may be removed and exchanged

very easily. The portions 33 may either be cast or welded eyes.

Referring now to the constructions illustrated in Figs. 10 and 11, an even plate or shovel 34 is fixed to the lower portion of the head 6 in such a way that the lower surface of the plate 34 is flush with the lower edge of the head 6. To provide for an appropriate guide of the head 6 lateral guide wings 35 (Figure 12) may be provided instead of the plate 34 of Figure 11.

With the aid of the installation as shown and described the operation of the apparatus according to the invention may, for example, be carried out as follows:

Assuming that the head 6 and the borehole tube 5 are already in the position of Fig. 1, i. e. already partially advanced in the stratum 1. The pump 17 delivers water or another liquid at a pressure of, for instance, 25 to 100 atmospheres through the conduit 16 and the pressure tube 12 to the pressure space 23 of the head 6. The water pressure chosen in the space 23 is determined by the properties of the stratum layer or layers to be pierced through and may for instance also amount to 100 atmospheres and even more by using a pump of corresponding delivery pressure. The pressure water flows from the pressure space 23 through the forwardly discharging jet or blast nozzles 29, 30 and 31 in the shape of jets with a very high kinetic energy and these jets meet one another at least approximately in a point 36 (Figs. 8 and 9). The jets have a heavy cutting effect and break up the compact formation of the stratum portion lying in front of the head 6 and the cut away material is carried off by the water of the jets through the scavenging pipe 11 into the shaft 2 where the boring sludge is sucked off by the pump 14. The scavenging effect is considerably increased by jets of high energy emerging at the same time from the pressure space 23 through the nozzles 32 wherefrom the jets enter the scavenging pipe 11 in a direction towards the shaft 2. The jets having cut away the stratum portion attainable by them, the borehole tube 5 with the head 6 is advanced in the stratum by the hydraulic press 8 in order to bring the head 6 into the hollow space obtained by the previous disintegrating action of the jets and to advance in this way the forwardly emerging water jets and the scavenging pipe 11 to the next stratum portion to be cut away whereupon the jets cut away this further stratum portion. Advancing the head is repeated until the borehole is completed. The lubricating liquid (for instance a thixotropic liquid) delivered by the pump 19 and leaving the pressure space 25 of the head 6 through the orifices 28 along the outer wall surface of the tube 5 decreases the friction between the borehole tube 5 and the stratum 1 surrounding it. The head 6 is preferably designed in such a way that it constitutes a sealing together with the surrounding stratum, so that undue escaping of the lubricating liquid in the forward direction is prevented. For this reason, the head must have sufficient length. All the nozzles lie inside the largest head diameter. The nozzles 29 and 31 lie nearer to the outer circumference of the head 6 than to the center line of the tube 5 and of the head 6, so that the jets cut out and disintegrate a stratum portion within a range corresponding at least to the larger portion of the largest cross section of the head 6. The diameter of the pilot head 6 is not appreciably larger than the diameter of the borehole tube 5 considering that very long boreholes are often made. Assuming that the pilot head has already been advanced a considerable distance from the shaft 2, the plastic clay wall of the borehole does not remain stable but will flow against the tube 5 along a large length and exert a radial pressure and, therefore, produce a considerable frictional force against the tube 5. This frictional force can be considerably reduced by lubricant released through the orifices 28. Water from the jet nozzles cannot escape back between the clay wall and the pilot wall, because the clay presses rather firmly against the pilot wall which has a predetermined length. The borehole tube 5 is made of component tubular pieces. These pieces are shorter than the diameter of the shaft and, after a component piece has been advanced to the stratum, another component piece is fixed in the shaft 2 to the previously advanced piece. However, this feature is also well-known in the art, reference being had, for example, to U. S. Patents Nos. 2,126,576, 2,383,496 and 2,550,408, and also German Patent 687,049 of 1940.

If a head with a shovel 34 as shown in Figs. 10 and 11 is used supply of the cut away material to the scavenging pipe 11 is improved by the shovel 34. At the same time the shovel may serve the head 6 as a guide.

The intake port 22 may be smaller than shown in the drawing in order to prevent large stones from entering and clogging the scavenging pipe 11.

Instead of arranging the jet nozzles 29 to 31 in a manner to obtain convergence of the jet streams, the axes of the nozzles may be parallel to one another in order to obtain jets parallel to one another.

The pressure of the medium (liquid or gas) to be supplied to the jet or blast nozzles 29 to 31 can be chosen in such a way that even hard rock or wood can be decomposed by the jets.

In certain cases compressed gas such as, for instance, compressed air can be used instead of pressure water, especially when the stratum layer to be traversed is not completely dry.

In order to increase the cutting effect of the jets granular material such as, for instance, sand or quartz can in certain cases be added to the liquid or gas jets discharged by the nozzles 29 to 31.

Instead of advancing the borehole from a shaft, it may also be advanced directly from the soil surface in any direction desired.

The apparatus according to the invention is especially well suited for making boreholes and siphons under rivers, buildings and other constructions etc., but is not limited thereto.

Many changes may be made in the described method and installation while retaining its features and operating principles.

I claim:

1. In an installation for making bores in a stratum, a borehole tube, a hollow pilot head in abutting relationship with the fore end of the borehole tube and adapted to be driven thereby, the pilot head having fore and intermediate portions with a scavenging opening in the fore portion, the pilot head including a body member, a pair of intersecting surfaces extending from the intermediate portion of the head towards the fore end thereof and inclined downwardly at an angle to the longitudinal axis of the borehole tube, the intersection thereof forming a ridge also directed downwardly towards the longitudinal axis of the borehole tube and tapering towards the fore end of the head, means forming a lubricant chamber within the pilot head, means forming an outlet for the lubricant chamber adjacent the fore end of the borehole tube, the body member of the pilot head providing a high pressure fluid chamber, a scavenging conduit extending through the borehole tube and said chambers and terminating at said scavenging opening, a high pressure fluid supply conduit extending through the borehole tube and discharging into the high pressure fluid chamber, a lubricant supply conduit extending through the borehole tube and discharging into the lubricant chamber, at least one forwardly directed jet nozzle for the high pressure fluid chamber extending through one of the intersecting surfaces and positioned towards the intermediate portion, at least another forwardly directed jet nozzle for the high pressure chamber extending through one of the intersecting surfaces and positioned at the fore end of the ridge adjacent the scavenging opening, at least still another forwardly directed jet nozzle for the high pres-

sure chamber and positioned at the fore end of the pilot head on the opposite side of the scavenging opening with respect to the second-mentioned jet nozzle, and a backwardly directed jet nozzle for the high pressure chamber extending into the scavenging conduit.

2. In an installation for making bores in a stratum, a borehole tube, a hollow pilot head in abutting relationship with the fore end of the borehole tube and adapted to be driven thereby, the pilot head having fore and intermediate portions with a scavenging opening in the fore portion, the pilot head including a body member, a pair of intersecting surfaces extending from the intermediate portion of the head towards the fore end thereof and inclined downwardly at an angle to the longitudinal axis of the borehole tube, the intersection thereof forming a ridge also directed downwardly towards the longitudinal axis of the borehole tube and tapering towards the fore end of the head, the body member of the pilot head providing a high pressure fluid chamber, a scavenging conduit extending through the borehole tube and said chamber and terminating at said scavenging opening, a high pressure fluid supply conduit extending through the borehole tube and discharging into the high pressure fluid chamber, at least one forwardly directed jet nozzle for the high pressure fluid chamber extending through one of the pair of intersecting surfaces and positioned towards the intermediate portion, at least another forwardly directed jet nozzle for the high pressure chamber extending through one of the pair of intersecting surfaces and positioned at the fore end of the ridge adjacent the scavenging opening, at least still another forwardly directed jet nozzle for the high pressure chamber and positioned at the fore end of the pilot head on the opposite side of the scavenging opening with respect to the second-mentioned jet nozzle, and a backwardly directed jet nozzle for the high pressure chamber extending into the scavenging conduit.

3. In an installation for making bores in a stratum, a borehole tube, a hollow pilot head in abutting relationship with the fore end of the borehole tube and adapted to be driven thereby, the pilot head having fore and intermediate portions with a scavenging opening in the fore portion, the pilot head including a body member, a pair of intersecting surfaces extending from the intermediate portion of the head towards the fore end thereof and inclined downwardly at an angle to the longitudinal axis of the borehole tube, the intersection thereof forming a ridge also directed downwardly towards the longitudinal axis of the borehole tube, and tapering towards the fore end of the head, the body member of the pilot head forming a high pressure fluid chamber, a scavenging conduit extending through the borehole tube and said chamber and terminating at said scavenging opening, a high pressure fluid supply conduit extending through the borehole tube and discharging into the high pressure fluid chamber, at least one forwardly directed jet nozzle for the high pressure fluid chamber extending through one of the intersecting surfaces and positioned towards the intermediate portion, at least another forwardly directed jet nozzle for the high pressure chamber extending through one of the intersecting surfaces and positioned at the fore end of the ridge adjacent the scavenging opening, and at least still another forwardly directed jet nozzle for the high pressure chamber and positioned at the fore end of the pilot head on the opposite side of the scavenging opening with respect to the second-mentioned jet nozzle.

4. In an installation for making bores in a stratum, a borehole tube, a hollow pilot head having a fore scavenging opening disposed at the fore end of said borehole tube and adapted to be driven thereby, the pilot head having a portion tapering towards the scavenging opening, means forming a lubricant chamber within said pilot head discharging outwardly of said borehole tube, and means forming a pressure fluid chamber within said pilot head, a scavenging conduit located within said borehole tube and said chambers and in fluid communication with said scavenging opening, a pressure fluid supply conduit located within said borehole tube and discharging into said pressure fluid chamber, a lubricant supply conduit located within said borehole tube and discharging into said lubricant chamber, at least one forwardly directed jet nozzle in fluid communication with said high pressure fluid chamber and mounted on said tapered portion of the pilot head, and a backwardly directed jet nozzle on said scavenging conduit in fluid communication with said pressure fluid chamber and discharging into said scavenging conduit.

5. In an installation for making bores in a stratum, a borehole tube, a pilot head having a scavenging opening disposed at the fore end thereof and adapted to be driven by the borehole tube, means forming a pressure fluid chamber within said pilot head, a scavenging conduit located within and running longitudinally of said borehole tube and said chamber and in fluid communication with said scavenging opening, a pressure fluid supply conduit located within and running longitudinally of said borehole tube by the side of said scavenging conduit and discharging into said chamber, and a forwardly directed jet nozzle in fluid communication with said pressure fluid chamber and positioned on said pilot head.

6. In an installation for making bores in a stratum, a borehole tube, a pilot head having a scavenging opening disposed at the fore end thereof and adapted to be driven by the borehole tube, means forming a pressure fluid chamber within said pilot head, a scavenging conduit located within and running longitudinally of said borehole tube and said chamber and in fluid communication with said scavenging opening, a pressure fluid supply conduit located within and running longitudinally of said borehole tube by the side of said scavenging conduit and discharging into said chamber, a forwardly directed jet nozzle in fluid communication with said pressure fluid chamber and positioned on said pilot head, and a guide plate fixed to and extending beyond said pilot head.

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