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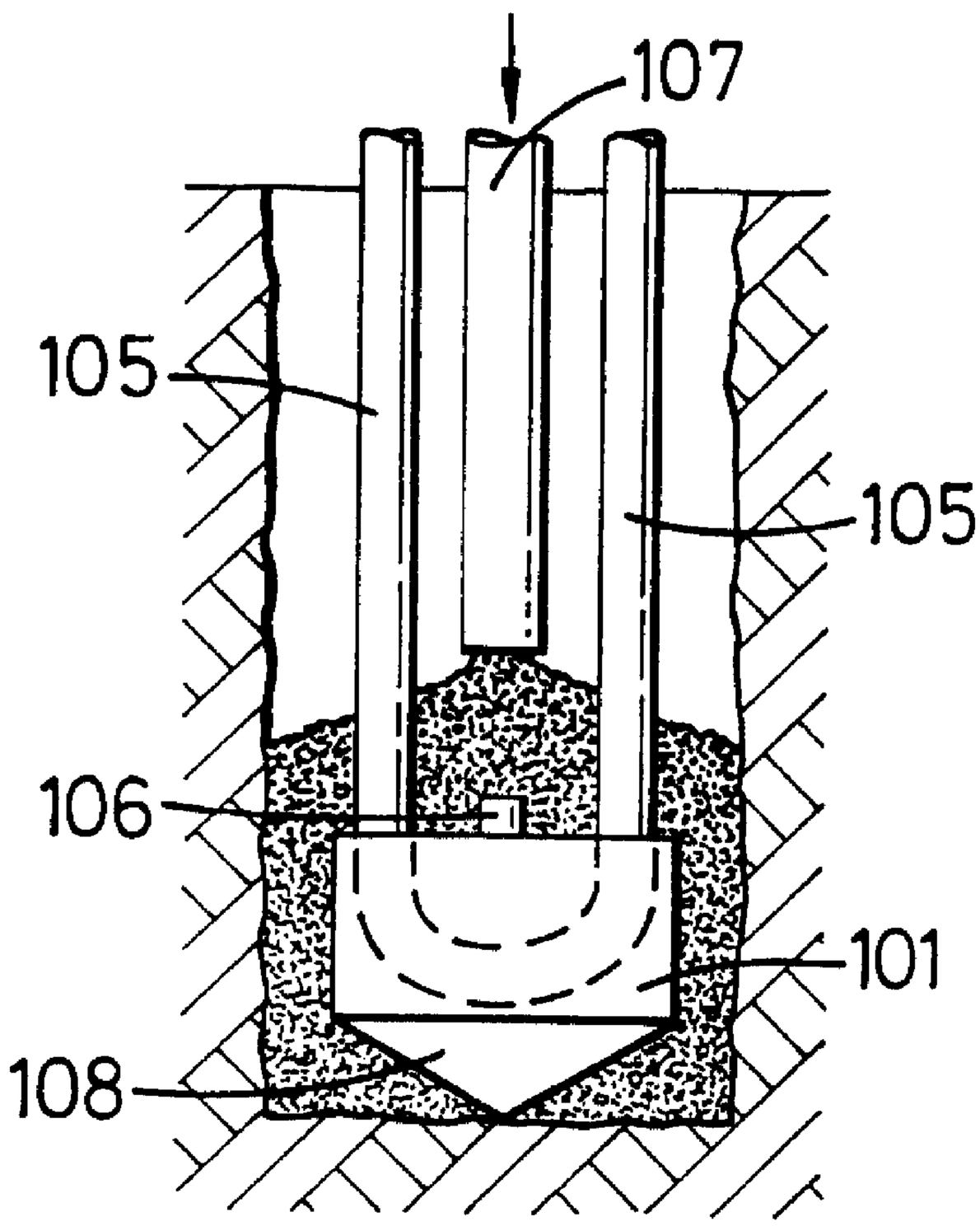
(54) Titre : APPAREIL ET PROCEDE POUR L'INSTALLATION D'UN TUYAU DANS UN PUITS
(54) Title: APPARATUS AND METHOD FOR INSTALLING A PIPE IN A WELLBORE



(57) Abrégé/Abstract:
Apparatus for installing a pipe (105) in a wellbore, which apparatus (101) comprises a body member (102, 103) securable to said pipe (105), and means (106) for releasably engaging a grout tube (107), the arrangement being such that, in use, after said body

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(57) Abrégé(suite)/Abstract(continued):
member (102, 103) has been secured to said pipe (105) said grout tube (107) can be engaged with said means and used to introduce said pipe (105) into said wellbore.

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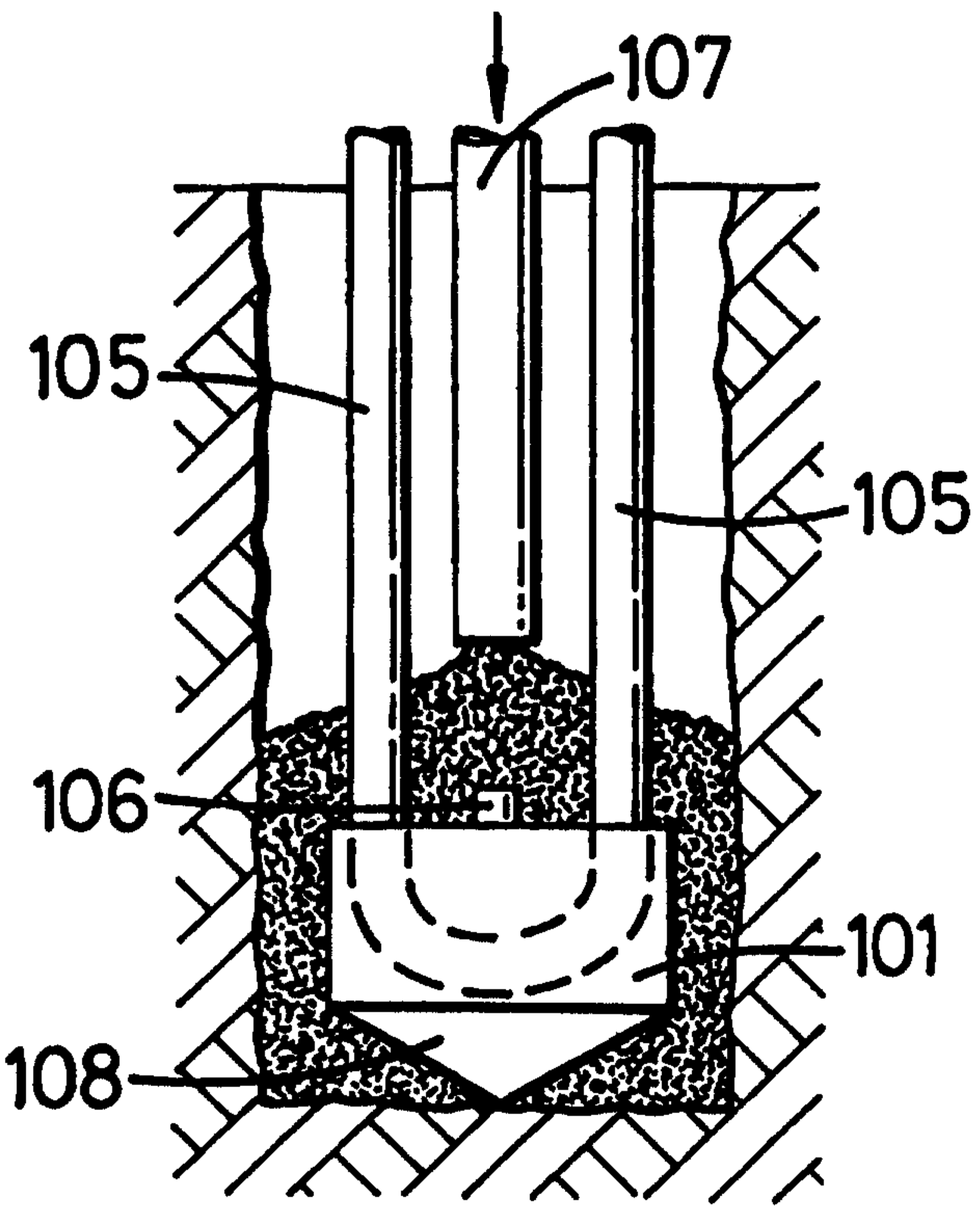
(54) Title: APPARATUS AND METHOD FOR INSTALLING A PIPE IN A WELLBORE

(57) Abstract

Apparatus for installing a pipe (105) in a wellbore, which apparatus (101) comprises a body member (102, 103) securable to said pipe (105), and means (106) for releasably engaging a grout tube (107), the arrangement being such that, in use, after said body member (102, 103) has been secured to said pipe (105) said grout tube (107) can be engaged with said means and used to introduce said pipe (105) into said wellbore.



Apparatus and Method for Installing a Pipe in a Wellbore

This invention relates to underground heat exchange systems and, more particularly but not exclusively, to an apparatus and a method for installing a pipe in a wellbore.

In accordance with an embodiment of the present invention there is provided a method for installing a pipe in a first wellbore, which method comprises the steps of: mounting on the pipe an apparatus comprising a body member and means for releasably engaging a grout tube and for receiving a pushing force from the grout tube, releasably engaging the means with the grout tube, pushing the apparatus and pipe with said grout tube down to a point within the first wellbore, releasing the grout tube from the apparatus, removing the grout tube from the body member and from the first wellbore, and pumping grout into the first wellbore through the grout tube as the grout tube is removed from the first wellbore.

In accordance with another embodiment there is provided an apparatus for carrying out the above method, the apparatus comprising a body member securable to the pipe, and means for releasably engaging a grout tube and for receiving a pushing force from the grout tube, the arrangement being such that, in use, after the body member has been secured to the pipe the grout tube can be engaged with the means and used to push on the apparatus, whereby the pipe is pulled into the wellbore.

Yet another embodiment of the present invention provides system for drilling wellbores and for installing pipes in the wellbore, the system comprising apparatus for

drilling wellbores, apparatus for installing a pipe in the wellbores, and apparatus for grouting the pipe in the wellbores, characterised in that the apparatus for installing the pipe in the wellbore comprises an apparatus as discussed hereinabove.

For a better understanding of the present invention reference will now be made, by way of example, to the accompanying drawings, in which:-

Fig. 1 is a schematic view of a prior art underground heat exchange system;

Fig. 2 is a schematic view showing the installation of a pipe in a wellbore using a prior art technique;

Fig. 3 is a side view of one embodiment of a device in accordance with the present invention;

Fig. 4 is a top view of the device shown in Fig. 3;

Figs. 5, 6 and 7 are schematic views showing progressive steps in the practice of one method according to the present invention for installing a pipe;

Fig. 8 is a schematic side view of a second embodiment of a device according to the present invention in a wellbore, the grout tube and part of the feed pipe and return pipe being omitted for clarity;

Fig. 9 is a side view of the device shown in Fig. 8;

Fig. 10 is a schematic view showing an underground heat exchange system constructed by a preferred method in accordance with the present invention;

Fig. 11 is a side view of part of a system in accordance with the present invention;

Fig. 12 is a top plan view of the system shown in Fig. 11; and

Fig. 13 is a schematic view showing the system of Figs. 11 and 12 and ancilliary equipment therefor.

Referring to Fig. 1 of the drawings there is shown a prior art heat exchange system which is generally identified by reference letter S. The heat exchange system S comprises three wellbores W each of which is about 76m in depth and from 10 to 11.5cm in diameter. The wellbores W are spaced about 3 to 4.5m apart. Each wellbore W accommodates a loop of pipe L comprising a

feed leg and a return leg.

In use, liquid from a processing unit U, for example a heat pump, is pumped through a header pipe I which is connected to the feed leg of each loop of pipe. The liquid flows down the feed legs and then passes up the return legs and enters a return pipe O which is connected to the processing unit U. The space between each loop of pipe and its associated wellbore W is filled with grout so that as the liquid passes through each loop of pipe heat exchange occurs with the surrounding soil.

In winter heat may be transferred from the earth to the liquid in the loops of pipes. In summer heat in the liquid leaving the processing unit U may be rejected to the earth as it passes through the loops of pipe L.

Referring to Fig. 2, after each wellbore W is drilled a loop of pipe L is lowered down the wellbore W using a sinker (not shown) which is attached to the end of a wireline. When the loop of pipe L reaches the bottom of wellbore W the sinker is recovered.

6m lengths of 5cm diameter grout tube T are then connected together and lowered down the wellbore W. Once the grouting pipe reaches the bottom of the wellbore W grout G (typically a mixture of bentonite and water) is pumped down the grout tube T by a pump P.

As the space between the loop of pipe L and the wellbore W fills with grout the grout tube T is withdrawn. The grout may be vibrated if desired both to enhance its heat transfer properties and to inhibit, for example water in one strata migrating to another strata.

After the grout has set a surface trench about 1.2m deep is dug to accommodate the header pipe I and the return pipe O. Once the trench is completed the header pipe I and the return pipe O are laid in position and heat fused to the feed legs and return legs of each of

the loops of pipe L. The whole system is then pressure tested before the trench is back filled.

One of the disadvantages with this system is that there are three separate operations which can damage the sides of the wellbore before grouting commences, i.e.:-

1. Insertion of the loop of pipe;
2. Withdrawal of the sinker; and
3. Insertion of the grout tube.

Referring now to Figs. 3 and 4, there is shown one embodiment of an apparatus in accordance with the present invention. The apparatus, which is generally identified by reference numeral 101 comprises a body member formed by two halves 102, 103 which are secured together over a loop of pipe 105 with bolts 104.

A rod 106 projects upwardly from the apparatus 101 to locate and loosely retain a rigid grout tube 107 (not shown in Fig. 3).

The bottom 108 of the apparatus 101 is tapered to facilitate entry into and movement through the wellbore.

In use, after a wellbore has been drilled the apparatus 101 is bolted to a loop formed in the centre of the pipe 105 which is about 155m in length and made of polyethylene. The grout tube 107 is then slipped over the rod 106 and is held in position by friction between the rod 106 and the pipe 105.

The pipe 105 is then inserted into the wellbore by pushing the grout tube 107 downwardly and increasing its length by screwing on further lengths of grout tube as required. The pipe 105 is maintained under light tension throughout this operation to prevent unintended separation from the grout tube 107.

Fig. 5 shows the apparatus 101 as it arrives at the bottom of a wellbore W. At this stage the tension on the pipe 105 is relaxed and grout is pumped down the grout tube 107 which is slowly raised. Normally the

force of the grout flowing from the bottom of the grout tube 107 will be sufficient to effect separation of the grout tube 107 from the apparatus 101. However, if necessary, the bottom 108 can be pushed into the earth to hold the apparatus 101 in place whilst the grout tube 107 is raised.

Fig. 6 shows the grout tube 107 being raised whilst Fig. 7 shows the arrangement after grouting is complete.

It will be appreciated that using the apparatus 101 only one operation is necessary which can damage the sides of the wellbore compared with the three previously required.

If desired, prior to introducing the grout, drilling fluid could be pumped down the grout tube 107 and allowed to flow back through the space between the grout tube 107 the pipes and the wellbore to remove debris therefrom. This will generally be unnecessary. Similarly, after grouting is complete drilling fluid, for example water, is conveniently pumped through the grout tube 107 to remove grout therefrom.

Figs. 8 and 9 show a second embodiment of an apparatus in accordance with the present invention. The apparatus, which is generally identified by reference numeral 201, comprises a body member formed by two hollow elbows 202, 203 which are fused together to form a generally U-shaped member. Each hollow elbow 202, 203 has a well thickness of about 2.9mm (0.113 inches).

A feed pipe 211 is fused to the elbow 202, whilst a return pipe 212 is fused to the elbow 203. The feed pipe 211 and return pipe 212 each have an internal diameter of 19mm (0.75 inch) and an external diameter of 28mm (1.1 inch). A stepped pipe 206 is secured to the feed pipe 211 and the return pipe 203 by tape 213. The stepped pipe 206 includes an upper section 206A and a lower section 206B which has a diameter less than the

diameter of the upper section 206A.

In use a grouting pipe (not shown) is inserted into the pipe 206 until it abuts the top of the lower section 206B thereof so that the grouting pipe can push the apparatus 201 and the feed pipe 211 and return pipe 212 to the bottom of the wellbore.

In addition, the apparatus 201 is provided with a resilient anchor 214 which extends across the pipe 206 and includes two projecting arms 215, 216. As the apparatus 201 is pushed down the wellbore the arms 215, 216 deflect inwardly. However, if any attempt is made to raise the apparatus 201 the arms 215, 216 dig into the wall of the wellbore and inhibit such movement.

It should be appreciated that the function of the grout is primarily to facilitate heat transfer between the liquid in the pipes and the surrounding soil. However, it is also desirable that the grout should prevent transfer of liquid between strata thus preventing, for example contaminated surface water entering an otherwise potable source of water at a greater depth.

An interesting advantage of the present invention is that whereas it was conventional to make the wellbore from 10 to 16cm in diameter it is now possible to make the wellbore just 7.5cm in diameter. There are three reasons for this. Firstly, conventional drilling rigs for drilling this type of wellbore are only able to handle tubulars with a maximum length of about 6m. However a 6m long sinker of 7.5cm diameter could not be guaranteed to push a pipe to the bottom of a wellbore. Accordingly, the sinkers are conventional nearly 10cm in diameter requiring a wellbore of correspondingly greater diameter. Secondly, after a wellbore has been drilled the earth surrounding the wellbore can, in certain circumstances, tend to expand thereby closing the wellbore. If desired, fluid (conveniently water) can be

pumped down the grout tube 41 as it is lowered down the wellbore. This can help clear any localized constrictions. Thirdly, the fact that the grout tube and the pipe are lowered together seems to require less space than lowering the grout tube after the pipe has been positioned.

The grout tube 41 may be formed by lengths of tube which are secured together as required. However, it has been found particularly advantageous to form the grout tube from coil tubing having an outer diameter of about 2.5cm.

Coil tubing is used in the oil industry for lowering tools into wellbores. It can be stored on drums and is thus very convenient to handle. Within the context of the oil industry it is regarded as having minimal compressive strength and, indeed, in the oil industry rigid tool strings are used in applications where it may be desired to transmit a compressive force from the surface, for example, to release or set a tool. However, in the present context, where wellbores are typically about 75m in depth and rarely more than 150m coil tubing is ideal for pushing the pipe to the bottom of the wellbore.

* * *

The next problem is one of space. As indicated above wellbores are typically drilled at 3.0 to 4.5 m centres. This leads to extensive trenching which is particularly expensive if the surface has already been prepared, for example with reinforced concrete. In order to reduce this problem another aspect of the present invention proposes to use deviated wellbores which extend downwardly and outwardly from a relatively small surface area. This can be seen in Fig. 10 where a

plurality of wellbores 317 extend downwardly and outwardly from a relatively small trench 318. The wellbores 317 are about 75m in depth and 10cm in diameter. At the bottom of the trench 318 the tops of the wellbores 317 are separated by a distance of from 0.6 to 0.9m. Each wellbore 317 is provided with a loop of pipe 319 which is installed as indicated hereinbefore. It will be noted that because of the proximity of the tops of the wellbores 317 the trenching requirements are very modest resulting in a very considerable saving. The remaining components of the system are generally similar to those shown in Fig. 1 and will not be further described.

* * *

Wellbores 317 could be drilled using a portable drilling rig comprising a tower about 6m in height supporting a top drive on a guide track. The guide track could be angled as desired to ensure that the wellbore is drilled in the desired direction. Whilst this would work quite adequately the tower requires significant headroom and thus could not be used within most commercial premises. In addition, the tower would typically extend over much or possibly all the area of trench 318 thus inhibiting grouting commencing until all the wellbores 317 had been drilled.

In order to overcome the problem a yet further aspect of the invention proposes using a downhole motor on coil tubing to drill the wellbores and coil tubing both to insert the pipe into the wellbore and to act as the grout tube.

Fig. 11 shows two drums of coil tubing 615, 616 arranged side by side. The coil tubing 616 is connected to a downhole motor (not shown) drilling wellbore B.

The downhole motor is powered by pumping drilling fluid through the coil tubing 616.

Whilst the wellbore B is being drilled the pipe is inserted in wellbore A by the coil tubing 615 and grouted in place as described previously. As soon as the drilling of wellbore B is completed the downhole motor is withdrawn and moved to start drilling wellbore C. At the same time the coil tubing 615 is used to insert the pipe in wellbore B and inject the grout. As shown in Fig. 12 the pipe 605 is conveniently stored alongside the coil tubing 615.

As shown in Fig. 13 the drilling and grouting equipment is powered from a trailer 320 on which are mounted a shale shaker 321, a de-silter 322, a pump 323 and a hydraulic power unit 324.

In use, pump 323 pumps drilling mud through line 326 to the coil tubing 616 through which it passes to the downhole motor. The drilling mud and debris recovered from the top of the wellbore are returned through line 327 to the shale shaker 321 where the solids are removed. The filtered drilling mud is passed through the de-silter 322 and supplemented by fresh drilling mud which is prepared in mud preparation tank 328 and recycled.

Grout is prepared in a grout unit 329 and is pumped by a Moyneaux (or progressive cavity) pump 330 and line 331 to coil tubing 615 which is used as the grout tube to inject grout intc the wellbore.

Area 332 is used for storing and transporting ancillary equipment. The hydraulic power unit 324 provides power for the drilling unit via line 333 and for the grouting unit via line 334.

Claims

1. A method for installing a pipe in a first wellbore, which method comprises the steps of:

mounting on said pipe an apparatus comprising a body member and means for releasably engaging a grout tube and for receiving a pushing force from said grout tube,

releasably engaging said means with said grout tube,

pushing the apparatus and pipe with said grout tube down to a point within the first wellbore,

releasing the grout tube from the apparatus,

removing the grout tube from the body member and from the first wellbore, and

pumping grout into the first wellbore through the grout tube as the grout tube is removed from the first wellbore.

2. The method according to claim 1, wherein said step of releasably engaging comprises using a friction fit between said grout tube and said means, and said releasing step comprises releasing said friction fit.

3. The method according to claim 1 or 2, wherein said grout tube comprises a rigid grout tube and said method comprises pushing said apparatus and pipe down said wellbore with said rigid grout tube.

4. The method according to claim 1 or 2, wherein said grout tube comprises coil tubing and said method comprises pushing said apparatus and pipe down said wellbore with said coil tubing.

5. The method according to claim 1, 2 or 3, wherein said grout tube comprises separate lengths and said method further comprises the step of securing said lengths of grout tube together as said pipe is inserted into said wellbore.

6. The method according to claim 1, 2, 3, 4 or 5, further comprising the step of holding said pipe in light tension as it is pushed down said wellbore by said grout tube, whereby separation of said apparatus and said pipe from said grout tube is inhibited.

7. The method according to claim 6, wherein when said apparatus and said pipe reach said point in said wellbore, the method further comprises the step of relaxing said tension on said pipe and pumping said grout down said grout tube to effect separation of said grout tube from said apparatus.

8. The method according to any one of claims 1 to 7, wherein said step of releasing the grout tube from the apparatus comprises the step of pulling up on said grout tube.

9. The method according to claim 8, wherein in order to facilitate separation of said grout tube and said apparatus, the method further comprises the step of holding said apparatus in place whilst said grout tube is pulled up.

10. The method according to any one of claims 1 to 9, further comprising, prior to introducing the apparatus into the first wellbore, drilling the first wellbore with drilling apparatus.

11. The method according to claim 10, further comprising pivoting the drilling apparatus, and drilling a second wellbore spaced apart from the first wellbore whilst the first wellbore is grouted.

12. The method according to claim 11, wherein the top of the first wellbore is spaced apart less than 1m from the top of the second wellbore.

13. The method according to claim 12, wherein said second wellbore extends downwardly and away from said first wellbore.

14. The method according to claim 10, 11, 12 or 13, further comprising pivoting the drilling apparatus from the second wellbore, commencing drilling of a third wellbore spaced apart from the first and second wellbores, and grouting the second wellbore while drilling the third wellbore.

15. For use in the method as claimed in any one of claims 1 to 14, an apparatus for installing a pipe in a wellbore, which apparatus comprises a body member securable to said pipe, and means for releasably engaging a grout tube and for receiving a pushing force from said grout tube, the arrangement being such that, in use, after said body member has been secured to said pipe said grout tube can be engaged with said means and used to push on said apparatus, whereby said pipe is pulled into said wellbore.

16. The apparatus as claimed in claim 15, wherein said body member comprises two pieces securable around a loop in said pipe.

17. The apparatus as claimed in claim 15 or 16, further comprising a loop of pipe connected to said body member.

18. The apparatus as claimed in claim 15, wherein said body member comprises a hollow member having a fluid flow channel therethrough and having an inlet connectable to a feed pipe, and an outlet connectable to a return pipe.

19. The apparatus as claimed in claim 15, 16, 17 or 18, wherein said means comprises a rod about which the grout tube can be emplaced and from which the grout tube can be released.

20. An apparatus as claimed in claim 15, 16, 17 or 18, wherein the means on the body member comprises a tubular

member into which the grout tube is insertable and from which the grout tube is releasable.

21. The apparatus as claimed in any one of claims 15 to 20, wherein said body comprises a shoulder against which said grout tube may be pushed in use.

22. The apparatus as claimed in any one of claims 15 to 20, wherein said body comprises a face against which said grout tube may be pushed in use.

23. The apparatus as claimed in any one of claims 15 to 22, further comprising anchor means for anchoring said apparatus in a wellbore.

24. The apparatus as claimed in Claim 23, wherein said anchor means comprises at least one arm which, when said apparatus is inserted into a wellbore is deflected inwardly but which, when said apparatus is withdrawn engages the wall of said wellbore to inhibit withdrawal of said apparatus.

25. The apparatus as claimed in any one of claims 15 to 24, further comprising said grout tube releasably connected to said body member.

26. A system for drilling wellbores and for installing pipes in said wellbore, said system comprising apparatus for drilling wellbores, apparatus for installing a pipe in said wellbores, and apparatus for grouting said pipe in said wellbores, characterised in that said apparatus for installing said pipe in said wellbore comprises an apparatus as claimed in any one of claims 15 to 25.

27. The system as claimed in claim 26, wherein said apparatus for drilling wellbores is pivotable upon completion of drilling of a first wellbore to commence drilling of a second wellbore.

28. The system as claimed in Claim 26, wherein said apparatus for inserting a pipe in said wellbore and said apparatus for grouting are pivotable to grout a second wellbore upon completion of grouting of a first wellbore.

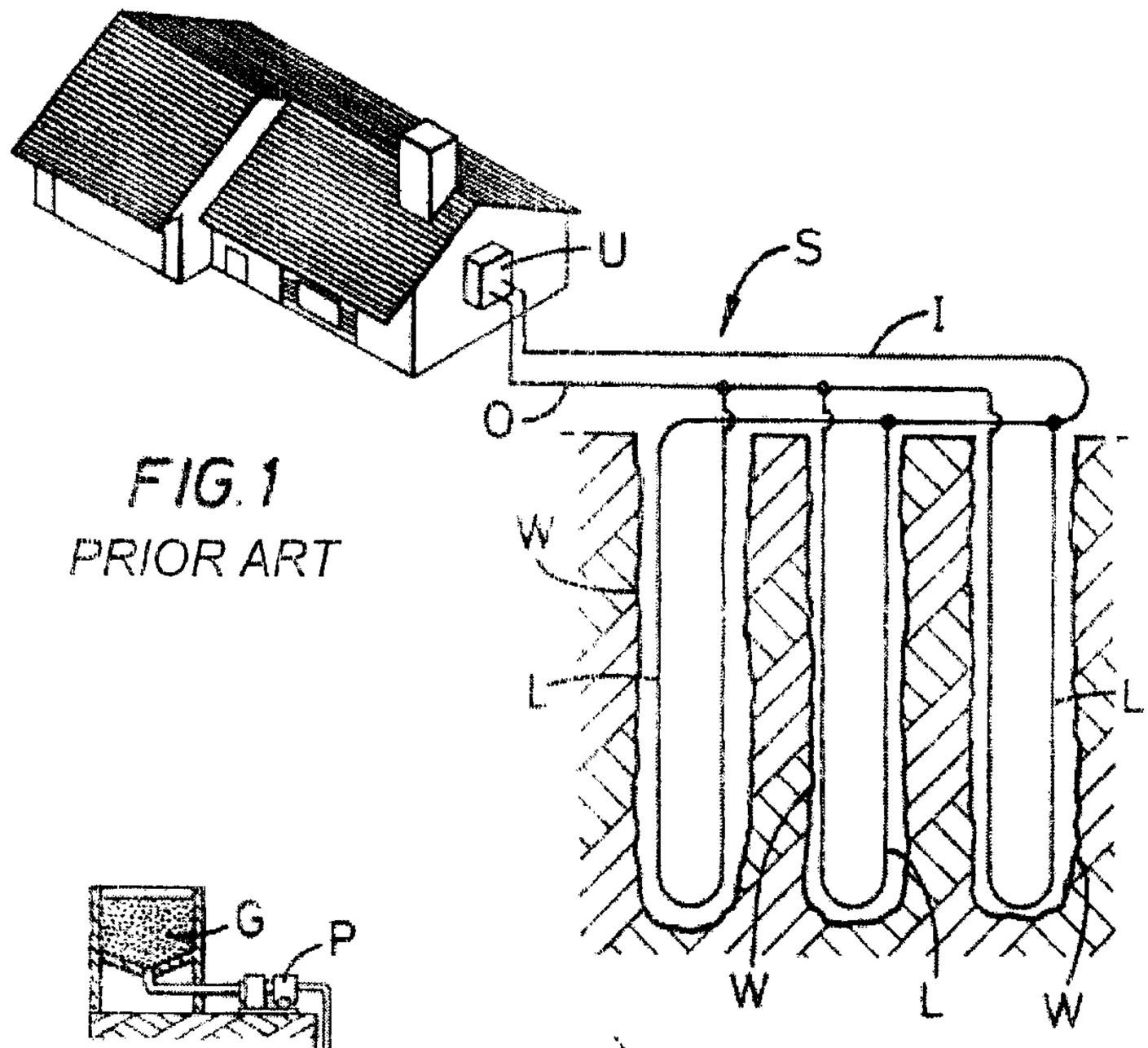


FIG. 1
PRIOR ART

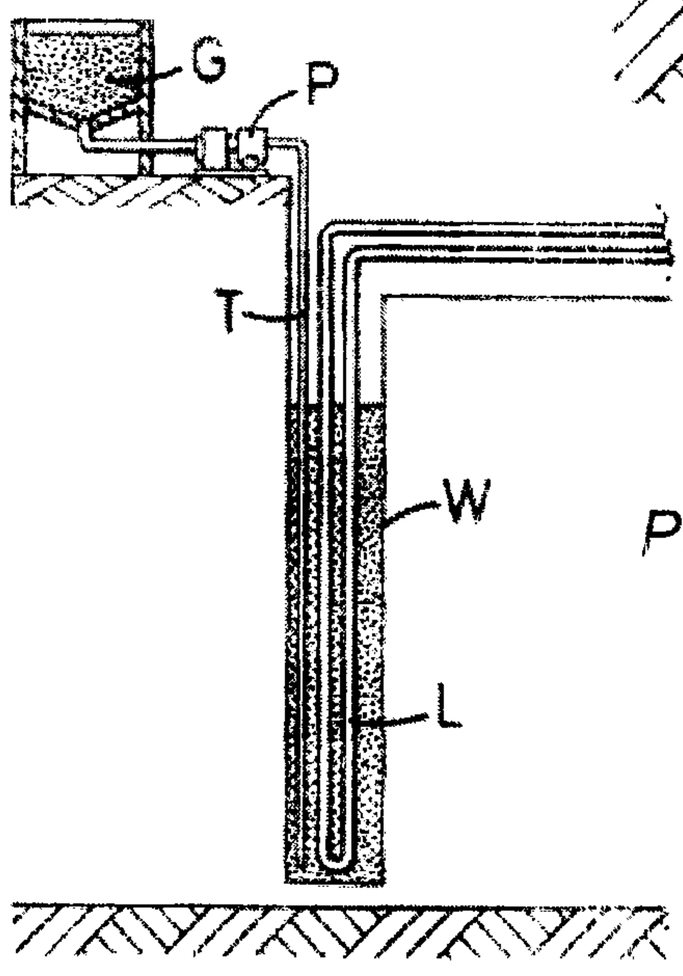
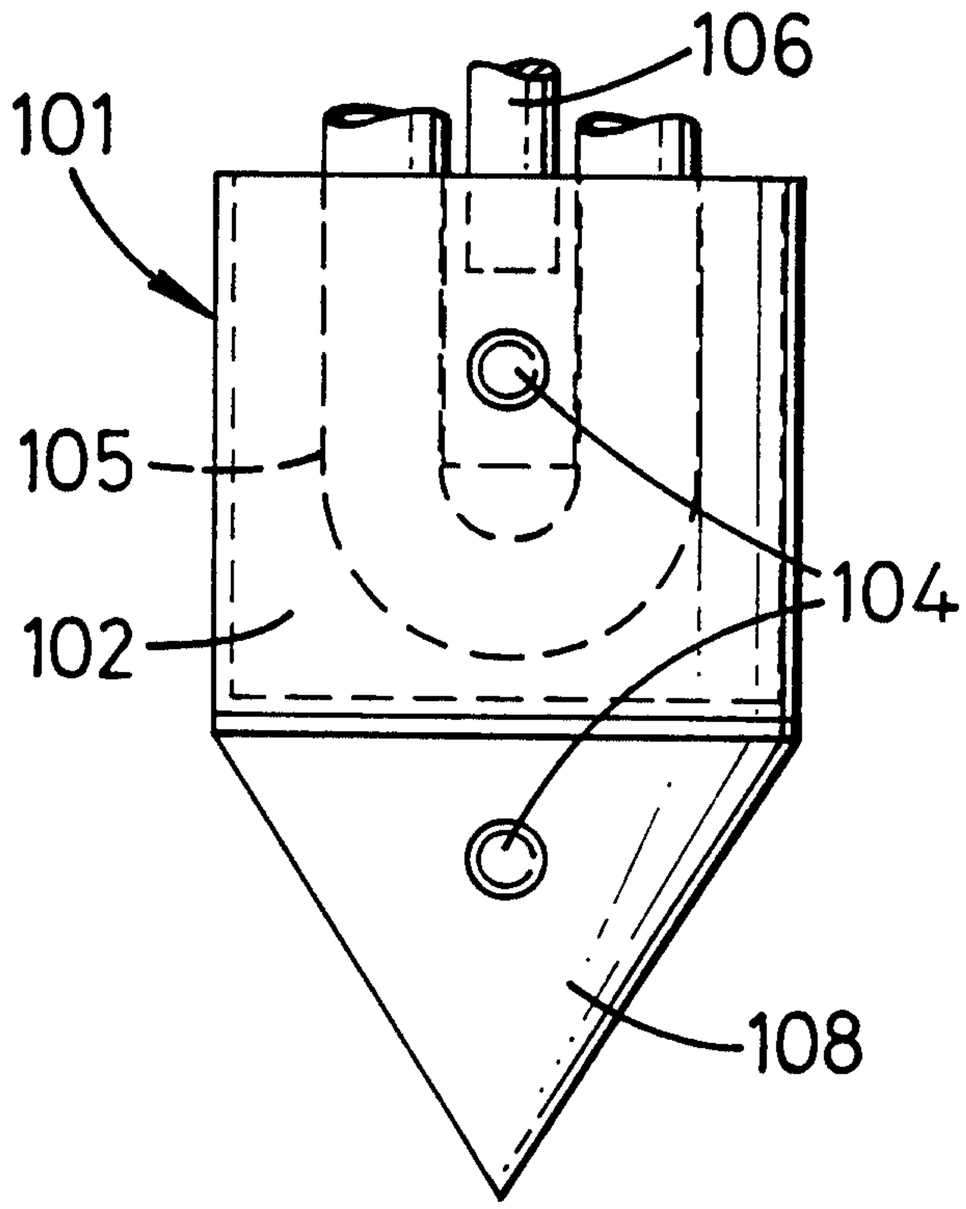


FIG. 2
PRIOR ART

FIG. 3



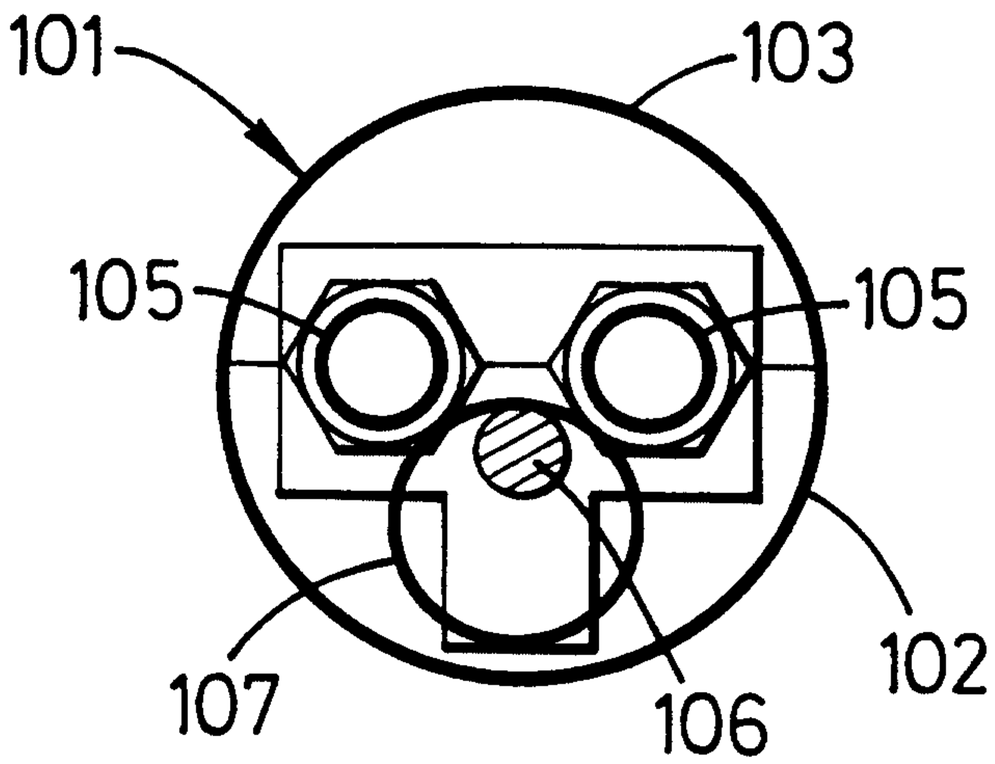


FIG. 4

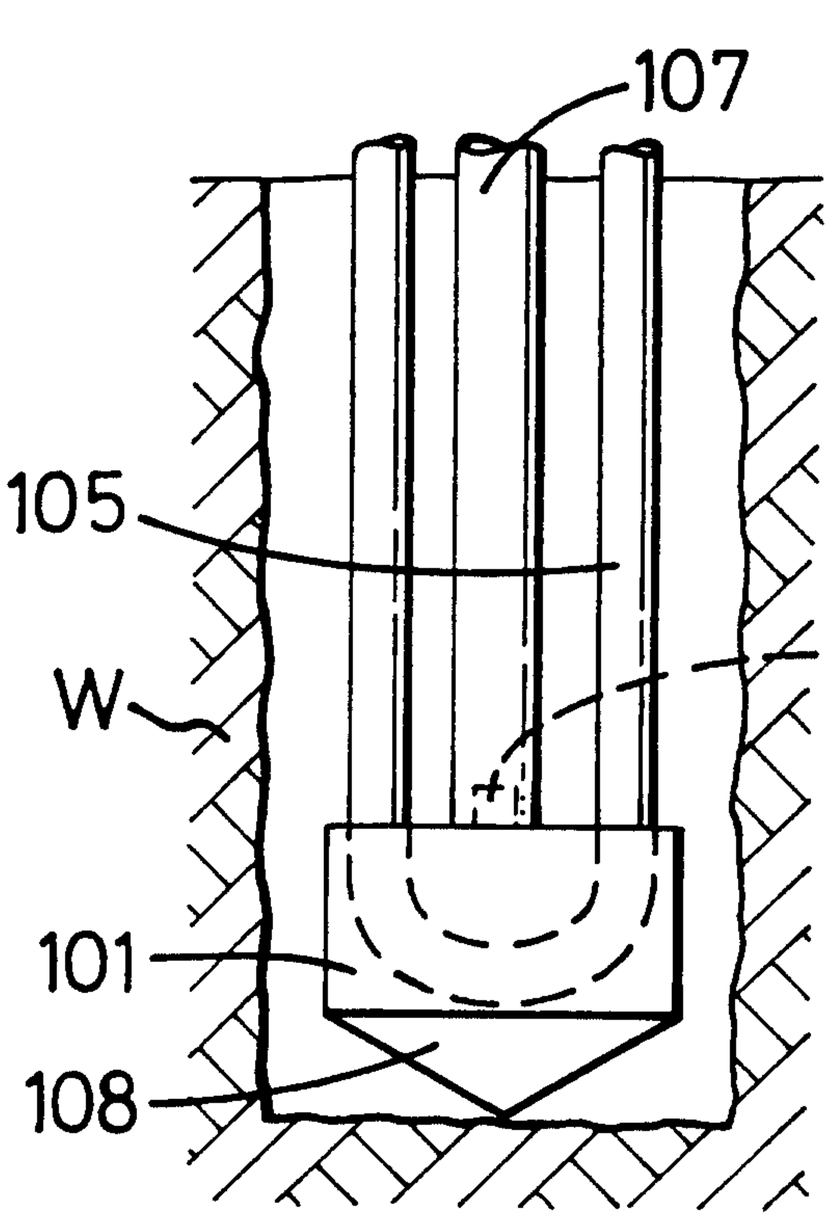


FIG. 5

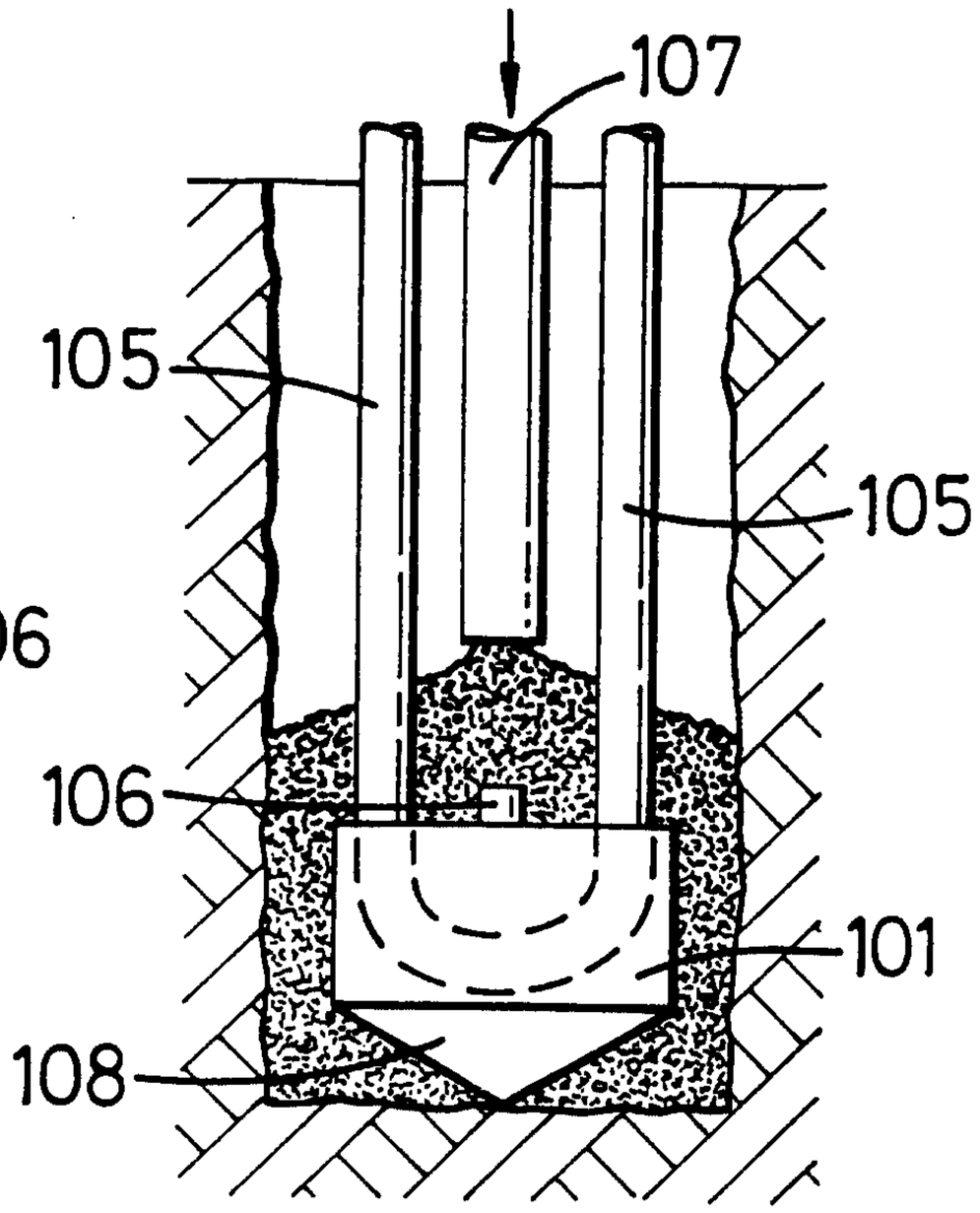


FIG. 6

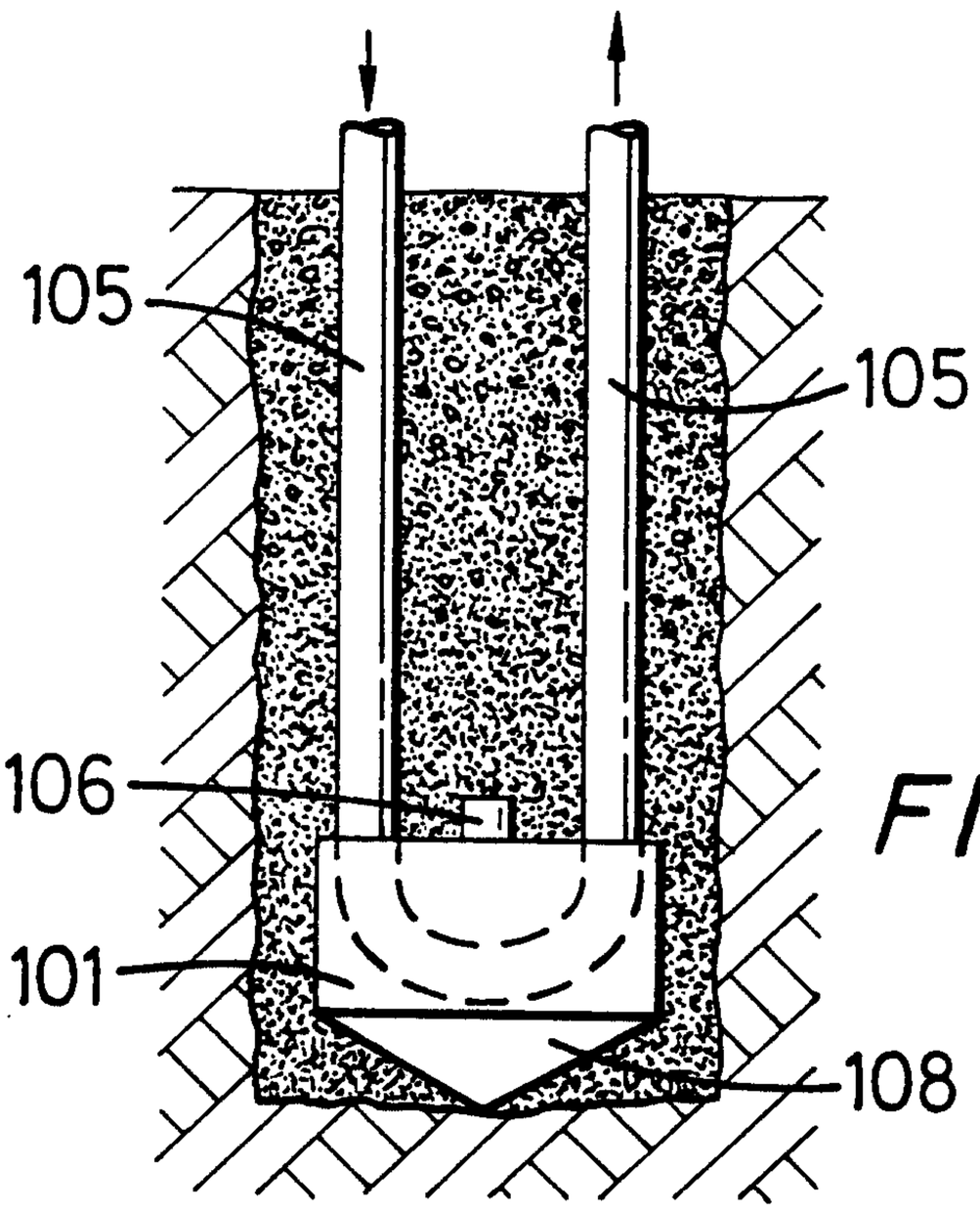
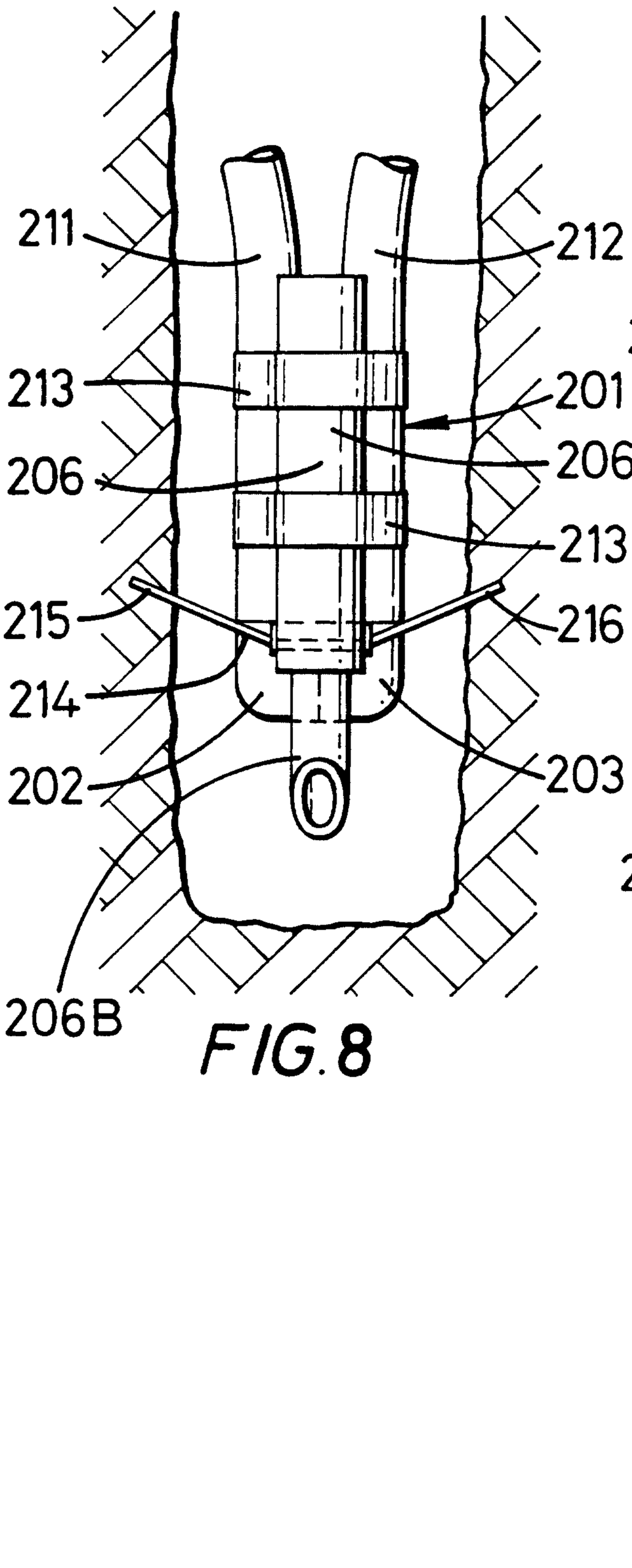


FIG. 7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212
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206A
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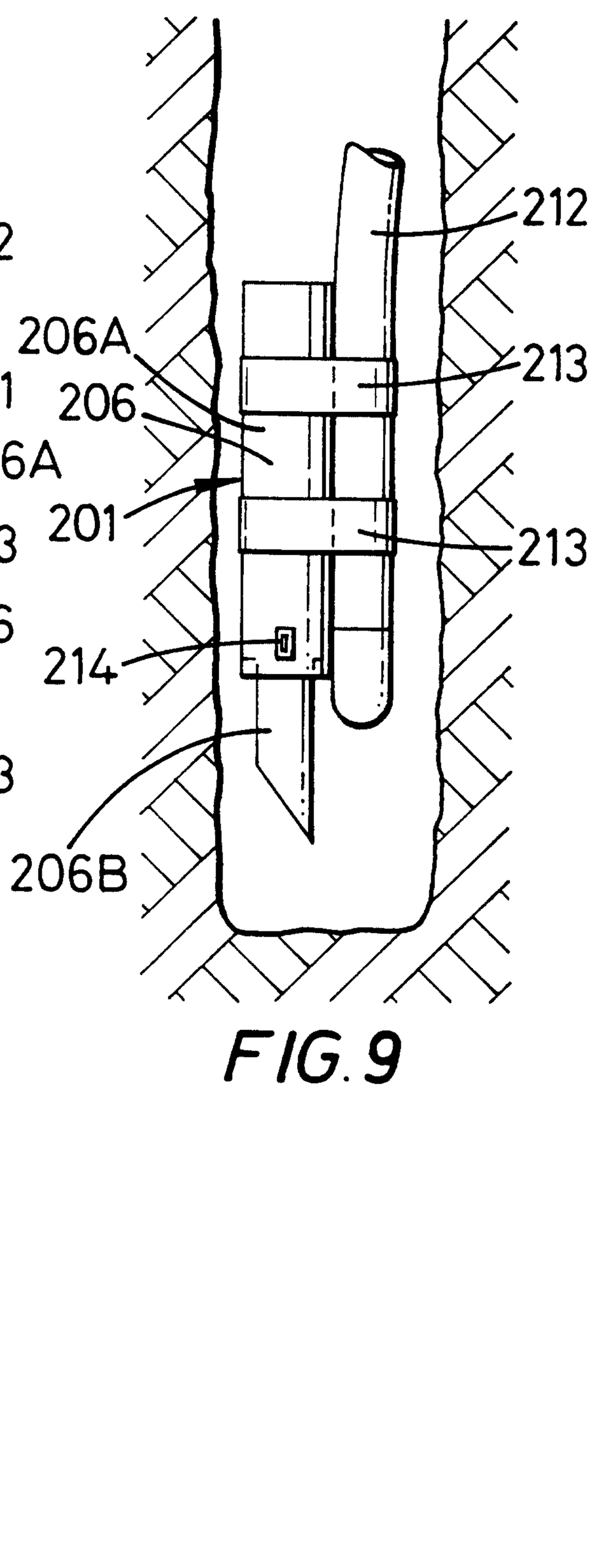
206B

FIG. 8


212
206A
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206B

FIG. 9

FIG. 10

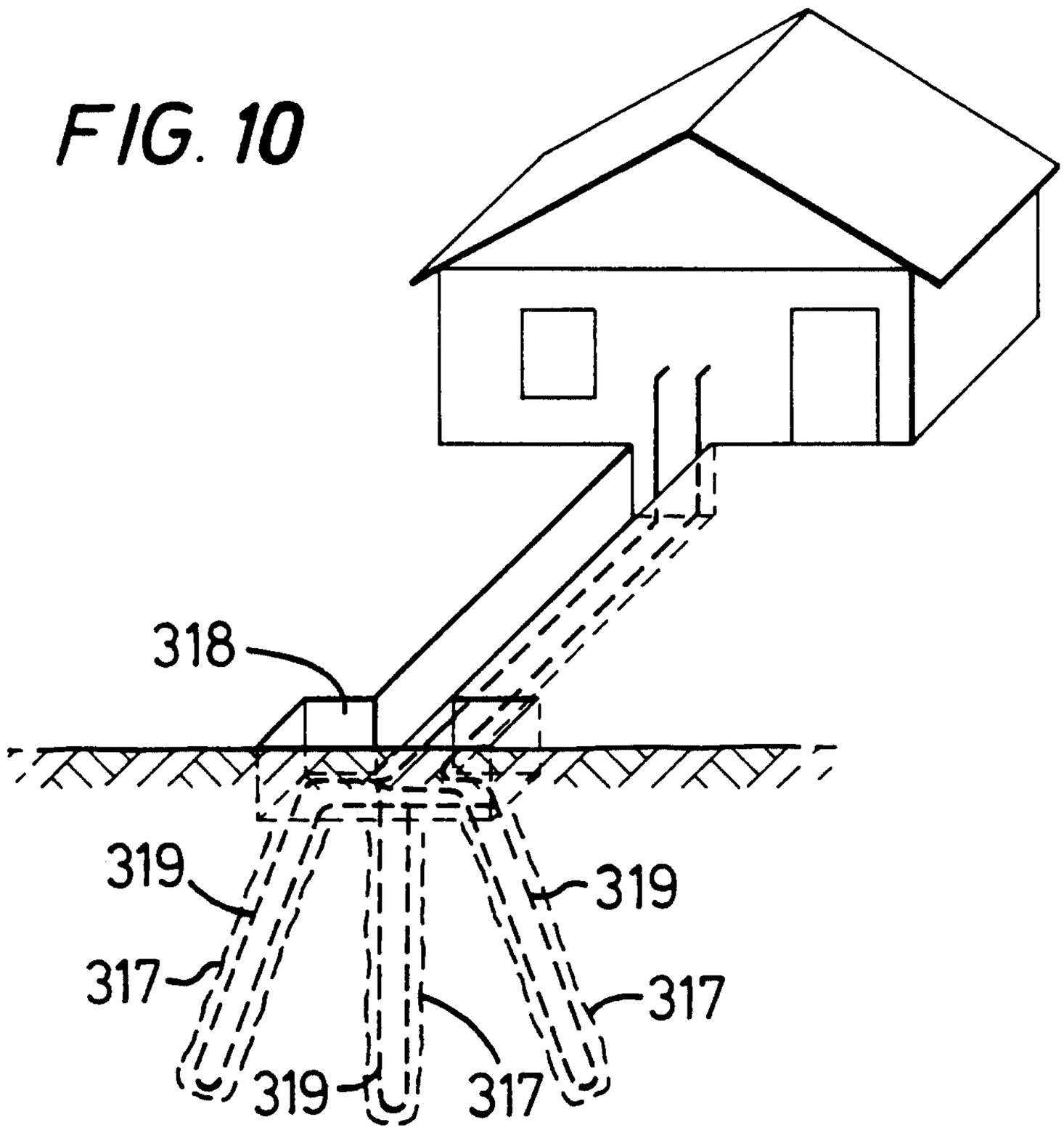


FIG. 11

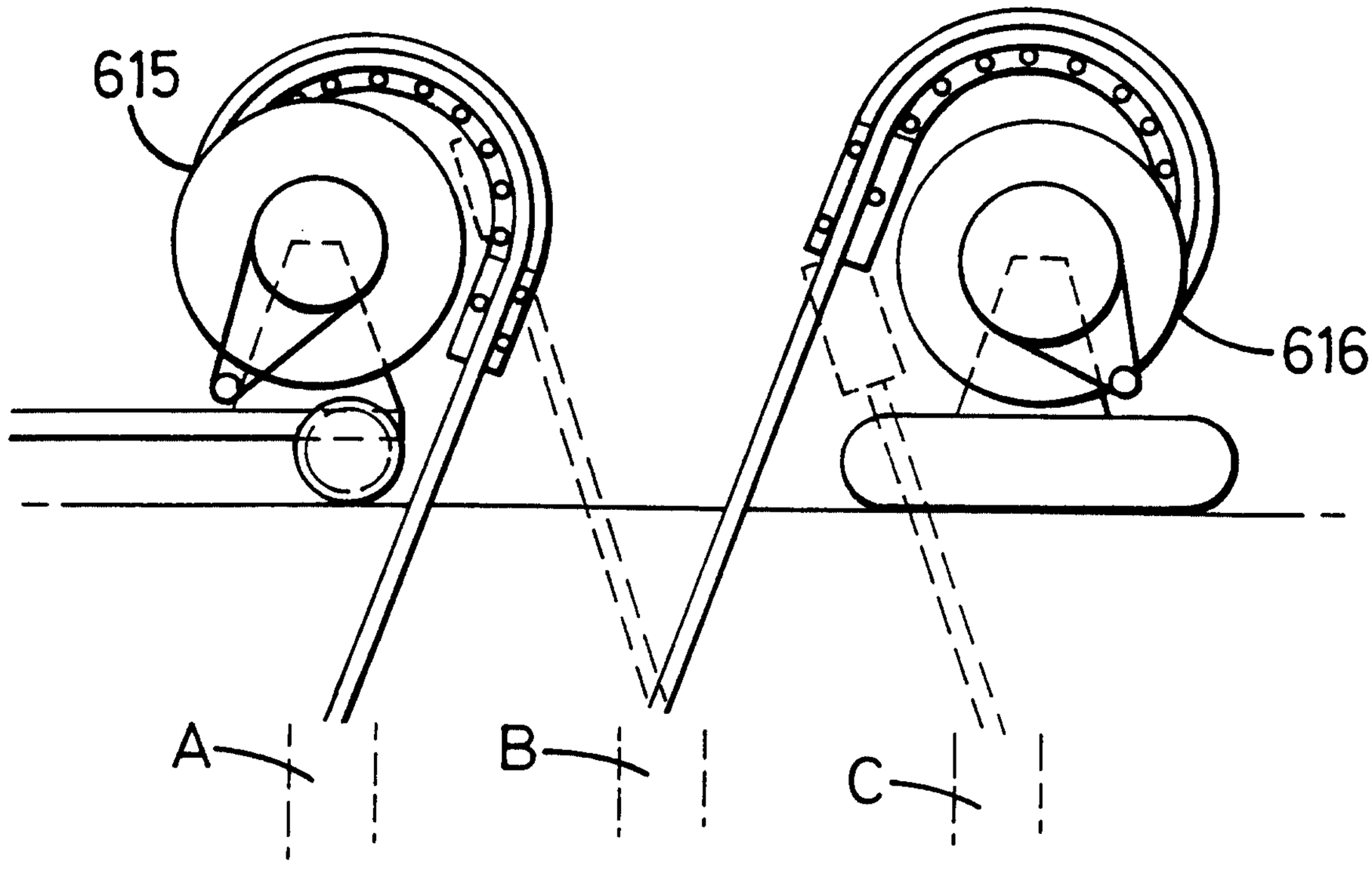


FIG. 12

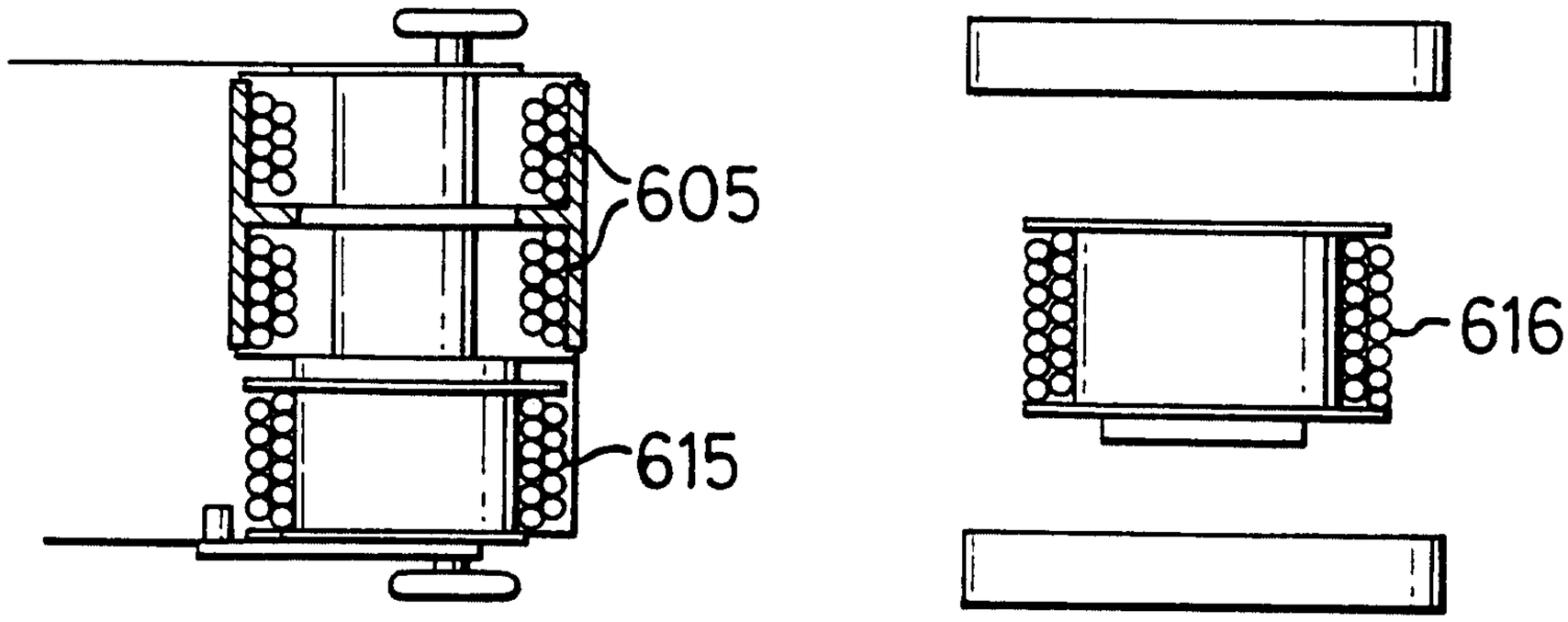
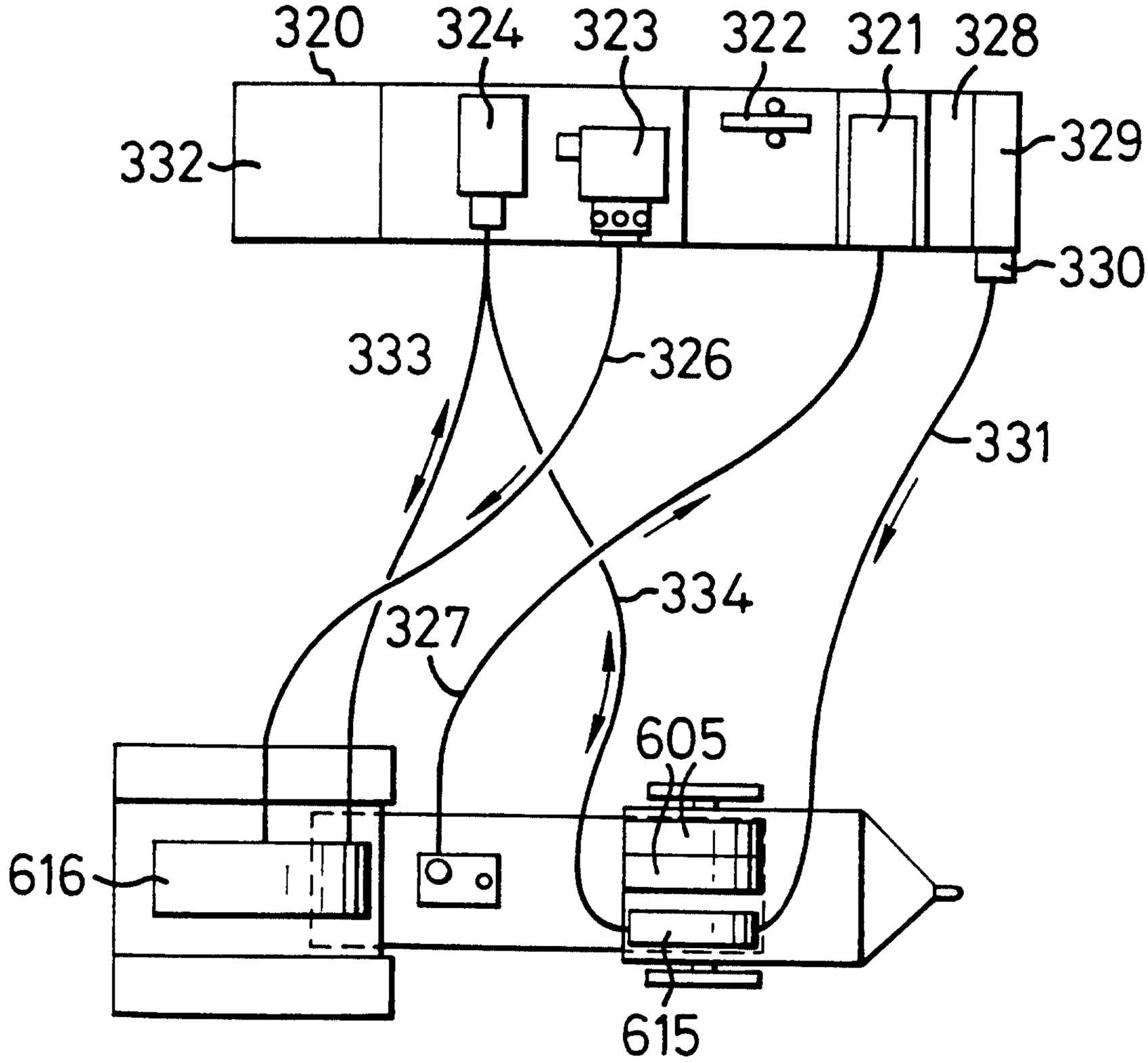


FIG.13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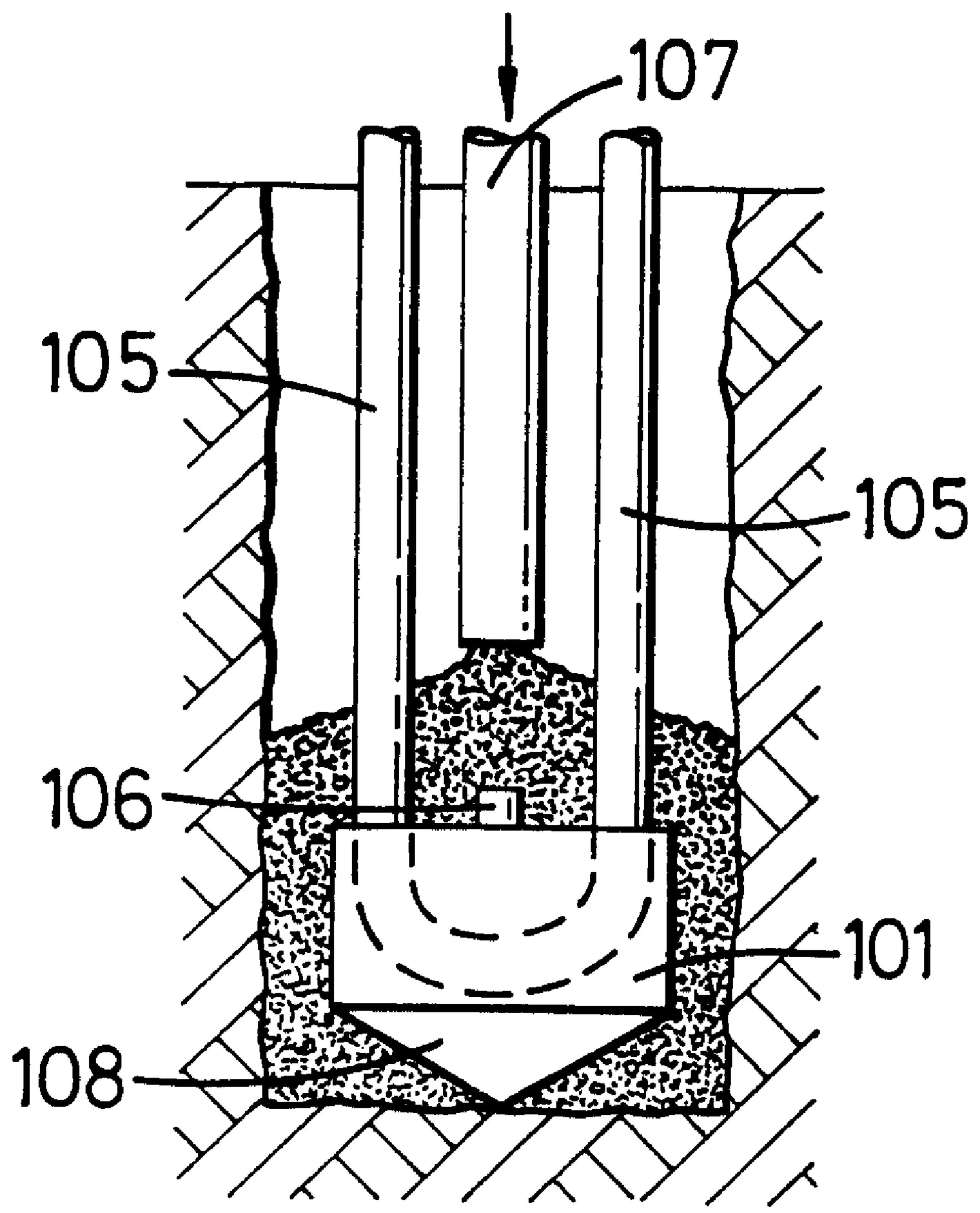
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