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Description

Background of the Invention

The present invention relates to a method and a system for embedding a pipe under ground, and more particularly to a method and a system for embedding a pipe of relatively small diameter under ground.

In embedding a pipe of 800 mm or less in diameter under ground, the conventional open cut method has now been replaced by the propelling method in which a pipe to be embedded is propelled by a drive unit such as a hydraulic cylinder installed in a working pit.

The propelling method includes two types. One is the pressing system in which the rear or backward end of the pipe to be embedded is pressed and propelled while compacting the soil at the forward end of the pipe, and the other is the augering system in which the rear end of the pipe to be embedded is driven while the soil at the forward end of the pipe is augered by rotating an auger mounted in the pipe by a drive unit in a working pit. The pressing system, which is generally used for a weak ground, requires a strong propelling force, and exerts a great force on the pipe so that the pipe is liable to be damaged. Further, the pipe tends to be displaced from a position to be embedded so that orientation accuracy is relatively low. The augering system has the disadvantages that an additional auger is required to be joined each time a succeeding pipe is joined, thereby making operation complicated. Examples of such prior art proposals for embedding a pipe underground by propelling the pipe from the rear end thereof while forming a hole by pressing or augering or other cutting operations are disclosed in DE—A—1634637 and DE—A1—2701066.

In U.S.—A—3688511 there is disclosed a method of embedding a pipe by connecting a leading head to the pipe to be embedded, and causing pulsating movement of the leading head. This patent specification also discloses an apparatus for embedding a pipe, comprising vibration heading means connected to the pipe to be embedded, the vibration heading means having a body connected to the pipe and vibrator means for causing pulsating movement of the body. In this prior method and apparatus the pulsating movement of the head is caused by directing a jet of a mixture of water and air through a nozzle having alternate contractions and expansions to the exterior of the head, the pulsating jet so caused generating oscillations of the head to facilitate its movement through the ground. This apparatus is not suitable for use in accurately embedding a rigid pipe at a depth beneath the surface of the ground due to the irregularity of the oscillations caused by the flush jetting of a mixture of water and air from the head which will affect the accuracy of the orientation of the pipe.

An object of the present invention is to provide a method and an apparatus by means of which a rigid pipe can be embedded underground whilst

being accurately orientated, a relatively small propelling force only being needed to force the pipe through the ground. Because of possibly using small propelling forces the possibility of damage to the pipe during the embedding process is minimised.

The method of the present invention is particularly characterized in that the pulsating movement of the leading head is a rotational movement of the central axis of the leading head around the longitudinal axis of the pipe, and a propelling force is applied to the backward end of the pipe while the leading head axis is being rotated so as to drive the pipe into the earth, transmission of the pulsating movement of the leading head to the pipe being damped by a vibration insulator forming a connection between the leading head and the pipe thereby substantially to prevent vibration due to the rotational movement of the head axis about the pipe axis from being transmitted to the pipe.

The vibration of the leading head provided at the forward end of the pipe to be embedded causes vibration of the earth in the vicinity of the forward end of the leading head. As a result, the arrangement of soil particles of the earth is disturbed so that the soil particles are mobilized thereby to reduce the strength of the earth. In this way, it is possible to easily propel the pipe with a small propelling force.

By vibrating the leading head by rotation of the central axis of the leading head around the longitudinal axis of the pipe a gap is formed between the leading head and the earth. As a result, the gap is formed between the pipe to be embedded and the surrounding earth, so that the frictional resistance of the earth acting on the pipe is greatly reduced, thereby reducing the propelling force to be exerted on the rear end of the pipe. In other words, when the leading head is vibrated laterally by revolution, not only the strength of the earth in the vicinity of the forward end of the leading head is decreased, but also the frictional resistance of the earth acting on the pipe is reduced, thus remarkably reducing the propelling force.

The vibration of the leading head is substantially prevented from being transmitting to the pipe to be embedded by the provision of the vibration insulator as the connection between the head and the pipe. This protects the rigid pipe from being subjected to lateral forces which might otherwise damage it.

Moreover, the pipe embedding method according to the present invention preferably further comprises the step of discharging from the leading head a liquid for reducing the strength of the earth and converting the earth into slurry. Said liquid may be water.

The apparatus of the present invention, is particularly characterized in that said vibrator means comprises a shaft rotatably mounted within said body and carrying an eccentric weight and means for rotating the shaft, drive means is associated with said backward end of the pipe for applying a

propelling force to the pipe from the backward end thereof so as to drive the pipe into earth, and vibration insulator means is connected between the vibration heading means and the forward end of the pipe to damp transmission to the pipe of movement of the body caused by rotation of the shaft and eccentric weight.

Moreover, the pipe embedding means according to the present invention preferably comprises means for supplying the earth adjacent to the vibration heading means with a liquid for reducing the strength of the earth and converting the earth into slurry. Said liquid supply means may include at least one liquid supply port formed in the body of said vibration heading means.

Brief Description of the Drawings

Fig. 1 is a schematic view showing a system for embedding a pipe under ground.

Fig. 2 is a longitudinal sectional view of the vibration heading unit making up part of the pipe embedding system shown in Fig. 1.

Figs. 3(a) to 3(d) are diagrams for explaining the principle of the pipe embedding method.

Fig. 4 is a schematic view similar to Fig. 1, showing an embodiment of the apparatus for implementing the pipe embedding method according to the present invention.

Fig. 5 is a sectional view of the vibration heading unit making up part of the pipe-embedding apparatus shown in Fig. 4.

Fig. 6 is a sectional view similar to Fig. 5 but showing the concrete structure of the vibration insulator shown in Fig. 5.

Fig. 7 is a diagram for explaining the operation of the vibration insulator shown in Fig. 6.

Fig. 8 is a sectional view similar to Fig. 6, showing another structure of the vibration insulator.

Fig. 9 is a schematic view similar to Fig. 1, showing another embodiment of the apparatus for implementing the pipe embedding method according to the present invention.

Fig. 10 is a sectional view of the vibration heading unit making up part of the pipe embedding apparatus shown in Fig. 9.

Fig. 11 is a sectional view taken along line VIII—VIII in Fig. 10.

Description of the Preferred Embodiments

With reference to Fig. 1, a system for implementing a method of embedding a pipe under ground is generally designated by reference numeral 2. The pipe embedding system 2 comprises a vibration heading unit 8 connected to a forward end 6 of a pipe 4 to be embedded under ground and a drive unit 12 associated with a backward end 10 of the pipe 4 for applying the propelling force to the pipe 4 from the backward end 10 thereby to drive the pipe 4 into earth 14.

In the system shown in the drawing, the pipe 4 to be embedded under ground includes three pipe elements 16, 18 and 20, and the drive unit 12 includes a hydraulic cylinder 24 installed within a working pit 22 provided in the earth 14.

As shown in Fig. 2, the vibration heading unit 8 preferably includes a body 26 connected to the forward end 6 of the pipe 4 to provide a leading head for the pipe 4, and a vibrator 28 for vibrating the body 26. The vibrator 28 includes an eccentric shaft 30 rotatably mounted within the body 26. The eccentric shaft 30 includes an eccentric weight 32 and is covered with a casing 34. The eccentric shaft 30 is rotated by a motor 36, which is connected through power supply lines 38 to a power source (not shown) arranged in the working pit 22.

In this pipe-embedding system, upon rotation of the motor 36, the eccentric shaft 30 of the vibrator 28 is rotated so that the centrifugal force of the eccentric weight 32 causes the lateral vibration of the body 26 of the vibration heading unit 8 in which, as shown in Figs. 3(a) to 3(d), the central axis O_1 of the body 26 revolves around the longitudinal axis O_2 of the pipe 4. Thus the strength of the earth in the vicinity of the forward end of the body 26 is reduced, and at the same time a gap ϵ is formed between the body 26 and pipe 4 and the earth 14, thereby reducing the frictional resistance of the earth 14 acting on the vibration heading unit 8 and the pipe 4. As a result, by applying only a small propelling force to the pipe 4 from the backward end 10 by the hydraulic cylinder 24, it is possible to drive the pipe 4 into the earth 14.

As described above, the method and the system for embedding a pipe under ground have the advantages that the propelling force to be applied to the pipe from the backward end thereof is considerably saved, and since a force exerted on the pipe is small, the pipe to be embedded is not likely to be damaged and it is possible to embed a pipe with high accuracy of orientation. Further, no additional operation is required when a succeeding pipe is joined, and therefore it is possible to improve the working efficiency and simplify the construction.

An embodiment of the apparatus for carrying out the method of embedding a pipe under ground according to the present invention will be described with reference to Figs. 4 and 5. The pipe embedding system shown in the drawings is generally designated by numeral 40, and component elements similar to those shown in Figs. 1 and 2 are denoted by like reference numerals respectively.

The pipe embedding apparatus 40 further comprises a vibration insulator 42 inserted between the vibration heading unit 8 and the forward end 6 of the pipe 4 to be embedded under ground. The vibration insulator 42 is adapted to cut off the vibration in the direction perpendicular to the central axis thereof, namely, the lateral vibration, while allowing transmitting of the force in the axial direction thereof. Numeral 44 designates a connector for facilitating connection between the pipe 4 and the vibration insulator 42.

In this pipe embedding apparatus 40, upon rotation of the motor 36, as in Fig. 1 and 2, the centrifugal force of the eccentric weight 32 causes

the central axis of the body 26 of the vibration heading unit 8 to revolve around the longitudinal axis of the pipe 4 to be embedded under ground, so that the vibration is applied to the earth 14 in the vicinity of the forward end of the body 26, thus reducing the strength of the earth. At the same time, a gap is formed between the vibration heading unit 8 and pipe 4 and the surrounding earth 14 thereby to greatly reduce the frictional resistance of the earth acting on the vibration heading unit 8 and the pipe 4. As a result, the propelling force to be applied to the pipe 4 from the backward end 10 of the pipe may be reduced. Further, since the vibration insulator 42 is interposed between the vibration heading unit 8 and the pipe 4, the vibration of the unit 8 is not transmitted to the pipe 4, thus preventing damage of the pipe 4. Also, the vibration insulator allows the object to be vibrated by the vibrator 28 to be limited to the vibration heading unit 8 and the pipe 4 is not vibrated, and therefore it is possible to reduce the vibrating force of the vibrator 28 and use a smaller size of the vibrator 28.

In the embodiment described with reference to Figs. 4 and 5, the vibration insulator 42 can take a concrete form as shown in Fig. 6. In this form, the vibration insulator 42 comprises a plurality of rods 46 of a relatively small diameter each having opposed ends rigidly connected to the body 26 of the vibration heading unit 8 and the connector 44, respectively. The rods 46 are equidistantly spaced from each other and circumferentially arranged about the central axis of the body 26.

In this vibration insulator 42, the lateral rigidity is relatively small and therefore when the body 26 of the unit 8 is laterally vibrated, the insulator 42 can be easily deformed as shown in Fig. 7 by broken lines thereby to reduce or damp the vibration transmitted to the pipe 4 to be embedded under ground, while the longitudinal rigidity of the insulator 42 is relatively large, and therefore the propelling force transmitted through the pipe 4 can be positively transmitted to the body 26 of the vibration heading unit 8.

The vibration insulator 42 can take an alternative structure as shown in Fig. 8. In this structure, the vibration insulator 42 comprises a cylindrical extension 48 of the body 26 of the vibration heading unit 8 at the rear end thereof, a cylindrical extension 50 of the connector 44 at the front end thereof, and a plurality of small diameter rods 52 each having opposed ends rigidly connected to the extensions 48 and 50, respectively. The rods 52 are equidistantly spaced from each other and circumferentially arranged about the central axis of the body 26.

In this vibration insulator 42, when the propelling force by the drive hydraulic cylinder 24 is transmitted to the rods 52, it acts on the rods 52 as tensile force, and therefore buckling of the rods 52 does not occur even if the diameter of each rod 52 becomes further smaller to reduce the lateral rigidity of the vibration insulator 42 thereby to enhance the ability of insulating lateral vibration. Thus it is possible to reduce the lateral rigidity of

the vibration insulator 42 and increase the longitudinal rigidity thereof, thereby allowing transmitting a large propelling force.

Additionally, the vibration insulator 42 may be provided with a cover for preventing soil from entering into the interior of the insulator 42.

A still further embodiment of the apparatus for carrying out the method of embedding a pipe under ground according to the present invention will be explained with reference to Figs. 9 to 11. The apparatus according to this embodiment is generally designated by reference numeral 60 and those component elements similar to those shown in Figs. 1 and 2 and Figs. 4 and 5 are denoted by like reference numerals, respectively.

The pipe embedding apparatus 60 further comprises means 62 for supplying the earth adjacent to the vibration heading unit 8 with a liquid for reducing the strength of the earth and converting the earth into slurry. This liquid supply means 62 includes liquid supply ports 64 formed in the forward end of the body 26 of the vibration heading unit 8, which liquid supply ports 64 are connected through liquid supply hoses 66 to a liquid supply source (not shown) such as a pump provided in the working pit 22. The working pit 22 contains a slurry pool 68.

This pipe embedding apparatus 60 operates in such a manner than upon rotation of the motor 36, the centrifugal force of the eccentric weight 32 causes the central axis of the body 26 to revolve around the longitudinal axis of the pipe 4 to be embedded as in the aforementioned embodiment. A liquid such as water is supplied to the liquid supply ports 64 through the liquid supply hoses 66, and the water is then supplied to the earth 14 adjacent to the forward end of the vibration heading unit 8. The earth 14 in the vicinity of the forward end of the vibration heading unit 8 is vibrated while water penetrates soil particles of the earth, thus greatly reducing the strength of the earth 14. At the same time, the earth 14 in the vicinity of the forward end of the vibration heading unit 8 is mixed with water and rapidly connected into slurry. Further, in view of the fact that the above-mentioned revolution of the vibration heading unit 8 forms a gap between the vibration heading unit 8 and pipe 4 and the earth 14, the slurry 70 formed in the vicinity of the forward end of the vibration heading unit 8 flows out to the working pit 22 through the gap and is received in the slurry pool 68. In this way, the slurry 70 formed in the vicinity of the forward end of the vibration heading unit 8 flows out through the gap between the vibration heading unit 8 and pipe 4 and the surrounding earth 14, and therefore the surrounding resistance including the frictional force and the adhesion between the vibration heading unit 8 and pipe 4 and the surrounding earth 14 is reduced substantially to zero. The result is that the propelling force to be applied to the pipe 4 from the backward end 10 thereof is greatly reduced.

In the case, the pipe is to be driven into the ground of fine soils, water may be used as the

liquid to be discharged by way of the liquid supply port 64. When the earth mainly contains coarse soils, however, bentonite solution may preferably be used as the earth is effectively converted into slurry and the resulting slurry flows out to the working pit more easily.

Claims

1. A method of embedding a pipe (4) by connecting a leading head (8) to the pipe (4) to be embedded, and causing pulsating movement of the leading head (8), characterized in that the pipe is located with forward and backward ends (6, 10) under ground and the leading head is coaxially connected to the forward end (6) of the pipe (4), the pulsating movement of the leading head (8) is a rotational movement of the central axis (O_2) of the leading head (8) around the longitudinal axis (O_1) of the pipe (4), and a propelling force is applied to the backward end (10) of the pipe (4) while the leading head axis is being rotated so as to drive the pipe into the earth, transmission of the pulsating movement of the leading head to the pipe being damped by a vibration insulator forming the connection (42) between the leading head and the pipe thereby substantially to prevent vibration due to the rotational movement of the head axis about the pipe axis from being transmitted to the pipe.

2. A method according to Claim 1, characterized in that a liquid is discharged from said leading head (8) to reduce the strength of the earth and convert the earth into slurry.

3. A method according to Claim 2, characterized in that said liquid is water.

4. An apparatus for embedding a pipe (4), comprising vibration heading means (8) connected to the pipe (4) to be embedded, the vibration heading means having a body (26) connected to the pipe and vibrator means (28) for causing pulsating movement of the body, characterized in that the pipe is located with forward and backward ends (6, 10) under ground and the vibration heading means (8) is coaxially connected to the forward end (6) of the pipe (4), said vibrator means (28) comprises a shaft (30) rotatably mounted within said body and carrying an eccentric weight (32) and means (36) for rotating the shaft, drive means (12) is associated with said backward end (10) of the pipe (4) for applying a propelling force to the pipe from the backward end thereof so as to drive the pipe into earth, and vibration insulator means (42) is connected between the vibration heading means (8) and the forward end (6) of the pipe to damp transmission to the pipe of movement of the body caused by rotation of the shaft and eccentric weight.

5. Apparatus according to Claim 4, characterized by the provision of means (64, 66) for supplying liquid to the earth adjacent to said vibration heading means (8) in use of the apparatus for mixing with the earth to form a slurry.

6. A system according to Claim 5, characterized in that said liquid supply means includes at least one liquid supply port (64) formed in the body (26) of said vibration heading means (8).

Revendications

1. Procédé pour poser un tuyau (4) dans le sol par accouplement d'une tête (8) d'avancement au tuyau (4) à poser, et application d'un mouvement pulsatoire à la tête (8) d'avancement, caractérisé en ce que le tuyau est placé avec ses extrémités avant et arrière (6, 10) dans le sol et la tête d'avancement est coaxialement accouplée à l'extrémité avant (6) du tuyau (4), le mouvement pulsatoire de la tête (8) d'avancement est un mouvement de rotation de l'axe central (O_2) de la tête (8) d'avancement autour de l'axe longitudinal (O_1) du tuyau (4), et une force de propulsion est appliquée à l'extrémité arrière (10) du tuyau (4) pendant que l'axe de la tête d'avancement est entraîné dans un mouvement de rotation afin de faire pénétrer le tuyau dans le sol, la transmission au tuyau du mouvement pulsatoire de la tête d'avancement étant amortie par un amortisseur de vibrations formant accouplement (42) entre la tête d'avancement et le tuyau, ce qui permet d'empêcher sensiblement que les vibrations provoqués par le mouvement de rotation de l'axe de la tête autour de l'axe du tuyau soient transmises au tuyau.

2. Procédé suivant la revendication 1, caractérisé en ce qu'un liquide est refoulé par la tête (8) d'avancement afin de réduire la résistance du sol et transformer ce dernier en boue.

3. Procédé suivant la revendication 2, caractérisé en ce que ce liquide est de l'eau.

4. Dispositif pour poser un tuyau (4) dans le sol, comprenant un moyen (8) d'avancement par vibrations accouplé au tuyau (4) à poser, ce moyen d'avancement par vibrations comportant un corps (26) accouplé au tuyau et un moyen (28) formant vibreur pour provoquer le mouvement pulsatoire du corps, caractérisé en ce que le tuyau est placé avec ses extrémités avant et arrière (6, 10) dans le sol et le moyen (8) d'avancement par vibrations est coaxialement accouplé à l'extrémité avant (6) du tuyau (4), le moyen (28) formant vibreur comprend un arbre (30) monté fou dans le corps et supportant un poids excentré (32) et un moyen (36) pour faire tourner l'arbre, un moyen (12) d'entraînement est associé à l'extrémité arrière (10) du tuyau (4) pour appliquer à ce dernier une force de propulsion à partir de son extrémité arrière de manière à faire pénétrer le tuyau dans le sol, et un moyen (42) amortisseur de vibrations est accouplé entre le moyen (8) d'avancement par vibrations et l'extrémité avant (6) du tuyau afin d'amortir la transmission au tuyau du mouvement du corps provoqué par la rotation de l'arbre et du poids excentré.

5. Dispositif suivant la revendication 4, caractérisé par la présence de moyens (64, 66) prévus pour alimenter en liquide le sol contigu au moyen (8) d'avancement par vibrations, utilisé dans le

dispositif pour être mélangé au sol et former de la boue.

6. Système suivant la revendication 5, caractérisé en ce que ces moyens d'alimentation en liquide comprennent au moins un orifice (64) d'alimentation en liquide, formé dans le corps (26) du moyen (8) d'avancement par vibrations.

Patentansprüche

1. Verfahren zum Erdverlegen eines Rohrs (4) durch Verbinden eines Einführungskopfs (8) mit dem zu verlegenden Rohr (4) und Versetzen des Einführungskopfs (8) in pulsierende Bewegung, dadurch gekennzeichnet, daß das Rohr mit dem Vorder- und dem Hinterende (6, 10) unterirdisch positioniert und der Einführungskopf koaxial mit dem Vorderende (6) des Rohrs (4) verbunden wird, die pulsierende Bewegung des Einführungskopfs (8) eine Drehbewegung der Mittenachse (O_2) des Einführungskopfs (8) um die Längsachse (O_1) des Rohrs (4) ist, und das Hinterende (10) des Rohrs (4) mit einer Vortriebskraft beaufschlagt wird, während die Achse des Einführungskopfs gedreht wird, so daß das Rohr in das Erdreich getrieben wird, wobei die Übertragung der pulsierenden Bewegung des Einführungskopfs auf das Rohr durch einen Schwingungsdämpfer gedämpft wird, der die Verbindung (42) zwischen dem Einführungskopf und dem Rohr bildet, so daß eine Übertragung der durch die Drehbewegung der Kipfachse um die Rohrachse hervorgerufenen Schwingung auf das Rohr im wesentlichen unterbunden wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß aus dem Einführungskopf (8) eine Flüssigkeit abgegeben wird, um die Festigkeit des Erdreichs zu vermindern und dieses zu Schlämme umzuwandeln.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Flüssigkeit Wasser ist.

4. Einrichtung zum Erdverlegen eines Rohrs (4), mit einem Vibrations-Einführungskopf (8), der mit dem zu verlegenden Rohr (4) verbunden ist, wobei der Vibrations-Einführungskopf einen mit dem Rohr verbundenen Hauptteil (26) und eine Vibrationseinheit (28), die den Hauptteil in pulsierende Bewegung versetzt, aufweist, dadurch gekennzeichnet, daß das Rohr mit dem Vorder- und dem Hinterende (6, 10) unterirdisch positioniert und der Vibrations-Einführungskopf (8) koaxial mit dem Vorderende (6) des Rohrs (4) verbunden ist, die Vibrationseinheit (28) eine in dem Hauptteil drehbar angeordnete und ein Exzentergewicht (32) tragende Welle (30) sowie Mittel (36) zum Drehen der Welle aufweist, dem Hinterende (10) Rohrs (4) ein Antrieb (12) zugeordnet ist, der das Rohr am Hinterende mit einer Vortriebskraft beaufschlagt, so daß das Rohr in das Erdreich getrieben wird, und zwischen den Vibrations-Einführungskopf (8) und das Vorderende (6) des Rohrs ein Schwingungsdämpfer (42) geschaltet ist, der die Übertragung von Bewegungen des Hauptteils, die durch die Drehung der Welle und des Exzentergewichts bedingt sind, auf das Rohr dämpft.

5. Einrichtung nach Anspruch 4, gekennzeichnet durch Mittel (64, 66) zur Zuführung von Flüssigkeit zum Erdreich angrenzend an den Vibrations-Einführungskopf (8) während des Betriebs der Einrichtung, wobei die Flüssigkeit mit dem Erdreich unter Bildung einer Schlämme vermischt wird.

6. Einrichtung nach Anspruch 5, dadurch gekennzeichnet, daß die Flüssigkeits-Zuführmittel wenigstens eine Flüssigkeits-Förderöffnung (64) aufweisen, die im Hauptteil (26) des Vibrations-Einführungskopfs (8) ausgebildet ist.

FIG. 1

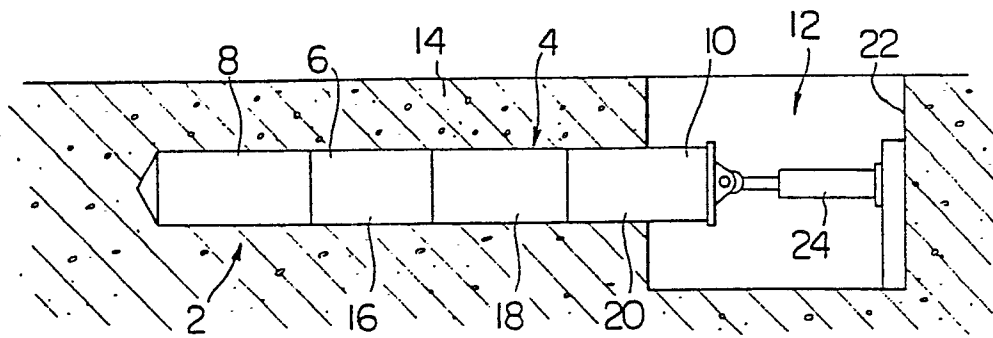


FIG. 2

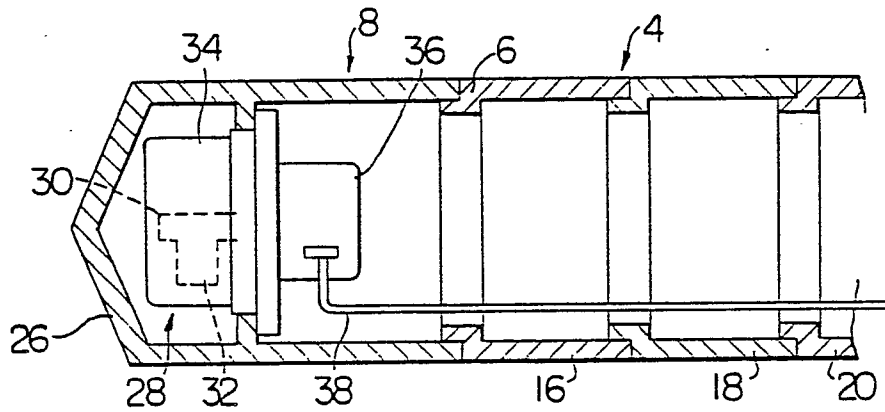


FIG. 3(a)

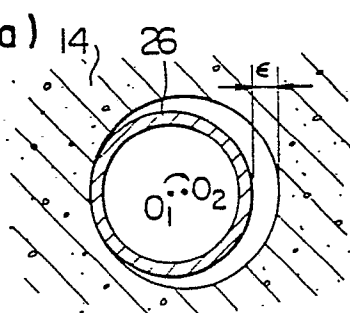


FIG. 3(b)

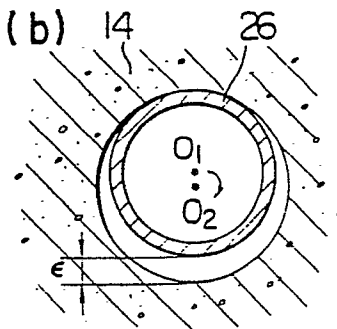


FIG. 3(c)

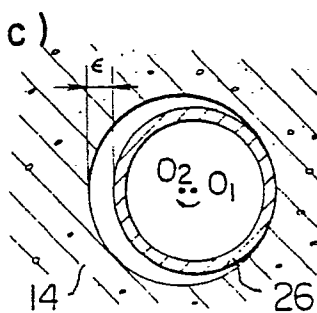


FIG. 3(d)

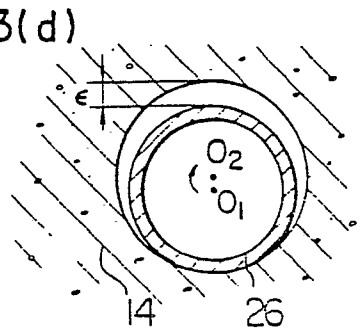


FIG. 4

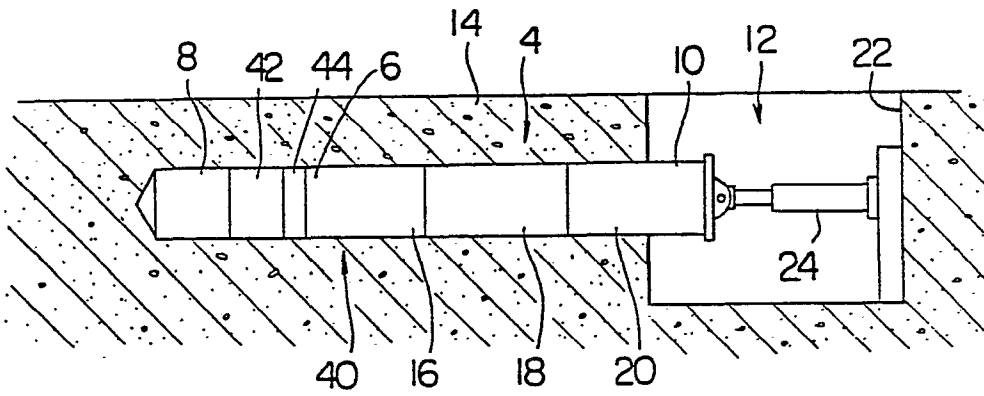


FIG. 5

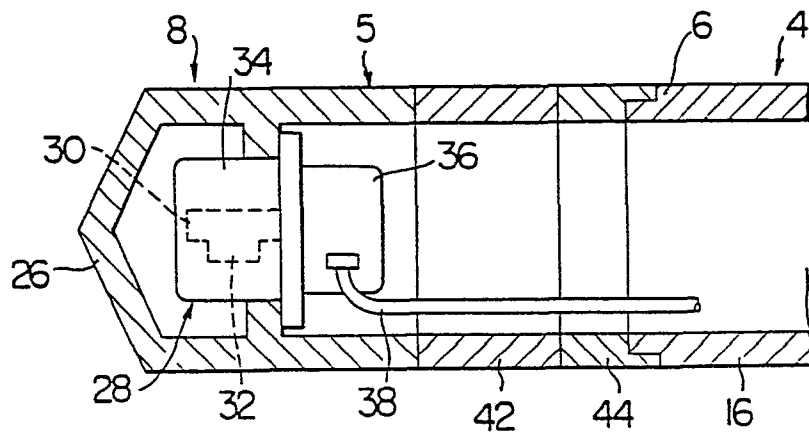


FIG. 6

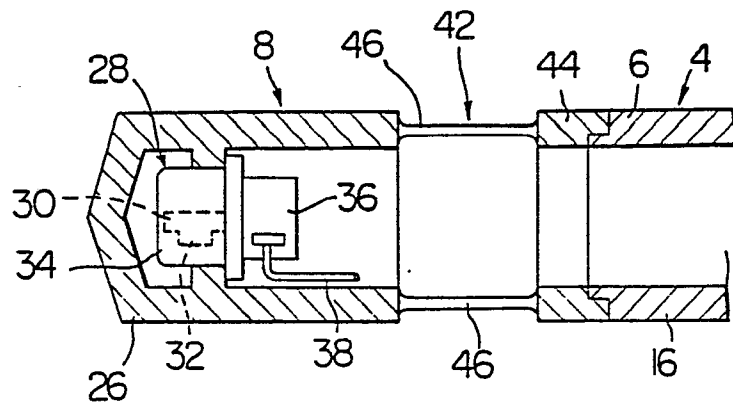


FIG. 7

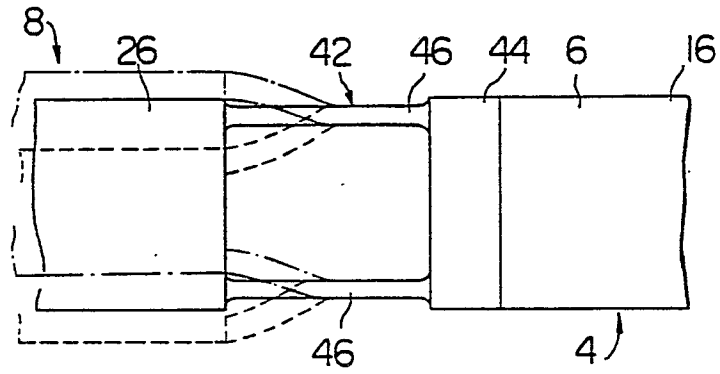


FIG. 8

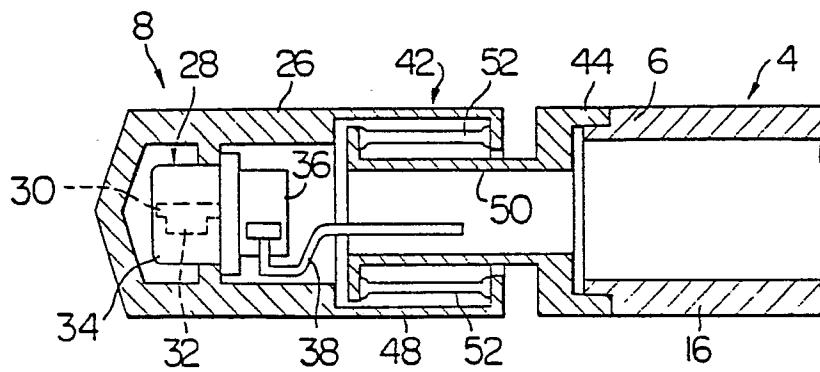


FIG. 9

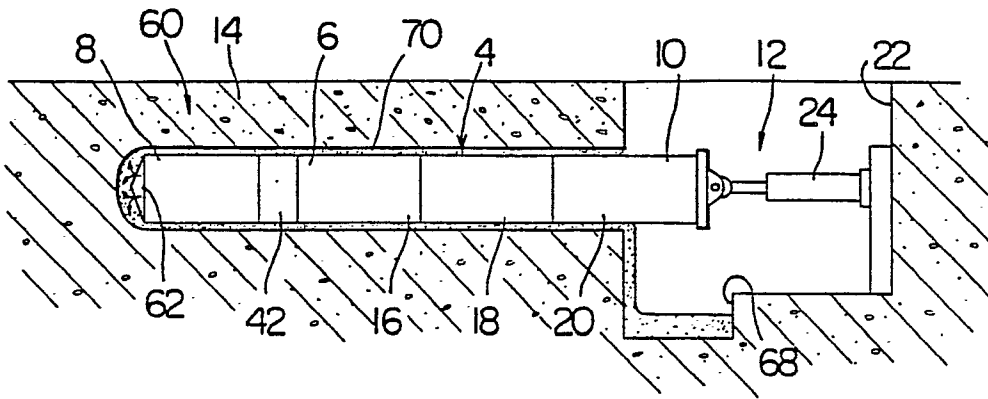


FIG. 10

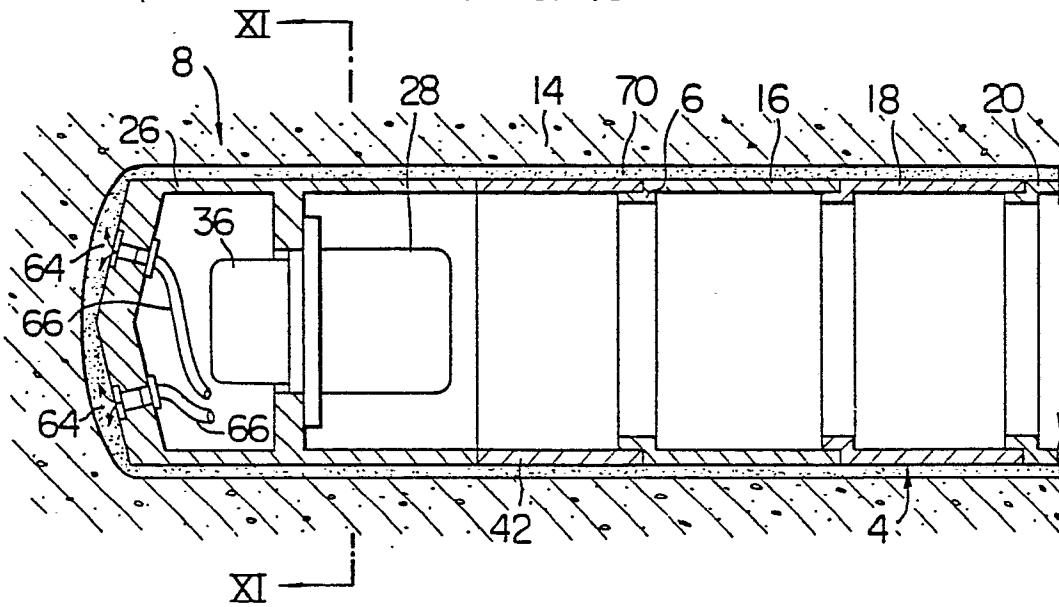


FIG. 11

