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(54) **Transmission system for soil examination.**

(57) Transmission system, which electrically connects a measuring head (4), being driven into the soil to signal measuring and recording means, which measuring head (4) transforms soil nature data such as of different soil layers, into electrical signals. The transmission system consists of mainly aligned pipes (2) placed one on top of the other and extending between the measuring head (4) and the signal processing means (10), and an electrical conductor system running through said aligned pipes (2), consisting of electrically conducting pins (6), one pin in each pipe. The pins (6) are electrically insulated from the electrically conducting pipe (2). Each pin (6) comprises at its ends electrical contact means (17,18) for the pins (6) in the adjacent pipes (2) and is of such length that upon placing the pipes (2) one on top of the other all pins (6) in all pipes (2) electrically contact one another, so that an uninterrupted electrical conductor is obtained.

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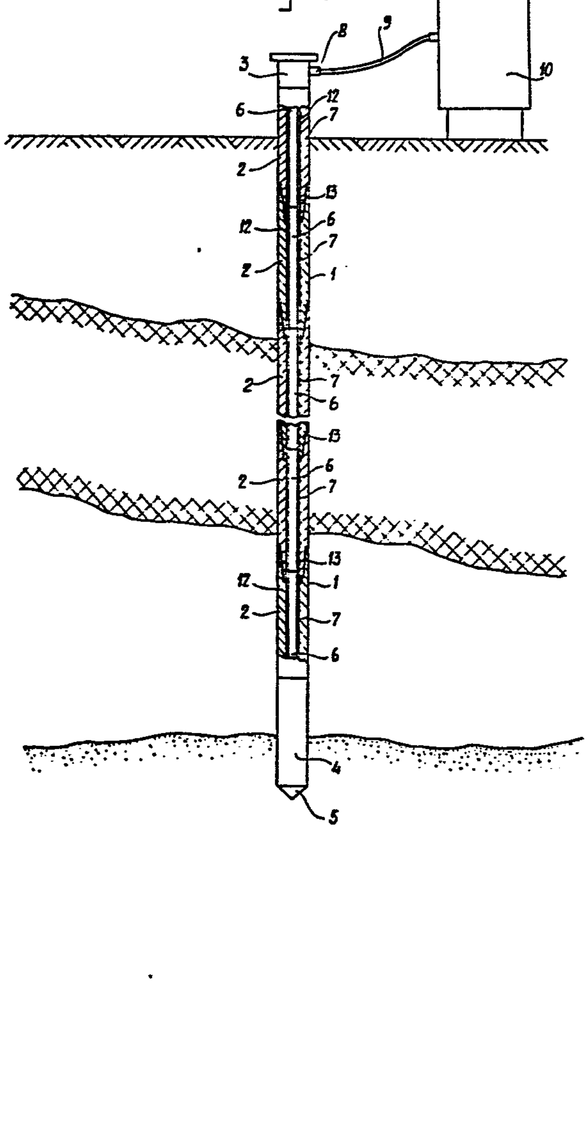
fig-1



Transmission system for soil examination.

The invention relates to a soil examination transmission system for electrically connecting a measuring head, being driven into the soil to signal processing means, such as measuring and recording means, said measuring head transforming soil nature data into electrical signals, said transmission system consisting of mainly aligned pipes placed one on top of the other and extending between the measuring head and the signal processing means, as well as an electrical conductor system running through said aligned pipes.

Lately, building activities increasingly are taking place in areas, which technically seen, are less suitable for such building activities. Therefore soil examination is increasingly indispensable. In case the soil upper surface is of insufficient carrying capability it is necessary to find a deeper soil layer, capable to take over the carrying function. In order to localize such layers of sufficient carrying capability and to ascertain the mechanical characteristics of this layer with respect to the carrying capability, several practical methods have been developed, such as pulse drilling, test ramming and sounding.

Because pulse drilling and test ramming involve high costs sounding only has been developed further.

In case of sounding a sounding cone is pressed into the soil, which cone at its front end comprises a conical end surface with a standarized top angle of 60^{o} and a base surface area of 1000 mm^{2}.

A sounding method may operate mechanically and electrically. In case of a mechanically operating system the pressure is measured, acting on an interior pin in order to press the sounding cone stepwise into the soil. This produces a cone resistance value. The said pin is surrounded by a tube, which is pressed after each time the pin has pressed the sounding cone over a certain distance into the soil. The pressure necessary to press this tube downwards is a measure for the so-called total friction over the entire length of the tube. The local friction cannot be ascertained by this method.

In case of the electrical method the steel tube is used only in order to press the sounding cone downwards. An electrical cable runs through this tube, connecting the electrical means in the measuring head, also forming the sounding cone, to the electrical measuring and recording means, generally housed in a sounding van at the surface near the measuring location. Tensile strain gages are generally used in this measuring head, which strain gages convert into electrical signals, the mechanical deformations caused by the forces acting on the measuring cone and its side surface upon pressing this cone into the soil by means of the tube. The said electrical signals are supplied to the measuring and recording means by the electrical cable. Also by means of this electrical cable it is fed the supply voltage for powering the electrical circuits in the measuring head and for the tensile strain gages. By means of last mentioned electrical sounding method also the local friction can be measured.

However, this electrical method requires much labour. The tube by means of which the measuring head/sounding cone is pressed into the soil consists of a large number of stacked pipes. The usual pipes are of a length of 1 meter and a maximum depth of the sounding cone of 20 meter is no exception. This maximum depth has to be estimated previously, after which an electrical cable having the necessary length has to be guided successively through the estimated number of pipes laid ready, for connection to the sounding cone. Among others because the pipes do not remain aligned upon pressing into the soil, there is a large possibility of calbe damage and even cable core rupture.

In connection with the above problems much search is spent on signal transmission methods without calbe, such as transmission by means of light, soundwaves and also microwaves.

Sound transmission is possible through the air in the tube or through the tube wall. However, this has the disadvantage that the sound attenuation is dependent on different conditions, which not always can be predicted and therefore can not be taken into account in the data processing. Such conditions are for instance air humidity, temperature, and tube wall material. Also in case of sound transmission interference is easily possible, for instance by external noise sources, such as engines, pumps, labour noise and even speech noise of personal and radios. This limits the sound transmission to a small sound frequency spectrum. Also battery power supply is necessary then, using a battery in the measuring head, which battery eventually will become exhausted and also needs space in the measuring head, which now cannot be used for other circuits, bearing in mind that these measuring heads generally are of relatively small dimensions.

Also transmissions by means of light through the tube interior requires a battery in the measuring head, resulting in the same above problems. Propagation of light within the tube interior may take place in the form of a straight beam, as long as the total tube has not been bent too much, or as indirect light by reflections and scattering against the tube inner wall. In practice the diversion from the straight line with a depth of 4 m is often 16 mm already, being the inner diameter of the tube. In such cases direct light beam contact between the light transmitter and light receiver is not possible. On the other hand the inner wall of the tube is far from ideal for light reflections, sothat very much light will be scattered and absorbed. The light attenuation over a certain distance is very difficult to predict. Even the use of laser light is not practical because of the light absorption and scattering at the tube inner wall. The reflection capability of the inner wall also will deteriorate by oxydation, dust deposition etc. Moreover laser light requires a very high battery power.

Micro waves require very particular conditions, which not easily can be fulfilled upon soil examination, such as polished tubes, accurate frequencies, polished contact surfaces, whilst also a battery has to be installed in the measuring head.

The above disadvantages now can be avoided by the transmission system of the present invention, which is characterized in that in each pipe it is mounted preferably coaxially an electrically conducting pin, said pin being electrically insulated from said electrically conducting pipe and having at its ends electrical contact means for the pins in the adjacent pipes and having such length that upon placing the pipes one on top of the other all pins in all pipes electrically contact one another.

The signal transmission from measuring head to the measuring and recording means now will take place by the serially connected pin conductors or by these pin conductors in combination with the tube formed by the stacked pipes surrounding the pins. This transmission can take place for instance in the form of a high frequency carrier wave, modulated by the measuring signals. The power supply of the measuring circuits in the measuring head also can take place through the pin conductors and the tube wall, using direct current or alternating current.

The transmission system of the present invention will assure under all conditions a good electrical connection with the measuring head. By pressing the measuring head / sounding cone in the soil by the pipes the used force will remove dust and oxydation layers from the electrical contact surfaces or will break off these layers, so that there will be always a low transmission resistance. A pipe-pin construction is extremely sturdy, also for storing and transport. The construction can be easily made self-centering and allows a very fast and reliable operation compared with the above said electrical method in which an uninterrupted cable previously has to be guided through all separate pipes. Now a distance of more than 30 m can be bridged without intermediate electrical amplification. As a matter of course no battery needs to be installed in the measuring head.

In a preferred embodiment of the present invention each pin is maintained movable in its longitudinal axial direction within a pipe by means of a sleeve of electrically insulating material, which sleeve closely surrounds said pin and which outer surface is held by the pipe inner surface. At least one ring can be placed around each pin, which ring will prevent said pin from sliding out of said sleeve.

In order to assure the contact pressure under all circumstances, each pin preferably comprises one end having an inner axial bore which conically narrows from said pin end and one end having a rounded off and split tip, conically decreasing in diameter towards said pin end.

In order to insulate the pins within the pipes said pipes are preferably over their total inner wall protected against contact with the pins by means of an electrically insulating lining. The pins may consist of stainless steel or copper, but also of an electrically conducting plastic or carbon. One of the main requirements is that no unbreakable oxyd layer can be formed on the contact surfaces.

The invention now will be further elucidated on the basis of the drawings showing some embodiments.

Figure 1 shows schematically the embodiment of a transmission system of the present invention upon use in soil examination;

Figure 2 shows a longitudinal cross-section of an embodiment of a pipe, comprising a coaxial pin for the transmission system of the present invention.

In figure 1 reference number 1 refers to a schematic section of a total transmission system of the present invention, comprising separate, stacked pipes 2, which in this practical embodiment each may be of a length of 1 meter. These pipes 2 are pressed from above into the soil by means of the pushing head 3, by tools not shown. At the lower end of the pipe assembly forming the transmission system there is shown the connected measuring head 4 with sounding cone 5. The cross-section of figure 1 also shows different earth layers, passed by the transmission system.

Each pipe 2 comprises a coaxial pin 6, kept in place by a schematically shown tube 7 of electrically insulating material. Each pin comprises a conical end and a counter conical end, forming contact surfaces but also forming the means for keeping these pins mechanically aligned upon pressing the measuring head 4 into the soil. In order that also pipes 2 remain in line upon pressing into the soil these pipe ends also are suitably conically machined.

Upon pressing down the pushing head 3 the pressure force is exerted through all stacked pipes 2 on the measuring head 4 and sounding cone 5.

The pushing head 3 comprises a connector for a plug 8 for connecting a cable 9, leading to the measuring and recording means in the casing 10. Generally this casing 10 will be installed in a sounding van, which also comprises the means for driving the measuring head 4 into the soil through the pushing head 3.

Each time after the uppermost pipe 2 is pressed into the soil over a certain length the pushing head 3 is removed from its top and a new pipe 2 with coaxial pin 6 is placed upon the foregoing pipe. After that the pushing head 3 is placed on the upper end of this new pipe 2 again. Because of the construction of the separate pipes 2 and pushing head 3, hereafter the electrical connection between measuring and recording means in casing 10 and measuring head 4 will be restored immediately.

Figure 2 shows a longitudinal cross-section of an embodiment of one of the pipes in figure 1. As a matter of course the transmission system of the present invention is not limited to this specific pipe shown here. This pipe 2 comprises in this embodiment a relatively thick pipe wall, on the inner surface of which it is applied an electrically insulated lining 11, covering the whole cilindrical inner surface of pipe 2. Coaxially within this pipe 2 the steel pin 6 is shown, kept in place by an electrically insulating sleeve 7. Around this pin 6 a resilient ring 12 is applied, which keeps this pin 6 in position within pipe 2. As soon as pipe 2 and pin 6 is placed on a foregoing pipe the weight of pin 6 gives sufficient contact pressure between the succeeding pins 6. Preferably also a pressure spring is used in the pushing head 3, which presses the contact within this pushing head 3 on the upper contact end of the first underlaying pin and, moreover, will give sufficient contact pressure for lower contact surfaces between the succeeding pins. For the pins located lower in the transmission system the weight of the stacked pins will contribute to a good electrical contact.

At the ends of pipe 2 an extern (13) and intern (14) conical contact surface is formed, respectively. The conical inner surface 14 will receive the conical outer surface 13 of the foregoing pipe 2, so that these pipes remain as much as possible aligned upon pressing into the soil.

For the same reason the ends of the pins 6 have been conically shaped. At the upper end in figure 2 a conical rounded off pin 16 has been machined, in which saw cuts 17 can be applied in order to remove by resilient action dust upon stacking pins 6. At the lower end a conical axial bore 18 has been formed having a conical angle such, that upon stacking pins 6 an optimum contact surface with the conical tip end 16 is obtained. By using this embodiment this contact is maintained also in case the stacked pins 6 do not remain in line. This is not imaginary, because upon driving into the soil the pipes 2 may bend in their conical coupling means 13, 14. Also when deviating from the purely straight longitudinal direction the electrical connection remains optimum. Generally the pipe is placed such, that the conical rounded off tip will be at the upper side, though this is not necessary.

In the pushing head 3 as well as in the measuring head 4 a part of a pin 6 can be mounted. In the pushing head 3 this part may consist of a lower half of pin 6 in figure 2 having a conical bore 18, whilst in the measuring head 4 the pin portion may consist of an upper half of pin 6 having a conically rounded off tip 16.

In the measuring head 4, which does not form a part of the present invention and which is used in the above discussed electrical measuring method already, tensile strain gages are used, measuring the deformations of predetermined surfaces, e.g. the surface of the sounding cone 5, by means of which the point pressure can be ascertained and the surface of the sides of the measuring heads 4 by means of which the local friction can be measured.

These tensile strain gages preferably form part of an electrical bridge circuit, by means of which the resistance variation as a function of their elongation can be measured. The tensile strain gages may be powered by direct current, however, in connection with drift alternating current is preferred. This alternating current can be supplied to the measuring head 4 through the transmission system of the present invention, but also can be generated in the measuring head 4 by means of a direct current supply, for the supply of which also pins 6 and pipes 2 can be used. The tensile strain gages may be change e.g. the frequency by changing their impedance.

These measuring frequencies are used preferably for the modulation of a high frequency carrier wave, which also can be generated within the measuring head 4. For the modulation use can be made of amplitude modulation and frequency modulation, which last way of modulation is preferred because frequency modulation is more interference proof.

For the transmission of this modulated carrier wave from the measuring head 4 to the pushing head 3, the transmission system of the present invention can be seen as a coaxial high frequency transmission cable or as a long line having a certain impedance. This impedance and mutual capacity as well as self-induction can be derived from the dimensions of the pipes 2 and pins 6. Using a length for each pipe of 1 meter, an outer diameter for the pins 6 of 12 mm and an inner diameter of the pipes 2 of 16 mm and using the usual p.v.c. materials for the insulation, neglecting the ohmic resistance of the metal of the pipes and pins, a capacitive impedance of 0.85 nF is obtained for frequencies between 1 kHz and 2 MHz. Therefore each pipe section operates as a capacitor.

In the transmission channel interfering voltages may be generated by variations of resistance and capacity by vibrations upon pressing the transmission channel into the soil. These interfering voltages can be seen as side bands of the carrier wave. These side bands can be blocked by means of suitable filters, so that the side bands do not influence the measuring procedure. Because the transmission channel is coaxial, the influence of external electrical and magnetic fields will be very small. In order to avoid transmission resistances between the pins by oxydation the pin ends may be chrom-plated, however, also use can be made of stainless steel or copper pins.

Because no longitudinal pressure will be exerted on the pins, apart from the pressure of their own weight, these pins can be made from electrically conducting plastic material or may consist of a plastic pin, in which a conductor is inbedded. This plastic pin should contain contact means at its ends. The pin ends, having bare contact means, may be inbedded in a soft resilient plastic material, not interfering the contact pressure between opposite stacked bare pin contacts. Because of the specific characteristics of carbon the pins also can be made of this material.

For the signal processing use can be made of analogous but also of digital technics.

It will be self-evident, that the invention is not limited to the above discussed specific embodiment, shown in the accompanying drawings, but that amendments and modifications can be made without departing from the scope of the present invention.

CLAIMS

1. Soil examination transmission system for electrically connecting a measuring head, being driven into the soil to signal processing means, such as measuring and recording means, said measuring head transforming soil nature data into electrical signals, said transmission system consisting of mainly aligned pipes placed one on top of the other and extending between the measuring head and the signal processing means, as well as an electrical conductor system running through said aligned pipes, characterized in, that in each pipe it is mounted preferably coaxially an electrically conducting pin, said pin being electrically insulated from said electrically conducting pipe and having at its ends electrical contact means for the pins in the adjacent pipes and having such length that upon placing the pipes one on top of the other all pins in all pipes electrically contact one another.

2. Transmission system as claimed in claim 1, characterized in, that each pin in each pipe is maintained movable in its longitudinal axial direction by a sleeve of electrically insulating material, said sleeve closely surrounding said pin, its outer surface being held by the pipe inner surface.

3. Transmission system as claimed in claim 2, characterized in, that at least one ring is unslidingly mounted around each pin, said ring preventing said pin from sliding out of said sleeve.

4. Transmission system as claimed in one of claims 2 or 3, characterized in, that each pin comprises one end having an inner axial bore, conically narrowing from said pin end, and one end having a rounded off and slit tip, conically decreasing in diameter towards said pin end.

5. Transmission system as claimed in one of the foregoing claims, characterized in, that each pipe comprises one end having a conical inner surface narrowing from said pipe end and one end having a conical outer surface decreasing in diameter towards said pipe end.

6. Transmission system as claimed in one of the foregoing claims, characterized in, that each pipe comprises an inner lining of electrically insulating material.

7. Transmission system as claimed in claim 1, characterized in, that the electrically conducting pin is moulded in the pipe in electrically insulating material and having ends comprising resilient contact means.

8. Transmission system as claimed in claim 7, characterized in, that the electrically conducting pin is moulded in a hardened plastic material, the pin contact ends being moulded in an elastic plastic material.

9. Transmission system as claimed in claims 2 - 6, characterized in, that the pins consist of stainless steel.

10. Transmission system as claimed in claims 2 - 6, characterized in, that the pins consist of copper.

11. Transmission system as claimed in claims 2 - 6, characterized in, that the pins consist of an electrically conducting plastic material.

12. Transmission system as claimed in claims 2 - 6, characterized in, that the pins consist of carbon.

13. Pipe for using in a transmission system of the present invention, comprising means as claimed in at least one of the foregoing claims.

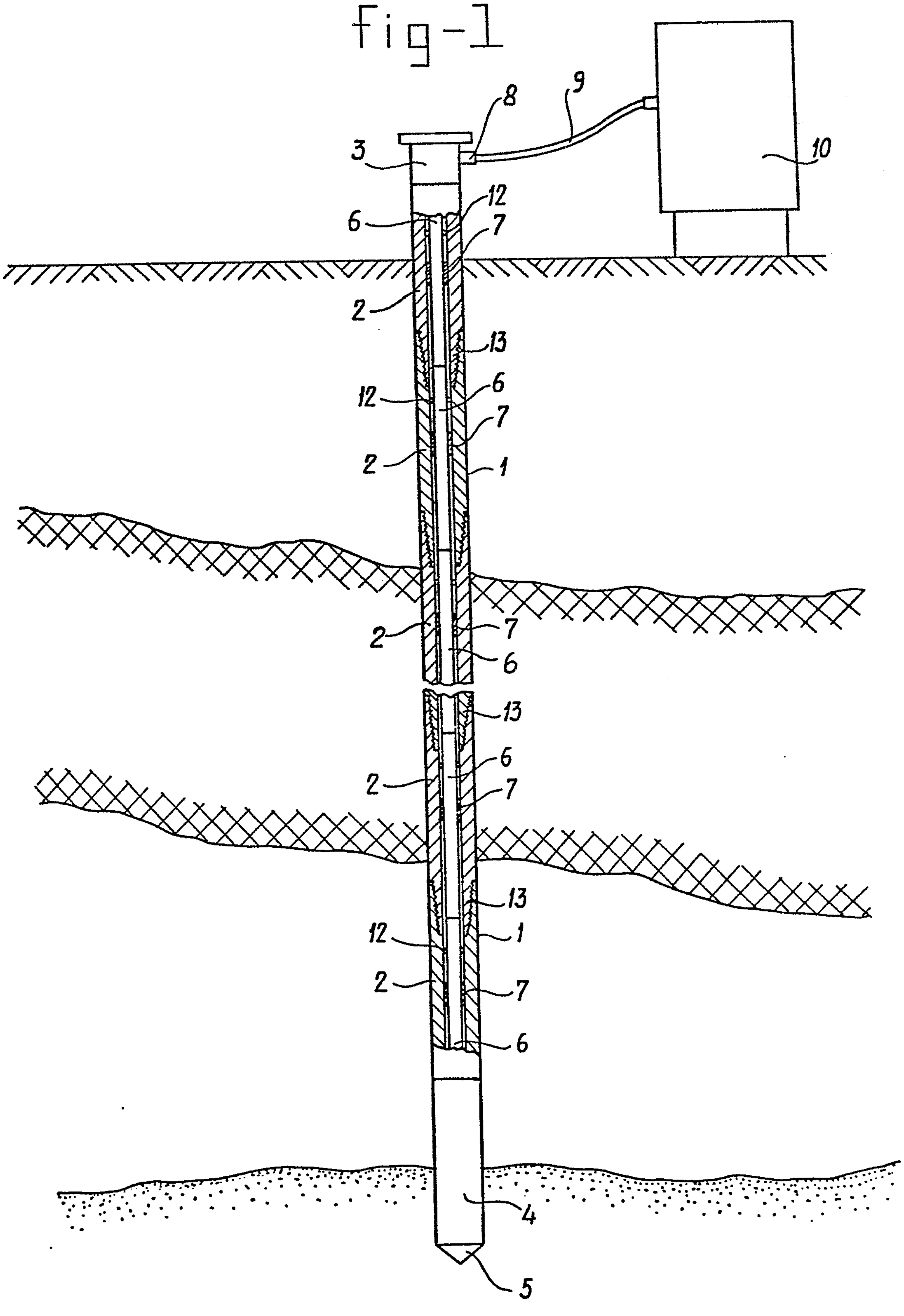
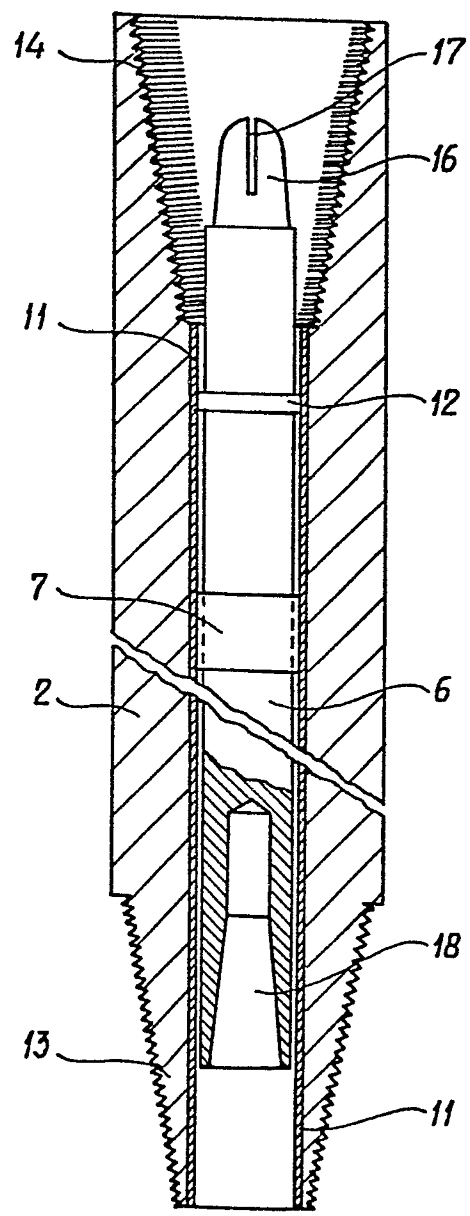


Fig-1

fig-2



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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 83 20 1253

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. ³)
X	DE-A-2 545 692 (DORNIER SYSTEM) * Page 9, last paragraph; page 10, lines 7-10; page 11; page 12; page 13, lines 1-18; page 14, paragraph 2,4; page 15; page 16; figures 1-5 *	1-5,7	E 02 D 1/02 E 21 B 17/02 H 01 R 31/00

A	US-A-2 531 120 (FEASTER) * Column 4, lines 7-75; column 5, lines 1-22; figures 1-4 *	1,7,8	

A	FR-A-2 359 358 (FERODO)		

A	US-A-3 866 678 (JETER)		

			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			E 02 D E 21 B H 01 R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-11-1983	RUYMBEKE L.G.M.

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
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