(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 360 321 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **89202233.6**

(22) Date of filing: **04.09.89**

(51) Int. Cl.5: **E21B 7/28 , E21B 7/20 , E21B 21/08**

(30) Priority: **16.09.88 NL 8802302**

(43) Date of publication of application:
28.03.90 Bulletin 90/13

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

(71) Applicant: **VISSER & SMIT HANAB B.V.**
Industrieweg 4
NL-3351 LB Papendrecht(NL)

(72) Inventor: **Van Hees, Henk**
Industrieweg 4
NL-3351 LB Papendrecht(NL)

(74) Representative: **de Bruijn, Leendert C. et al**
Nederlandsch Octrooibureau
Scheveningseweg 82 P.O. Box 29720
NL-2502 LS 's-Gravenhage(NL)

(54) Process for laying a pipeline through an earth mass.

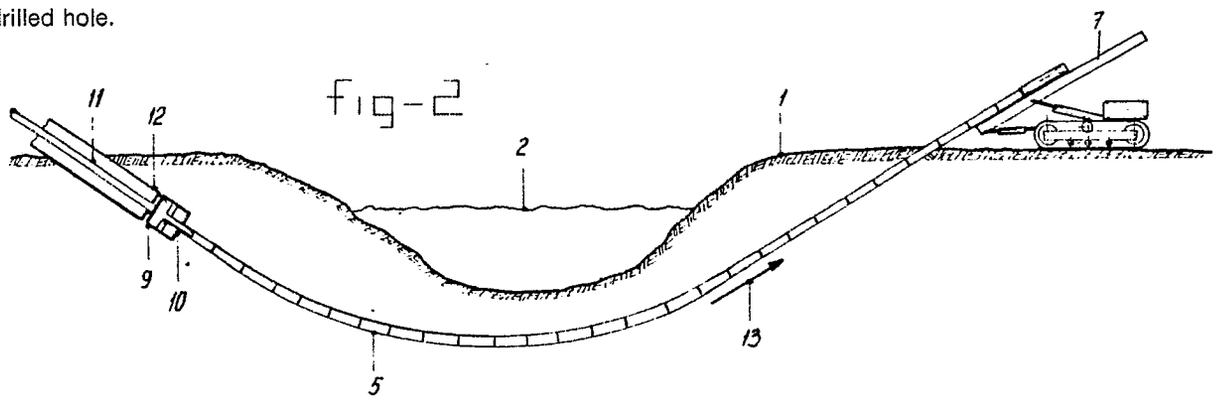
(57) Process for laying a pipeline (12) according to a curved path (3) through an earth mass(1) by first moving a drill(4) and a series of pipe sections (5) in one direction,mounting a reamer (9) to the drill and returnung in the opposite direction with the pipeline (12) connected to the reamer (9),said reamer being open at the front (10) but closed at the rear adjacent a rotational coupling with the pipeline(12) and at said closed end connected to a dichargeline(11).

During pulling of the reamer and pipeline by the drill-series water under pressure is fed to the reamer (9) and the pulling force is kept in balance with the waterpressure at the reamer (9) and the counterpressure in the dichargeline (11).

Lubrication of the outside of the pipeline is limited,sothat no lubricant,such as bentonite leaves the drilled hole.

EP 0 360 321 A1

fig-2



Process for laying a pipeline through an earth mass.

The invention relates to a process for laying a pipeline through an earth mass, in which a drill having behind it a hollow drill series is moved along a predetermined path from one side of the earth mass to the other side through rotation and axial pressure, and using a drilling mud, then after reaching the other side of the earth mass a reamer is fastened to the drill series, the diameter of said reamer being greater than that of the drill series, and the pipeline to be laid is coupled to the reamer, after which the drill series, together with the reamer and the pipeline, is pulled through the earth mass with simultaneous rotation of the reamer in a direction opposite to the direction in which the drill series was moved, at least until the reamer with the start of the pipeline has come out of the earth mass, while the earth coming away during this treatment taking place under traction is discharged, and the outside of the pipeline is lubricated using drilling mud such as bentonite.

Such a process is known from Dutch Patent Application 174293, laid open for inspection, and on which a patent has been granted. This application refers, on p. 1, para. 2, to US Patent Specification 3,878,903, from which it is known to carry out a drilling through an earth mass along a predetermined, in particular curved, path using a drill and drill series. After the mention of this US patent it is said that an effort was made by means of an experiment after drilling through the earth mass to couple a reamer of greater diameter and the pipeline to be laid to the drill series, and to pull this assembly of drill series, reamer and pipeline in the opposite direction through the earth mass. The problem occurred here that reamer and pipeline did not correctly follow the pilot hole made by the drill series.

The above-mentioned Dutch Patent Application 174293 solves this problem by pushing the assembly of drill series, reamer and pipeline from the side of the pipeline along the path of the pilot hole.

The object of the invention is then to produce a process by which the pulling of drill series, reamer and pipeline is actually possible, even when the path is curved.

This object is achieved according to the invention in that a reamer is used open at the front in the direction of drilling, which reamer is closed at the coupling to the pipeline which permits a rotation between reamer and pipeline, and is connected there to a discharge line which runs via the pipeline, in that during the pulling via the drill series or the pipeline pressurized water is fed to the reamer, while the pulling force to be exerted on the drill series is kept in balance with the water pressure at the reamer plus the counterpressure in the discharge line running through the pipeline, and in that the outside of the pipeline is lubricated, via a supply line running through the pipeline or through the drill series and emerging near the reamer, only with such a small quantity of drilling mud, such as bentonite, that during the pulling of reamer and pipeline through the earth mass and after reaching the other side of the earth mass no amount of drilling mud of any significance comes out of the earth.

While in the process known from Dutch Application 174293 use is made of a closed reamer, according to the invention a reamer which is open is used, so that the loosened earth can go into the hollow of the reamer. Pressurized water is fed into this space via the drill series or via the pipeline during pulling and rotation of the reamer, said water forming a mixture with the loosened earth which is discharged through the discharge line. This discharge line can be a hose which extends through the pipeline to be laid.

In the process described in Patent Application 174293, in which the assembly of drill series, reamer and pipeline was pushed along the path of the pilot hole, the pipeline was lubricated through the infeed of drilling mud, such as bentonite, on the outside of the reamer, with the discharge of a mixture of loosened earth with bentonite either along the outside of the pipeline or fully or partially via a discharge line upstream of the reamer on the outside of the pipeline, and running through the pipeline. However, this means that a thick layer of drilling mud, mixed with earth, is always present around the pipeline, and this mixture has to be collected at the point where the pipeline is pressed into earth. This takes up a large amount of space, is a nuisance for the environment, and requires separation of the components for possible recycling of the bentonite. The infeed of the drilling mud takes place here at high pressure, which can be harmful to the environment. It is stated that when a pipeline is being laid under a riverbed there is a risk of the earth mass being broken through, which means that drilling mud can go into the watercourse.

In the process according to the invention the loosened earth is only mixed with water, and thus not with bentonite, and this mixture is discharged separately through the pipeline and can be separated in a normal manner into earth and water by settling, as in the case of dredgings. The drilling mud, such as the bentonite, is used only for lubricating the outside of the pipeline and only a very thin film is needed for that purpose. The

supply line is therefore such that it takes into account the quantity for maintaining a lubricating film, which is determined by the advance of the pipeline into the earth mass. Bentonite does not emerge either at the beginning of the drill hole or at the end when it is reached. There is therefore no need to collect or treat bentonite.

It is very important that according to the process according to the invention at the reamer a balance is maintained between the pulling force pulling the assembly of drill series, reamer and pipeline through the earth and the water pressure present at the reamer plus the counterpressure in the discharge line. The mixture of water and earth flows into this discharge line, which results in a flow resistance in the discharge line. This flow resistance or water pressure, combined with the water pressure of the supply line, forms a pressure at the mouth of the reamer which must be such that earth with ground water from the environment cannot enter the reamer, which could lead to erosion, while on the other hand the pressure must not be so great that a disruption of the environment, such as a blow-through, could occur. This balance also ensures that the path of the pilot hole is followed.

This balance can be controlled in a simple manner by regulation of the pulling force or the water pressure. Measurements of pulling force, water pressure and line resistance can be achieved in a simple manner.

Since, however, it is desirable to work with a constant pulling force and with a constant water pressure, for the water coming out of the drill series must form the mixture of earth and water, the simplest maintenance of the balance is achieved by influencing the pressure in the discharge line. This can be achieved in a simple manner by changing the throughflow cross-section when an increase in pressure is required.

When a pressure reduction is needed, which can occur with increasing length, this can be achieved according to the invention by connecting the discharge line to a suction pump or installing a suction pump in the discharge line.

It is also possible according to the invention that while the drill series is drilling into the earth mass, and after a predetermined distance is covered, a pipe of greater diameter, and with a front end displacing the earth, is disposed over the drill series, rotatably relative to the drill series, said pipe also being lubricated with drilling mud while it is penetrating into the earth mass, and said pipe being coupled to the reamer after reaching the other side and after removal of the drill series. The pilot hole can be cleared in this way and reinforced, the pipe of larger diameter here acting as a supporting pipe. Greater lengths can be spanned in this way.

The invention also relates to a reamer for use in the process according to the invention, said reamer being provided, at the end of the drill series projecting into the reamer, with a hollow wheel, which is mounted in a freely rotatable manner on said end and has tangentially directed outflow apertures, and which is connected to the interior of the drill series. The tangentially outflowing water ensures the rotation of this wheel, and thus produces the one swirl of the earth loosened by the reamer with the water supplied, through which a more homogeneous mixture is obtained, which can be discharged through the discharge line.

The reamer can be provided at the front, instream from the teeth, with a non-return protection device, such as a non-return valve, which opens inwards. If there is a sudden upset in the balance, this protection device prevents mixture from emerging from the reamer.

The invention will now be explained in greater detail with reference to the drawings.

Fig. 1 shows schematically a first phase, known per se, of the process according to the invention.

Fig. 2 shows the next phase in the same way as Fig. 1.

Fig. 3 shows schematically on a larger scale again the connection between reamer and pipeline during the phase shown in Fig. 2.

Fig. 4 is a variant of the embodiment of Fig. 3.

Fig. 5 shows another variant of the embodiment of Fig. 3.

Fig. 6 shows schematically a part of Fig. 5.

Fig. 7 shows a variant of the phase shown in Fig. 1.

Figs. 1 and 2 show an earth mass 1 with a watercourse 2. Under the watercourse a pipeline has to be laid along the route indicated by the broken line 3. This is carried out by means of a drill series, comprising a drill head 4, which can be controlled in a known manner, and connected to it are the drill series pieces 5, comprising pipe lengths coupled to each other. One begins at 6, where constantly succeeding sections of the drill series are coupled to the series already placed in the ground and are driven in a thrusting and rotating manner by the device 7.

This is all known per se from American Patent Specification 3,878,903.

After reaching the other side at 8 the drill 4 is removed, and the front section 5 is fixed to a reamer 9, essentially comprising a cylindrical element which is provided at the front side with teeth 10 and has a connection in the rear wall for a discharge hose 11. The latter projects into the section of the pipeline 12 to be laid which is

coupled rotatably to the reamer.

After coupling with reamer and pipe section 12, the drill series is moved in the opposite direction, in the direction of the arrow 13, the reamer being rotated without the pipeline 12 being set in rotation.

The section comprising a part of the drill series, the reamer and the front part of the pipeline is shown on a larger scale in Fig. 3. Through the drill series 5 pressurized water is fed to the interior of the reamer, and this water is mixed there with the earth loosened by the teeth 10. Loosened earth and water form a mixture which is discharged via the discharge hose 11 through the pipeline.

The reamer has a diameter which is equal to or slightly greater than the diameter of the pipeline.

Via the schematically shown pipes, 14, 15 and 16 bentonite is fed in during this phase of the process according to the invention to the outside of the pipeline 12. This bentonite is applied in a thin layer, which serves solely for lubrication. This application takes place in such a quantity that no flow can take place in the lengthwise direction of the pipeline.

The pulling force which is exerted by the device 7 on the drill series must be in balance here with the infed water pressure and the flow resistance in the discharge hose 11, so that at the mouth of the reamer at 10 a pressure prevails which prevents more earth than the loosened earth from entering the reamer, or mixture from coming out of the reamer in the wrong direction.

The embodiment shown in Fig. 4 differs from that of Fig. 3 in that the supply of pressurized water takes place through a separate pipe 25, which runs parallel to the discharge line 11 through the pipeline 12, and which can have a jet nozzle or nozzles 26 directed in the direction of the discharge line.

In this embodiment the bentonite or drilling mud is supplied through the drill series 5 and transverse conduits 27, 28, which open out on the periphery of the reamer 9. This bentonite provides the lubricating film 29, just as in the embodiment of Fig. 3.

The embodiment shown in Fig. 5 differs from that of Fig. 3 in that a wheel 18 is freely rotatably mounted on the end 17 of the drill series 5 projecting into the reamer 9, said wheel having tangentially directed outflow apertures 19, as schematically indicated in Fig. 6. These apertures ensure rotation of the wheel and produce a circular flow which ensures mixing of the water with the loosened earth coming in via the reamer. The earth can be guided here by blades 20.

The embodiments shown in Figs. 3, 4 and 5 can all be provided with non-return protection devices which go into action when there is undesirable disturbance of balance, in which mixture could flow out of the reamer 9 in the wrong direction. This protection device can be in the form of one or more non-return valves (not shown) which is/are placed behind the teeth of the reamer and open inwards.

Fig. 6 shows the drill 4 whose direction is adjustable. The drill series 5 connects to the drill.

A second pipe 21, whose front end 22 is freely rotatable relative to the drill series 5 and forms a closed head there, is placed over the drill series a distance away from the drill.

The drill is lubricated by feeding in drilling mud, such as bentonite, through the pipe 23, said drilling mud flowing back out round the drill series during drilling of the pilot hole. In the variant shown in Fig. 7 this drilling mud flows round the outside of the pipe 21.

The front end of the pipe 21 is shown in Fig. 7 a short distance away from the drill. This distance can, however, be greater, for example 25 metres.

Lubrication of the second pipe 21 takes place by feeding in drilling mud, such as bentonite, through the interior of the second pipe 21, during the progress of the pipe 21 said drilling mud coming out through apertures on the front and flowing back round the outside.

Claims

1.Process for laying a pipeline through an earth mass, in which a drill having behind it a hollow drill series is moved along a predetermined path from one side of the earth mass to the other side through rotation and axial pressure, and using a drilling mud, then after reaching the other side of the earth mass a reamer is fastened to the drill series, the diameter of said reamer being greater than that of the drill series, and the pipeline to be laid is coupled to the reamer, after which the drill series, together with the reamer and the pipeline, is pulled through the earth mass with simultaneous rotation of the reamer in a direction opposite to the direction in which the drill series was moved, at least until the reamer with the start of the pipeline has come out of the earth mass, while the earth coming free during this treatment taking place under traction is discharged, and the outside of the pipeline is then lubricated using drilling mud such as bentonite, characterized in that a reamer is used which is open at the front in the direction of drilling and is closed at the coupling to the pipeline which permits a rotation between reamer and pipeline and is connected there to a discharge line which runs via the pipeline, in that during the pulling via the drill series or the pipeline pressurized water is fed to the reamer, while the pulling force to be exerted on the drill series is kept in balance with the water

pressure at the reamer plus the counterpressure in the discharge line running through the pipeline, and in that the outside of the pipeline is lubricated, via a supply line running through the pipeline or through the drill series and emerging near the reamer, only with such a small quantity of drilling mud, such as bentonite, that during the pulling of reamer and pipeline through the earth mass and after reaching the other side of the earth mass no amount of drilling mud of any significance comes out of the earth.

2.Process according to Claim 1, characterized in that the balance between pulling force, on the one hand, and water pressure plus pipe resistance, on the other, is measured by measurement of the pulling force, the water pressure, the drill series and the mixture pressure in the discharge line, and the balance is control led by influencing the pressure in the discharge line.

3.Process according to Claim 2, characterized in that for the regulation of the pressure in the discharge line use is made of a suction pump connected to or placed in the discharge line.

4.Process according to one or more of the preceding claims, characterized in that while the drill series is being introduced into the earth mass and after a predetermined distance is covered along the drill series a pipe of greater diameter and with a front end displacing the earth, is disposed over the drill series, rotatably relative to the drill series, said pipe also being lubricated with drilling mud while it is penetrating into the earth mass, and said pipe being coupled to the reamer after reaching the other side and after removal of the drill series.

5.Reamer for use in the process according to one or more of the preceding claims, characterized in that the reamer is provided, at the end of the drill series projecting therein, with a freely rotatable hollow wheel, which is mounted on said end and has tangentially directed outflow apertures, and which is connected to the interior of the drill series.

6.Reamer for use in the process according to one or more of the preceding claims, or reamer according to Claim 5, characterized in that the reamer is provided at the front side with a non-return protection device, such as a non-return valve opening inwards.

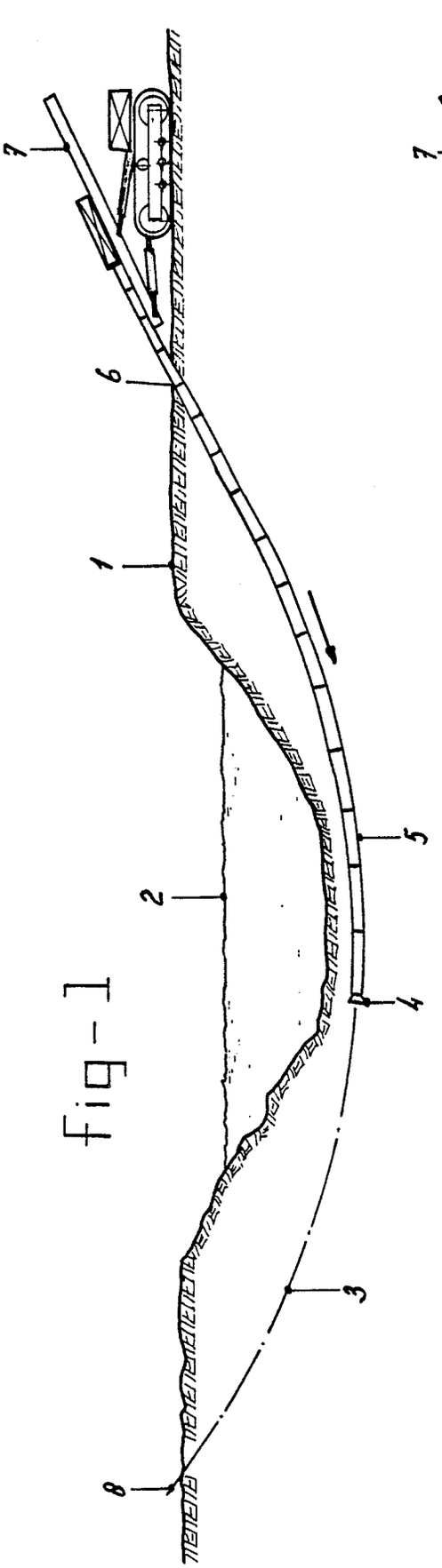


fig-1

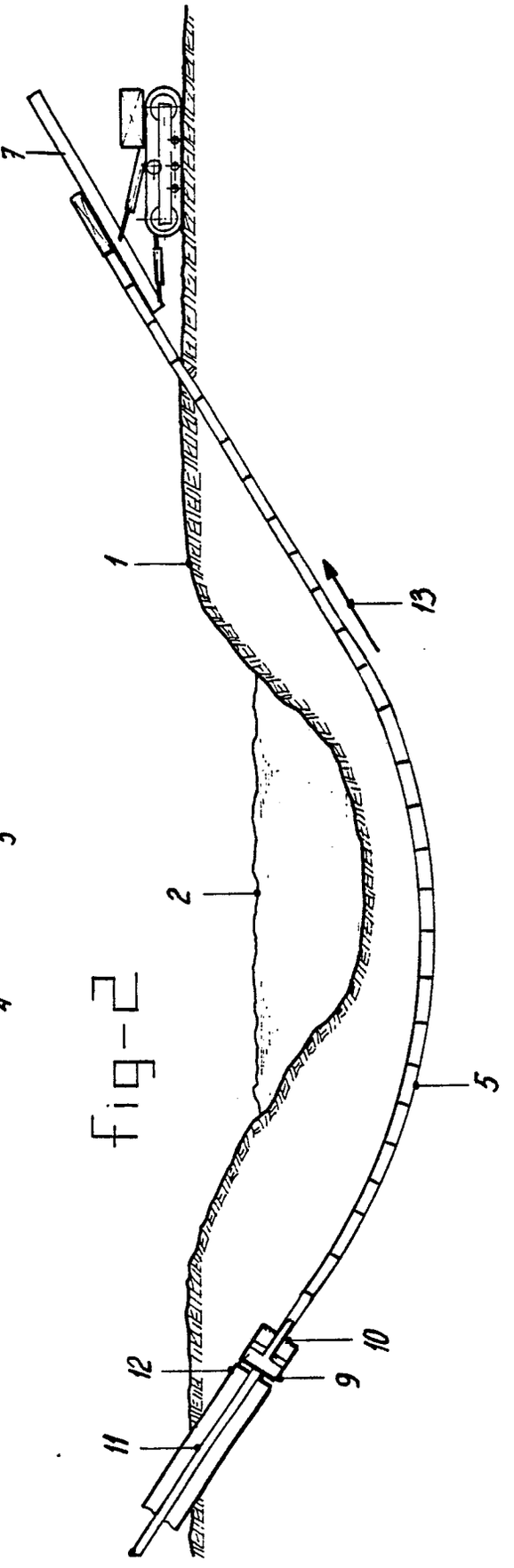


fig-2

Fig-3

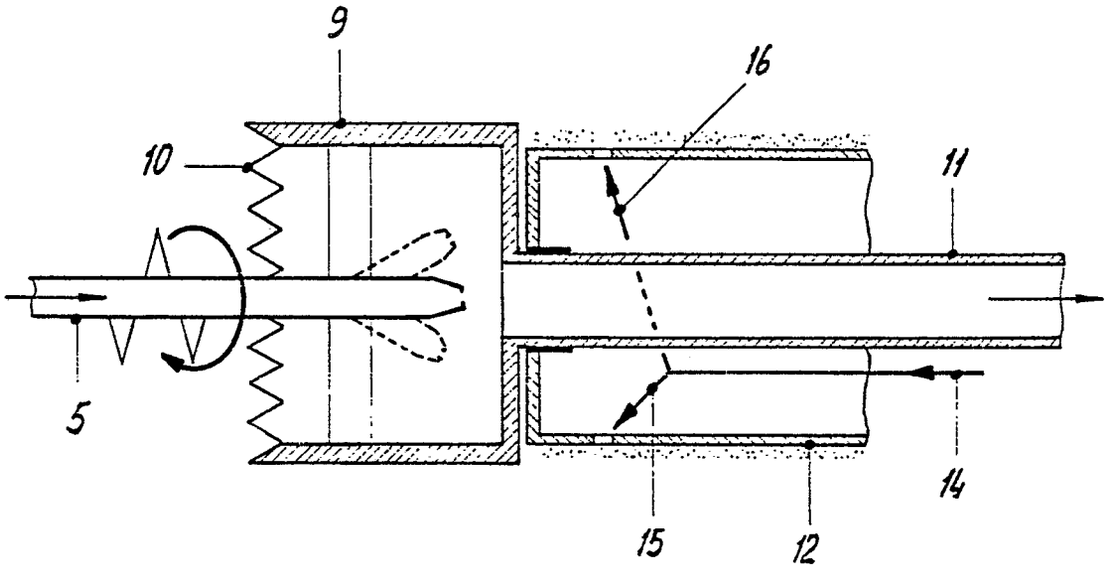


Fig-5

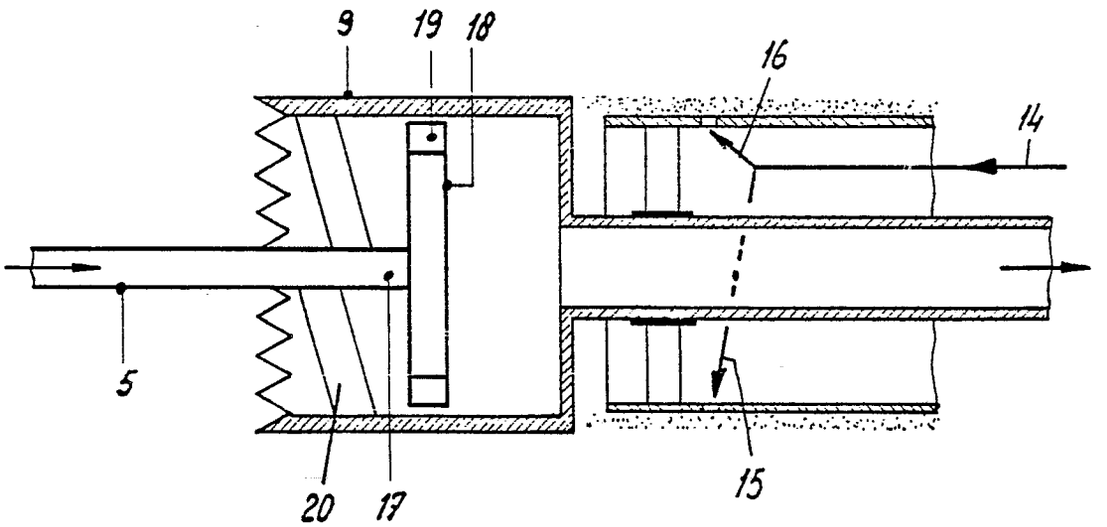


Fig-6

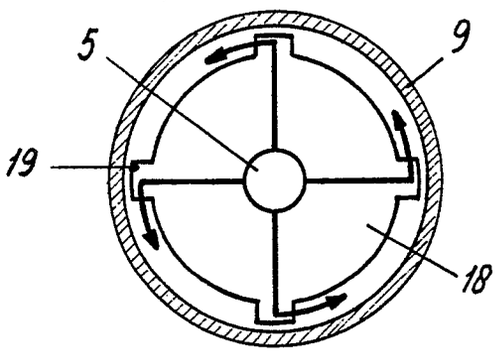


Fig-4

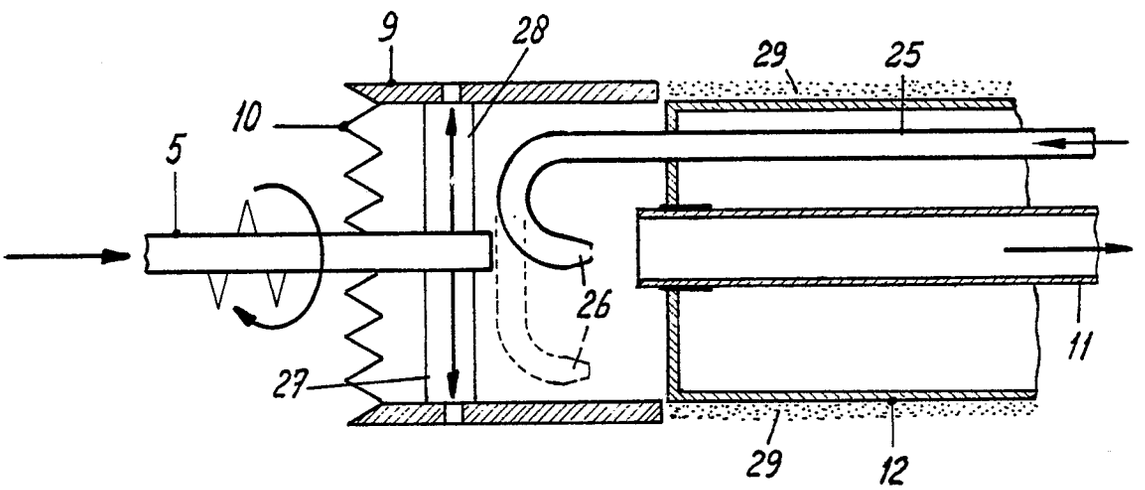
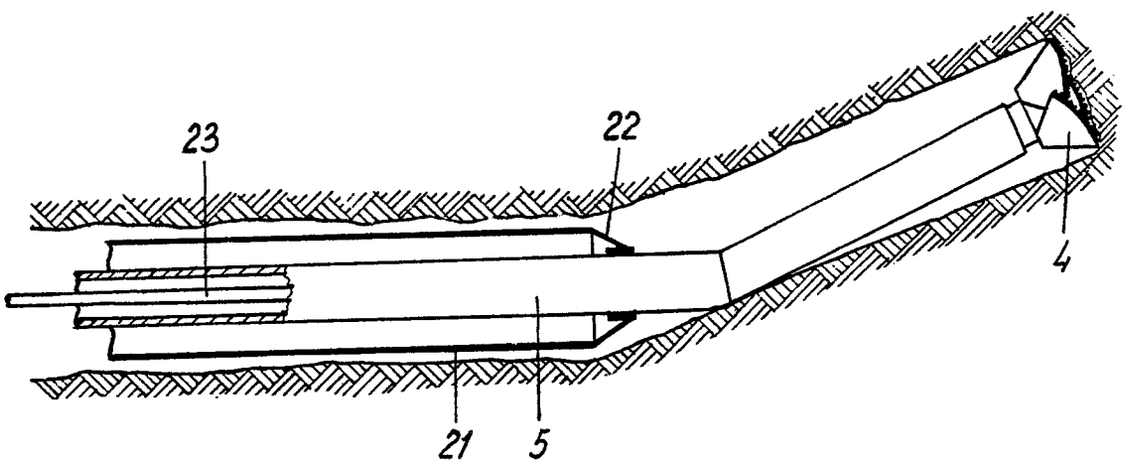


Fig - 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 20 2233

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)
A	US-A-4 176 985 (CHERRINGTON) * Abstract; figure 2; column 6, lines 27-33,44-68 *	1	E 21 B 7/28 E 21 B 7/20 E 21 B 21/08
A	WO-A-8 808 480 (HORIZONTAL DRILLING INTERN.) * Abstract; figures 1-4; page 5, line 24 - page 7, line 23 *	1	
A	US-A-4 221 503 (CHERRINGTON) * Abstract; column 16, lines 25-34 *	1	
A	NL-C- 174 293 (READING & BATES) * Figures *	1	
A	US-A-3 878 903 (CHERRINGTON)	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E 21 B 7/28

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-12-1989	WEIAND T.

CATEGORY OF CITED DOCUMENTS

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

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

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)