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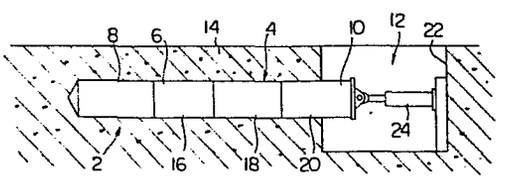
(54) Pipe embedding method and system.

(57) A method and a system for embedding a pipe under ground in which a forward end (6) of a pipe (4) to be embedded is connected with a vibration heading unit (8). The body (26) of the vibration heading unit is vibrated while a propelling force is applied to the pipe (4) from the backward end (10) thereof by a drive unit (12), thereby driving the pipe (4) into earth (14).

FIG. 1



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PIPE EMBEDDING METHOD AND SYSTEM

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In embedding a pipe of 800 mm or less in diameter under ground, the conventional open cut method has now been replaced by the propelling method in which a pipe to be embedded is propelled by a drive unit such as a hydraulic cylinder installed in a working pit.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

SUMMARY OF THE INVENTION

An object of the present invention is to provide a method and a system for embedding a pipe under ground which allow the pipe to be embedded with a relatively small propelling force.

Another object of the present invention is to provide a method and a system for embedding a pipe under ground which allow the pipe to be embedded without damage thereof.

A still another object of the present invention is to provide a method and a system for embedding a pipe under ground which allow the pipe to be embedded with high accuracy of orientation.

A further object of the present invention is to provide a method and a system for embedding a pipe under ground which allow the pipe to be embedded without complicated operation.

According to the present invention, there is provided a method of embedding a pipe having forward and backward ends under ground, comprising the steps of: providing a leading head at the forward end of the pipe to be embedded under ground; vibrating the leading head; and simultaneously applying a propelling force to the backward end of the pipe to drive the pipe into earth.

In the pipe embedding method according to the

present invention, 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.

The leading head may be vibrated either laterally of the pipe to be embedded or longitudinally along the axis of the pipe. In the case the leading head is vibrated laterally, it is preferable that the central axis of the leading head is revolve around the longitudinal axis of the pipe. By vibrating the leading head in this way, 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 further 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.

In the pipe embedding method according to the present invention, the vibration of the leading head is preferably substantially prevented from transmitting to

the pipe to be embedded.

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.

According to the present invention, in order to carry out the above-mentioned method, there is also provided a system for embedding a pipe having forward and backward ends under ground, comprising: vibration heading means connected to the forward end of the pipe to be embedded under ground: and drive means associated with the backward end of the pipe for applying a propelling force to the pipe from the backward end thereof to drive the pipe into earth.

In the pipe embedding system according to the present invention, the vibration heading means preferably includes a body connected to the forward end of the pipe to be embedded, and vibrator means for vibrating said body. The vibrator means may include an eccentric shaft rotatably mounted within the body and means for rotating the eccentric shaft.

The pipe embedding system according to the present invention preferably further comprises vibration insulator means connected between the vibration heading unit and the forward end of the pipe to be embedded.

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 shematic view showing an embodiment of the system for embedding a pipe under ground according to the present invention.

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 according to the present invention.

Fig. 4 is a shematic view similar to Fig. 1, showing another embodiment of the system for implementing the pipe embedding system according to the present invention.

Fig. 5 is a sectional view of the vibration heading unit making up part of the pipe-embedding system 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 sectiona view similar to Fig. 6, showing another structure of the vibration insulator.

Fig. 9 is a schematic view similar to Fig. 1, showing still another embodiment of the system 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 system 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 preferred embodiment of the system for implementing the method of embedding a pipe under ground according to the present invention 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 embodiment 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 36 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.

The foregoing description of the embodiment concerns a pipe embedding system having a vibration heading

unit for generating a lateral vibration. As an alternative, a vibration heading unit for generating a vibration longitudinal of the pipe to be embedded may be employed, which is also capable of reducing the strength of the earth in the vicinity of the forward end of the vibration heading unit, thereby making it possible to drive the pipe into earth by applying only a small propelling force to the pipe from the backward end thereof by the hydraulic cylinder 24.

As described above, the method and the system for embedding a pipe under ground according to the present invnetion have, as compared with the conventional pressing systems, 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, as compared with the conventional augering system, 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.

Another embodiment of the system 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 system 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 system 40, upon rotation of the motor 36, as in the embodiment shown 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 8 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 is 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 system 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 system according to this embodiment is generally designated by reference numeral

60 and those component elements similar to those of the embodiments shown in Figs. 1 and 2 and Figs. 4 and 5 are denoted by like reference numerals, respectively.

The pipe embedding system 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 system 60 operates in such a manner that 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 having forward and backward ends under ground, comprising the steps of: providing a leading head at said forward end of the pipe to be embedded under ground; vibrating said leading head; and simultaneously applying a propelling force to said backward end of the pipe to drive the pipe into earth.

2. A method according to Claim 1, wherein said leading head is vibrated laterally.

3. A method according to Claim 1, wherein said leading head is vibrated by being moved in such a manner that the central axis thereof revolves around the longitudinal axis of the pipe to be embedded.

4. A method according to Claim 1, wherein during the vibration of said leading head, the vibration of said leading head is substantially prevented from transmitting to the pipe to be embedded.

5. A method according to Claim 1, further comprising the step of discharging from said leading head a liquid for reducing the strength of the earth and converting the earth into slurry.

6. A method according to Claim 5, wherein said liquid is water.

7. A system for embedding a pipe having forward and backward ends under ground, comprising: vibration heading means connected to said forward end of the pipe to be embedded under ground; and drive means associated

with said backward end of the pipe for applying a propelling force to the pipe from the backward end thereof to drive the pipe into earth.

8. A system according to Claim 7, wherein said vibration heading means includes a body connected to the forward end of said pipe to be embedded, and vibrator means for vibrating said body.

9. A system according to Claim 8, wherein said vibrator means includes an eccentric shaft rotatably mounted within said body and means for rotating said eccentric shaft.

10. A system according to Claim 7, further comprising vibration insulator means connected between said vibration heading means and said forward end of said pipe to be embedded.

11. A system according to Claim 7 or 8, further comprising means for supplying the earth adjacent to said vibration heading means with a liquid for reducing the strength of said earth and converting the earth into slurry.

12. A system according to Claim 11, wherein said liquid supply means includes at least one liquid supply port formed in the body of said vibration heading means.

FIG. 1

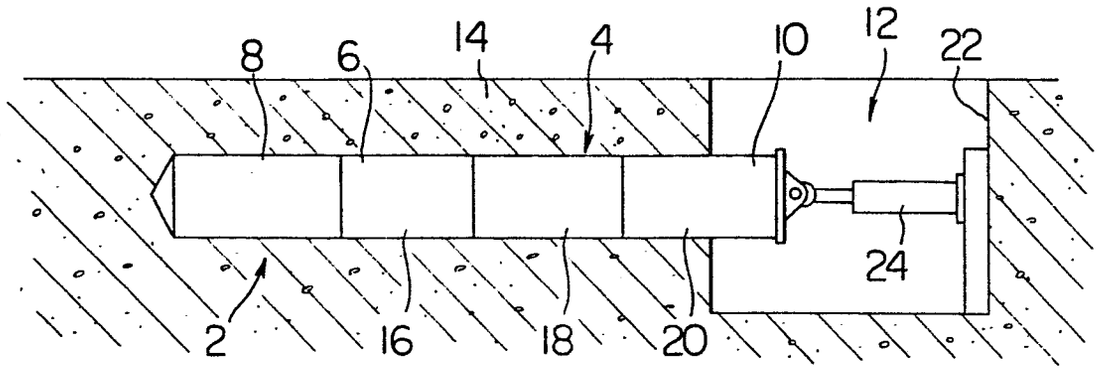


FIG. 2

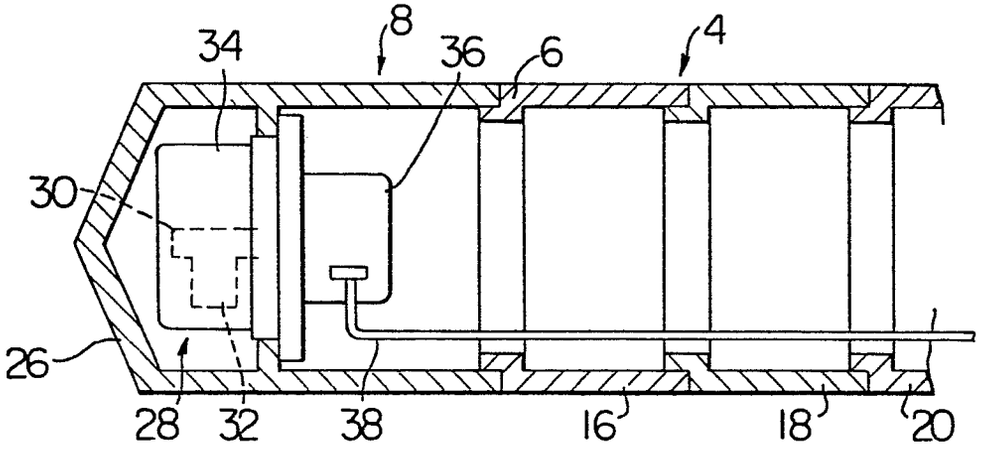


FIG. 3(a)

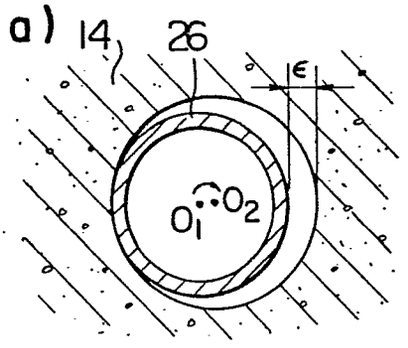


FIG. 3(b)

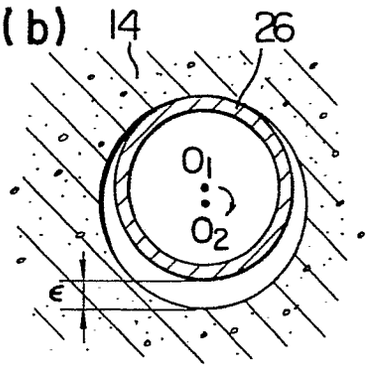


FIG. 3(c)

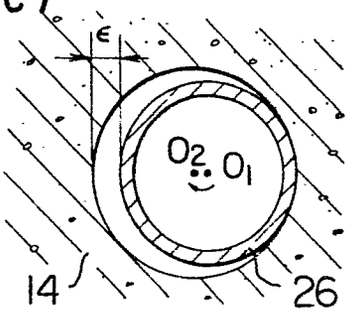


FIG. 3(d)

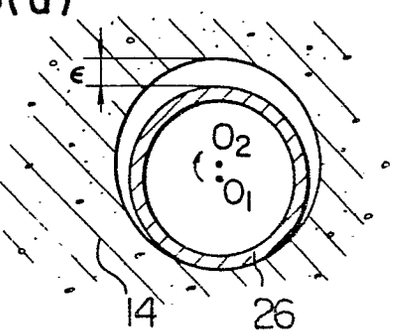


FIG. 4

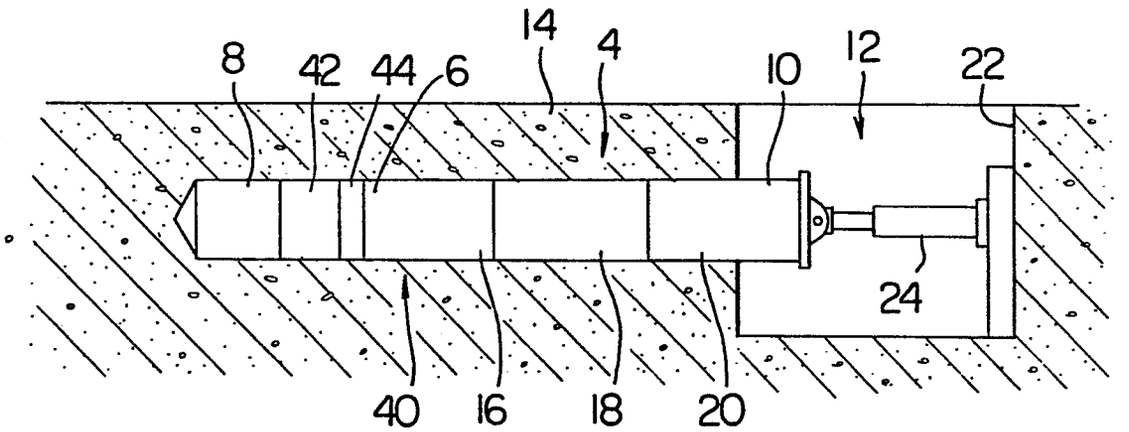


FIG. 5

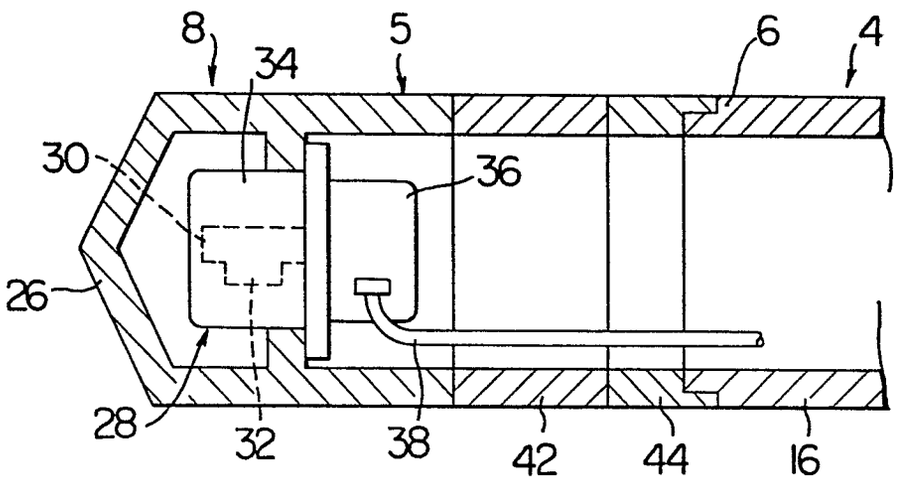


FIG. 6

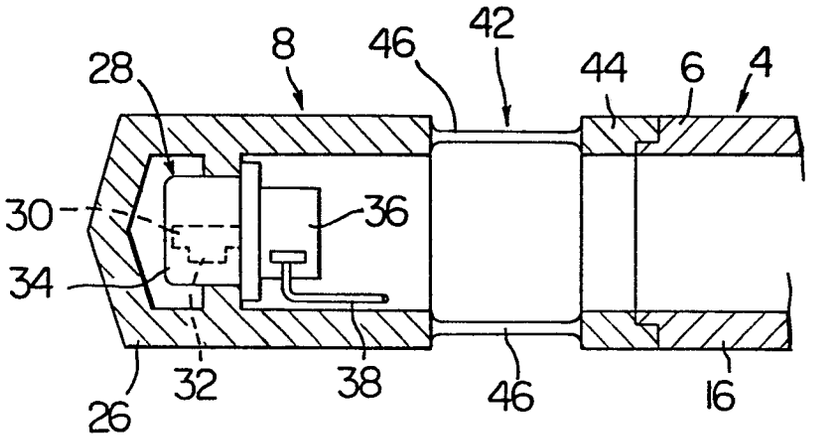


FIG. 7

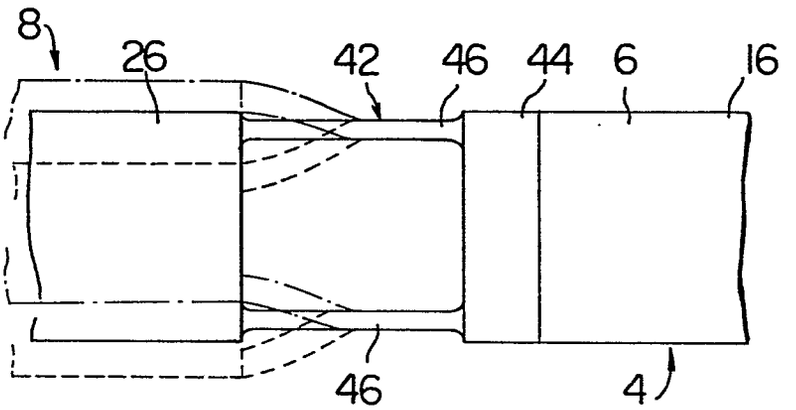


FIG. 8

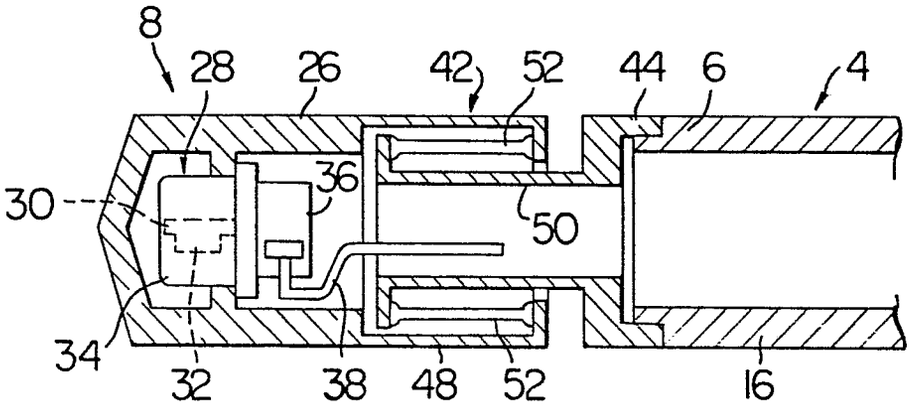


FIG. 9

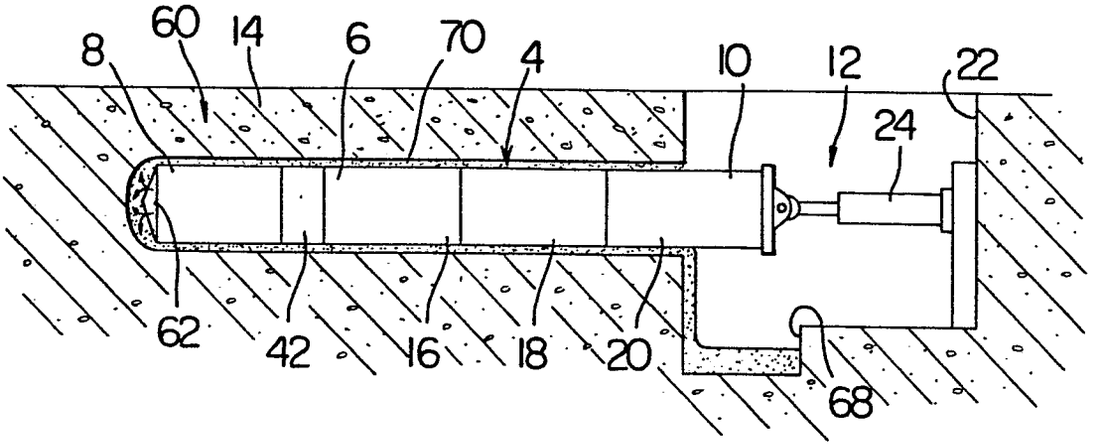


FIG. 10

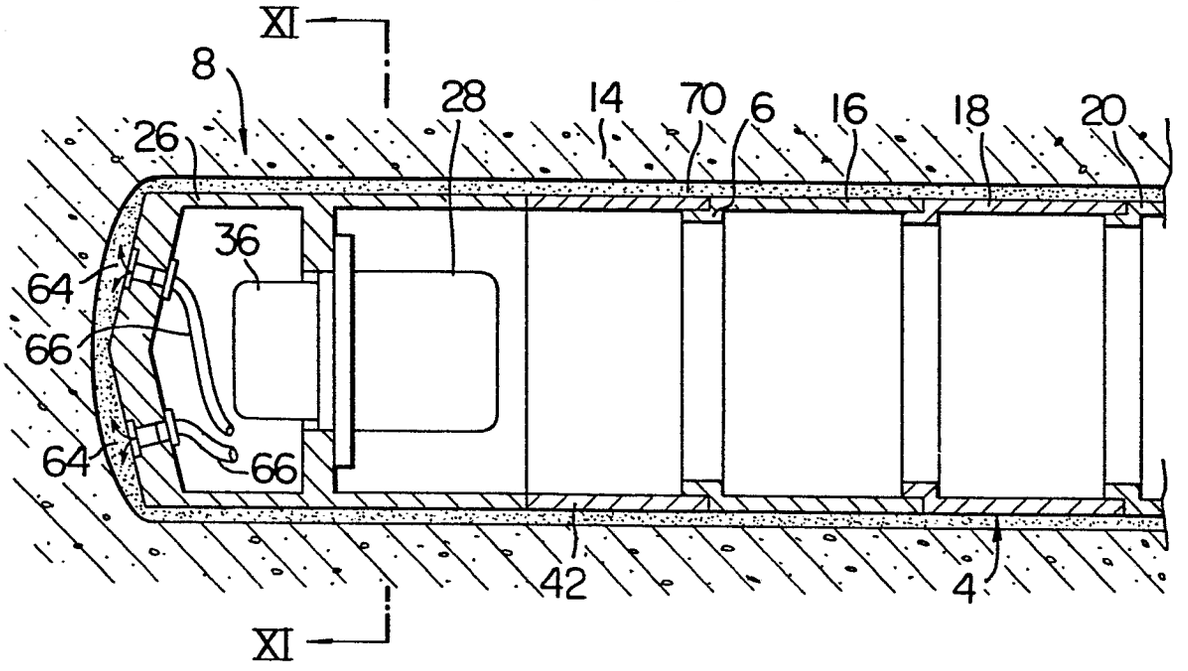
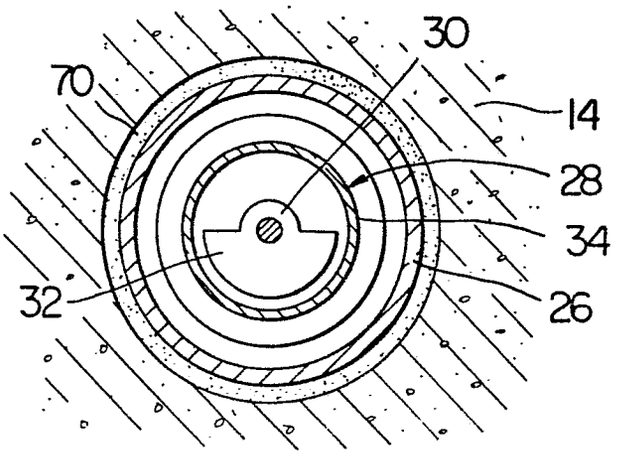


FIG. 11



European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 82300313.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	DE - A - 1 634 637 (THYSSENGAS AG) * Totality *	1,7
A	US - A - 3 688 511 (HARMSTROF) * Claims 3,4; fig. 5 *	1,5,6, 7,11
A	DE - A1 - 2 701 066 (K.K. KOMATSU SEISAKUSHO) * Claims 1,4; fig. 1,2 *	1,5,7

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

F 16 L 1/02

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

F 16 L 1/00
F 16 L 55/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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A: technological background
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P: intermediate document
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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

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	09-04-1982	SCHUGANICH