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(71) Applicant
Kurimoto Limited

(Incorporated in Japan)

12-19 Kitahorie 1-chome, Nishi-ku, Osaka, Japan

(72) Inventors
Kenji Kondo
Hiroyoshi Inagaki
Michio Toyohuku

(74) Agent and/or Address for Service
Forrester Ketley & Co
Forrester House, 52 Bounds Green Road, London,
N11 2EY, United Kingdom

(54) Pipe replacement by mole

(57) In a method of replacing an old pipe (1) with a new pipe (2) by use of a bursting mole (3) pulled forward by a traction cable 5 so that an air hammer head of the bursting mole intrudes into the old pipe and bursts it, a compressive force for forward movement to the new pipe is also applied using a jack (6) installed in a starting pit (4) at the end of the old pipe. The jack (6) may be supplemented by an intermediate jack 8 comprising sleeves 8A, 8B telescopically expandable by a jack member 8C.

Fig.2.

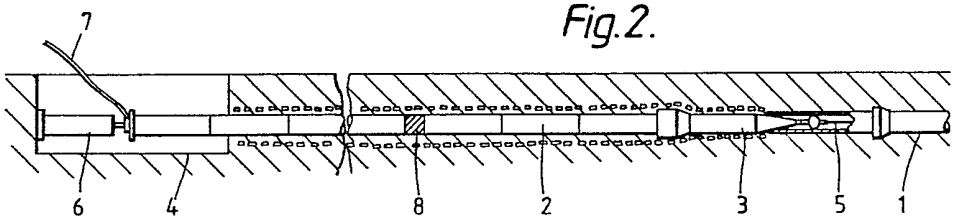
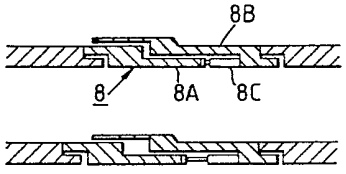


Fig.3.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print incorporates corrections made under Section 117(1) of the Patents Act 1977.

Fig.1.

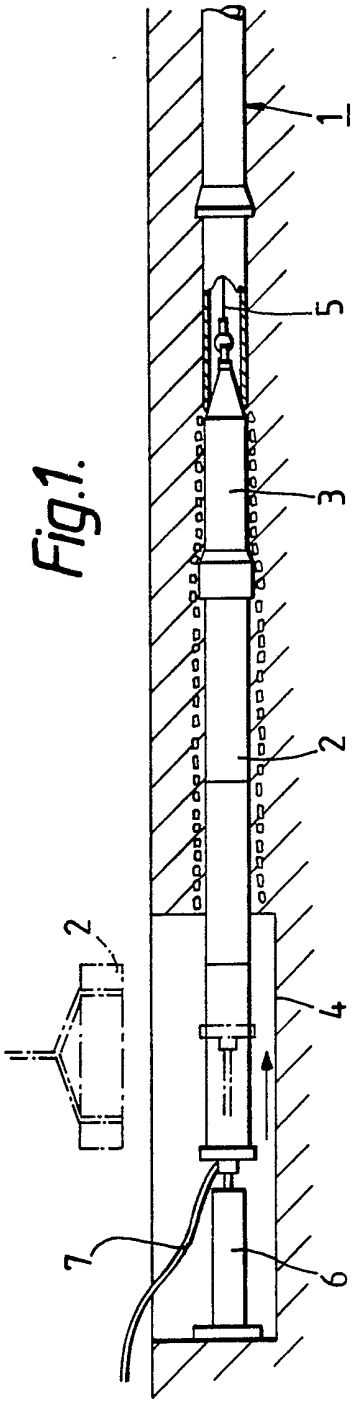


Fig.2.

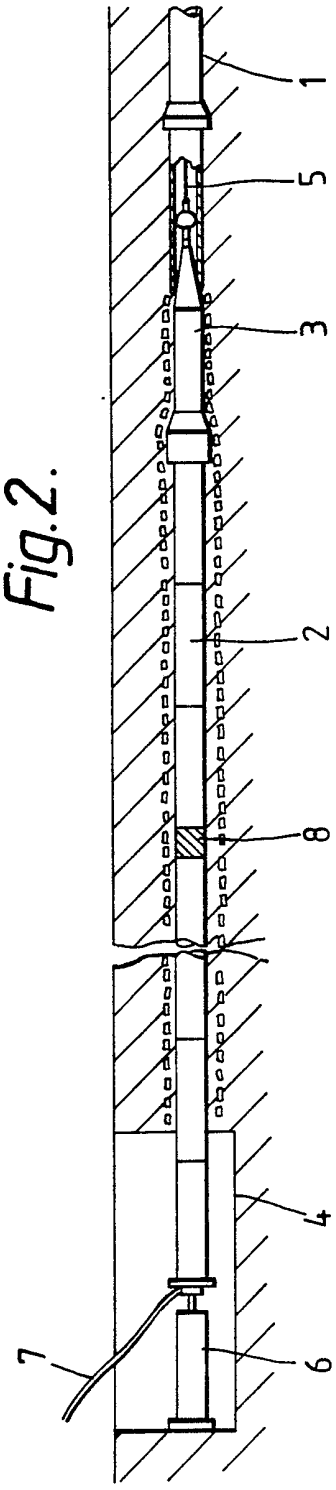
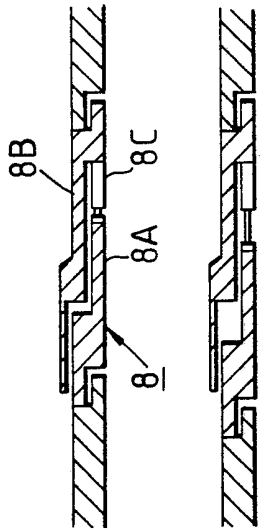


Fig.3.



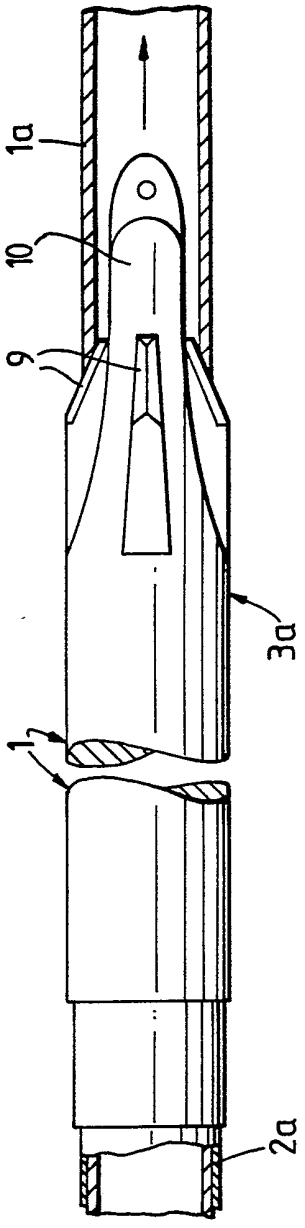


Fig.4.

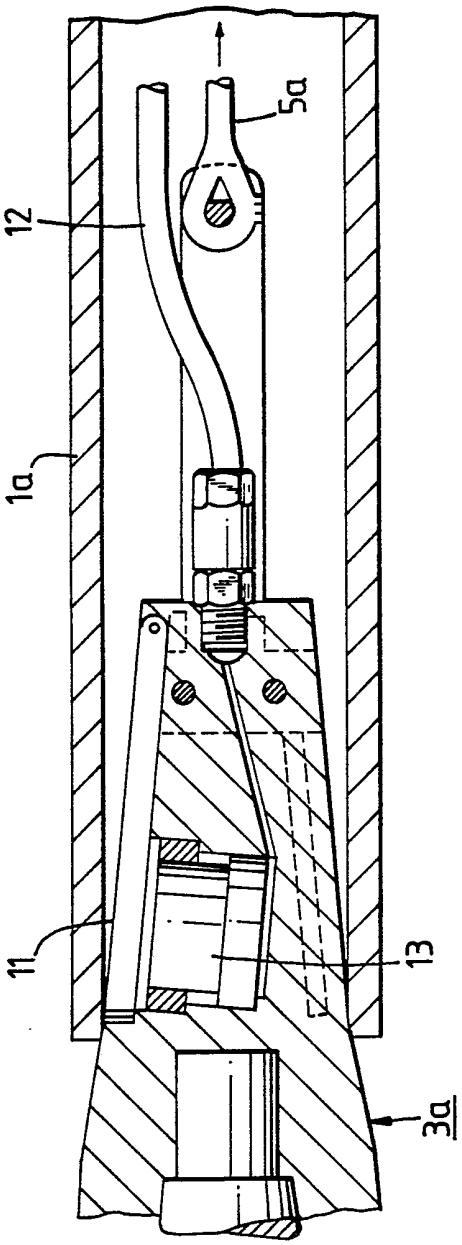


Fig.5.

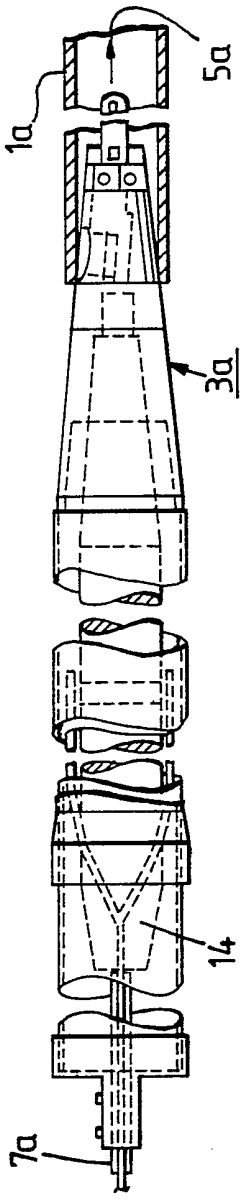


Fig.6.

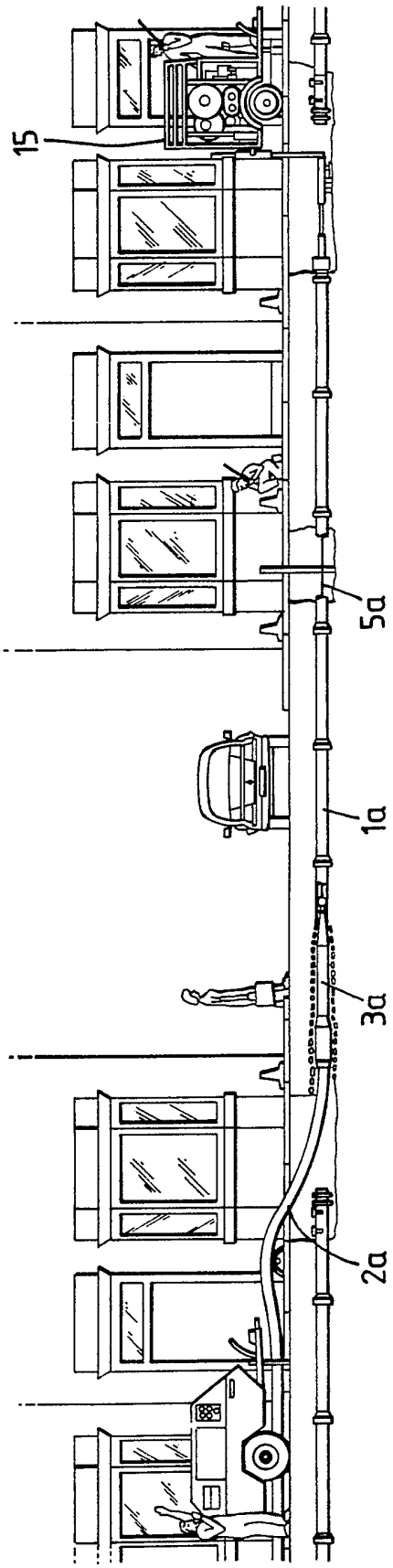


Fig.7.

"Method and apparatus for pipe replacement"

THIS INVENTION relates to a method of replacing an existing old buried pipe, such as a water main or gas main, with a new pipe and, in particular, to a method of replacing an old pipe with a new one without having to excavate the ground along the length of the old pipe. The invention also concerns apparatus for use in the method of the invention.

When an old buried pipe, in particular a cast iron pipe, has deteriorated with age or when it is necessary to replace the old pipe with a new one due to new requirements, it is desirable to be able to replace the old pipe with a new one without digging up the ground, because great labour and cost is involved in excavating the old pipe and because such digging work unavoidably obstructs traffic or affects means of transport and communication.

According to a known method of pipe replacement called "pipe-in-pipe", a new pipe is simply inserted into the old one under the ground, but this inevitably means that the internal diameter of the new pipe must be smaller than that of the old pipe, resulting in a reduction in the capacity for transporting gas or water.

An attempt has already been made to overcome the above-discussed drawback of the pipe-in-pipe method, as disclosed in UK Patents GB 2152624B "Pipe Replacement System", GB 2124325B and GB 2092701B "Mains Insertion". Apparatus in accordance with this prior proposed is

illustrated in detail in Figures 4 to 6 of the accompanying drawings, Figure 7 illustrating a manner of actual use of this prior apparatus and being taken from a catalogue explaining the practical use of the apparatus on a commercial base.

The aforesaid prior art discloses a method and an apparatus for pipe replacement in which a new pipe is attached to a rear end of a bursting mole having a cylindrical body with an external diameter which is larger than an old pipe to be replaced. The bursting mole and the new pipe move forward together, and a front end or head of the bursting mole intrudes into the old pipe and progressively bursts the old pipe to form an enlarged space to receive the new pipe following behind the bursting mole, so that the old pipe is replaced with the new one.

An embodiment of this prior art apparatus will now be more specifically described with reference to Figures 4 and 5.

The bursting mole 3a comprises a front section which intrudes into the old pipe 1a and bursts the wall thereof, and a rear section which is connected to the new pipe 2a to tow the new pipe behind the bursting mole.

The front section of the mole 3a has a head 10 provided with cutting edges 9 thereon, and a front end of the head is drawn forward by a winch (not illustrated) by way of a traction cable 5a which is passed through the old pipe.

The cutting edges 9 are provided on blades 11, and at least one blade 11 can be pivoted outwardly from the bursting mole in order to cut the wall of the old pipe.

In Figure 5, a fluid pressure-hose extending forwardly through the old pipe delivers a pressure fluid to actuate a piston 13 provided in the head of the bursting mole. The piston acts on blade 11 to pivot it outwardly, thereby to cut the wall of the old pipe 1a and push it outwardly to form an enlarged space for the new pipe following behind the mole 3a.

Another embodiment (Figure 6) is also disclosed in the prior art, wherein the forward movement of the bursting mole and the new pipe attached thereto is performed by winching through the cable attached to the front end of the bursting mole, and an air hammer 14 is disposed in a hollow section of the cylindrical body of the bursting mole as illustrated in Figure 6 so that the piston in the air hammer slides back and forth in response to pressurized air delivered through an air hose 7a attached to the rear end, whereby an additional impulsive driving force is applied to the bursting mole.

Figure 7 illustrates the way in which the apparatus of the aforesaid prior art is used in practice. As illustrated in the drawing, this prior art is mainly applied to a gas main replacement procedure in which an old cast iron pipe 1a is replaced with a new plastic pipe 2a, the new pipe being continuous and having a small diameter and high flexibility.

Generally, a new main is made of a material such as polyethylene and, in order to reinforce the mechanical strength (such as external pressure resistance, and abrasion resistance) thereof, a protective sheath of vinyl chloride resin, stronger by far than polyethylene, is first installed. Accordingly, the procedure is first to replace the old pipe with the protective sheath and then insert the new main into the protective sheath. In the drawing, reference numeral 15 indicates a winch for

the cable 5a.

The prior art of the above constitution, however, still has the following remaining drawbacks:

(1) Restriction on the maximum length of a pipe to be replaced:

Frictional resistance between the new pipe or protective sheath and the adjacent soil increases in proportion to the length of the working distance, and the maximum working distance is thus dictated by the driving force provided by the winch and air hammer (if provided) incorporated in the bursting mole.

In particular, when replacing cast iron pipes of small or medium diameter for water service use, the soil resistance rapidly increases with increasing pipe diameter, eventually making it impossible to advance the new pipe.

(2) Ability to burst the old pipe:

If the old pipe still containing any strong components such as a joint ring (collar) or metallic member for preventing disengagement, it is often impossible to fracture such component. If this occurs, then it becomes necessary to interrupt the work and excavate the resistant component.

Although the impulsive force of the air hammer, where this is provided, contributes to the bursting of old pipes, its contribution to the fracturing force decreases in proportion to the length of the working line due to the increase of frictional resistance.

Particularly in the case of replacing a cast iron

pipe of medium diameter, the above-discussed problem is serious, since pipe thickness generally increases in proportion to increase in pipe diameter.

(3) Dimensions of the starting pit:

Since it is necessary for a series of new pipes to be conducted smoothly (within the range of flexibility thereof) from the ground surface to the beginning of the old pipeline to be replaced, the length of the starting pit increases with increasing depth of the old buried pipe, resulting in increased cost, labour and traffic obstruction.

The present invention aims to solve or at least mitigate the above-discussed problems and to provide a method of replacing an old buried pipe with a new pipe in which the allowable working distance is extended and which is applicable to cast iron pipes of small or medium diameter, thereby providing significantly increased versatility as compared with the prior art.

Accordingly, the invention provides a method of replacing an old buried pipe with a new pipe, comprising attaching the new pipe to a rear end of a bursting mole having a cylindrical body whose external diameter is larger than the old pipe, and moving the bursting mole forward so that a head of the bursting mole intrudes into the old pipe and bursts it to provide an enlarged space for the new pipe following the bursting mole, which method further includes applying a compressive force for forward movement to the new pipe attached to the rear end of the bursting mole.

The invention also provides apparatus for replacing an old buried pipe with a new pipe, comprising a bursting mole having a cylindrical body with an

external diameter which is larger than the old pipe, means for attaching a new pipe to a rear end of the bursting mole and means for moving the bursting mole forward so that a head of the bursting mole intrudes into the old pipe and bursts it to provide an enlarged space for the new pipe, which apparatus further includes means for applying a compressive force for forward movement to the new pipe attached to the rear end of the bursting mole.

Preferably, the method comprises mounting a hydraulic jack in a starting pit dug to expose one end of the old pipe and using the jack to apply the said compressive force to a rear end face of each of a succession of pipe sections constituting the new pipe.

An intermediate jacking device may also be incorporated between selected adjacent sections of the new pipe and used to apply a compressive force to the pipe section located forwardly of the intermediate jacking device.

The pipe sections used to constitute the new pipe are preferably short so that they have sufficient strength to endure the compressive force and so that the installation of the new pipe can be performed easily by attaching each section to a preceding section within the starting pit.

A preferred method of pipe replacement embodying the present invention proceeds as follows.

First, the bursting mole is positioned in known manner at the beginning of an old pipe to be replaced with a new pipe.

One end of a traction cable passed through the old

pipe is connected to the front end of the bursting mole while the other end is connected to a winch which takes up the cable so as to move the bursting mole forward. Connected to the rear end of the bursting mole is the leading end of a first section of the new pipe with which the old pipe is to be replaced. An air hose connected to a compressor extends through the new pipe to an air hammer within the bursting mole.

When starting the replacement work, the bursting mole moves forward, bursting the old pipe by the driving force from the winch in cooperation with the impulsive action of the air hammer.

At the same time, a hydraulic jack provided in the starting pit for pushing the new pipe from the starting point is actuated, pushing the rear end of the new pipe by the reaction from the inner wall of the pit, thereby applying a compressive force to move the rear end of the new pipe forward.

In case it proves difficult to replace the whole of the old pipe line with the new one due to large resistance inhibiting further forward movement being encountered after several sections of the new pipe have been installed, an intermediate jacking device for pushing the new pipe from an intermediate point is incorporated in the new pipe line between adjacent pipe section at a pre-calculated intermediate point of the new pipe line, so that a further driving force for forward movement may be applied either by operating the intermediate jacking device alone or by operating both the jack and the intermediate jacking device together. As a result, the maximum working distance for the replacement work can be considerably extended.

Thus, by incorporating an intermediate jacking

device within the new pipe line, it may be possible to extend the working distance without limitation.

Since only the jack and the intermediate jacking device for pushing from the starting point and/or from the intermediate point are added to the prior art apparatus, the arrangement is simple and application thereof is easy.

Further, since the force for bursting the old pipe is increased, old pipes of larger diameter and/or thickness can now be broken by the bursting mole thereby overcoming the restriction imposed on the prior art.

Furthermore, since the connection of a new pipe section of the new pipe line is carried out within the starting pit, the required dimensions of the pit are not affected by the depth of the old buried pipe, allowing the dimensions of the pit to be smaller than the dimensions of the pit required by the prior art method which do depend on the depth of the buried old pipe. The dimensions of the starting pit can be made very small by reducing the length of the individual sections of the new pipe.

In order that the invention may be readily understood, an embodiment thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic sectional view illustrating one method of pipe replacement embodying the invention;

Figures 2 and 3 are respectively a diagrammatic sectional view and an enlarged fragmentary view illustrating another method embodying the invention;

Figures 4 to 6 are side and sectional views illustrating a prior art pipe replacement apparatus; and

Figure 7 is a diagrammatic view illustrating a typical prior art pipe replacement method.

Referring first to Figure 1, in order to replace an old buried pipe 1 with a new pipe 2, a bursting mole 3 is positioned at one end of the old pipe line. To this end, a starting pit 4 is dug in the ground over a length sufficient to expose one end of the old pipe line to be replaced and to accommodate related equipment and tools.

Then, one end of a traction cable 5 passed through the old pipe 1 is attached to a front end of the bursting mole 3. The cable 5 is attached at its other end to a winch (not shown) which pulls the bursting mole into the old pipe to burst it and replace it with the new pipe 2 following behind the mole 3. Since the external diameter of the cylindrical section of the bursting mole is larger than that of the old pipe, a space (including fragments of the old pipe) larger than the old pipe is formed by the bursting mole to accommodate the new pipe attached to the rear end of the mole 3.

In the method illustrated in Figure 1, the new pipe 2 is in the form of short pipe sections and a horizontally extending hydraulic jack 6 is telescopically mounted on the inner wall of the starting pit. The hydraulic jack 6 acts on the rear end face of each section of the new pipe 2 to push the pipe section in the direction indicated by the dot-dash line.

After the insertion of the first new pipe section, the next new pipe section (illustrated by the dot-dash line) is lowered into the pit, connected to the previous pipe section and then compressively inserted from the

starting point by the actuation of the hydraulic jack synchronously with the forward movement of the bursting mole.

A pneumatic hose 7 has one end inserted through the new pipe and connected to the rear part of the bursting mole 3 and its other end connected to a compressor (not illustrated) on the ground to drive an air hammer (not illustrated) for assisting forward movement of the bursting mole.

Figures 2 and 3 illustrate another embodiment of the invention which differs from the embodiment of Figure 1 in that an intermediate hydraulic jacking device 8 is incorporated between adjacent pipe sections at an intermediate location in the new pipe line 2 so that compressive force can be applied to the new pipe sections forwardly of the device 8, when required.

Figure 3 is an enlarged fragmentary view illustrating the intermediate jacking device 8 which comprises relatively movable internal and external sleeve members 8A and 8B and a jack member 8C by which the internal and external members are telescopically expanded.

In order to feed the jacking device 8 with operating oil, an feed oil hose (not illustrated) pipe passes from a hydraulic chamber (not illustrated) on the ground to the jack 8 through the new pipe.

It is necessary for the air hose 7 and any oil feed hose for device 8 passing through the new pipe to be lengthened as the length of the new pipe line increases. In that case, it is preferred that the hoses are both extended at the time of connecting a new pipe section.

The new pipe 2 may be either a replacement pipe for the old pipe or a sheath for the replacement pipe.

CLAIMS:

1. A method of replacing an old buried pipe with a new pipe, comprising attaching the new pipe to a rear end of a bursting mole having a cylindrical body whose external diameter is larger than the old pipe, and moving the bursting mole forward so that a head of the bursting mole intrudes into the old pipe and bursts it to provide an enlarged space for the new pipe following the bursting mole which method further includes applying a compressive force for forward movement to the new pipe attached to the rear end of the bursting mole.

2. A method according to claim 1, comprising mounting a hydraulic jack in a starting pit dug to expose one end of the old pipe and using the jack to apply the said compressive force to a rear end face of each of a succession of pipe sections constituting the new pipe.

3. A method according to claim 2, comprising incorporating an intermediate jacking device between selected adjacent pipe sections of the new pipe and using the intermediate jacking device to apply a compressive force, to the pipe sections located forwardly of the intermediate jacking device.

4. A method according to claim 2 or 3, comprising forming the new pipe from short pipe sections having a strength able to endure the application of the compressive force and connecting the pipe sections to one another in the starting pit.

5. A method of replacing an old buried pipe with a new pipe substantially as hereinbefore described with reference to Figure 1 or Figures 2 and 3 of the accompanying drawings.

6. Apparatus for replacing an old buried pipe with a new pipe, comprising a bursting mole having a cylindrical body with an external diameter which is larger than the existing old pipe, means for attaching a new pipe to a rear end of the bursting mole and means for moving the bursting mole forward so that a head of the bursting mole intrudes into the old pipe and bursts it to provide an enlarged space for the new pipe, which apparatus further includes means for applying a compressive force for forward movement to the new pipe attached to the rear end of the bursting mole.

7. Apparatus according to claim 6, wherein the means for applying compressive force includes a hydraulic jack for mounting in a starting pit to act on the rear end face of each of a succession of pipe sections constituting the new pipe.

8. Apparatus according to claim 7, wherein the means for applying compressive force includes an intermediate jacking device for incorporation between successive pipe sections of the new pipe for applying a compressive force to the pipe sections located forwardly of the intermediate jacking device.

9. Apparatus for replacing an old buried pipe with a new pipe substantially as hereinbefore described with reference to Figure 1 or Figures 2 and 3 of the accompanying drawings.

10. Any novel feature or combination of features disclosed herein.

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