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METHOD FOR INSTALLING NONDISPLACEMENT SAND DRAINS

Filed Jan. 8, 1964 3 Sheets-Sheet 1

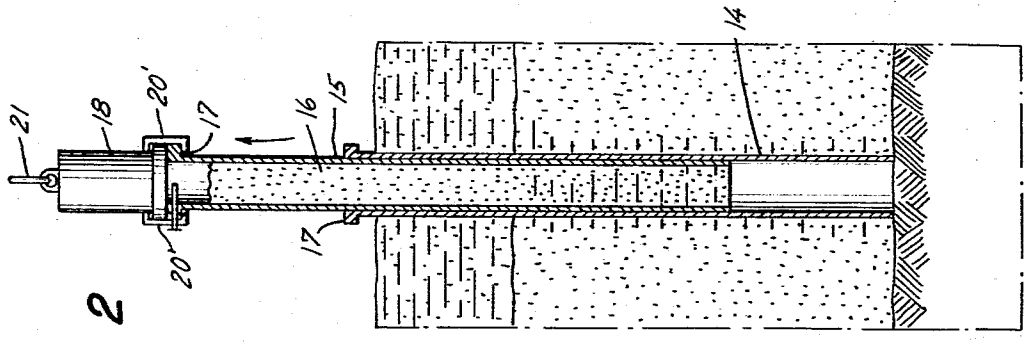

FIG. 2

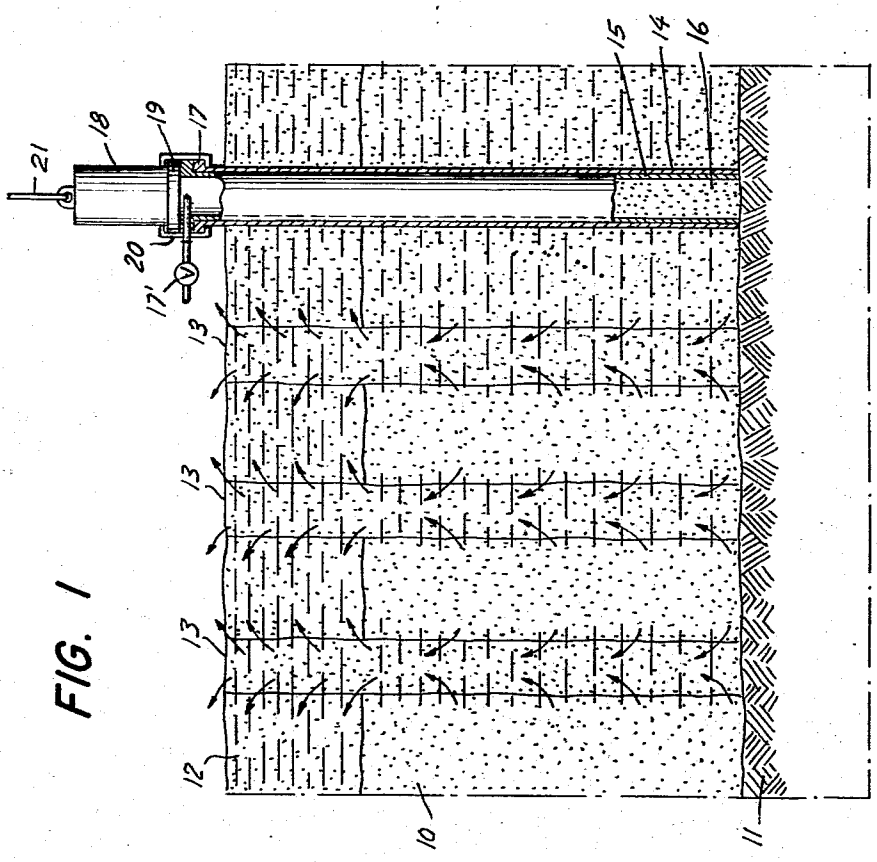

FIG. 1

METHOD FOR INSTALLING NONDISPLACEMENT SAND DRAINS

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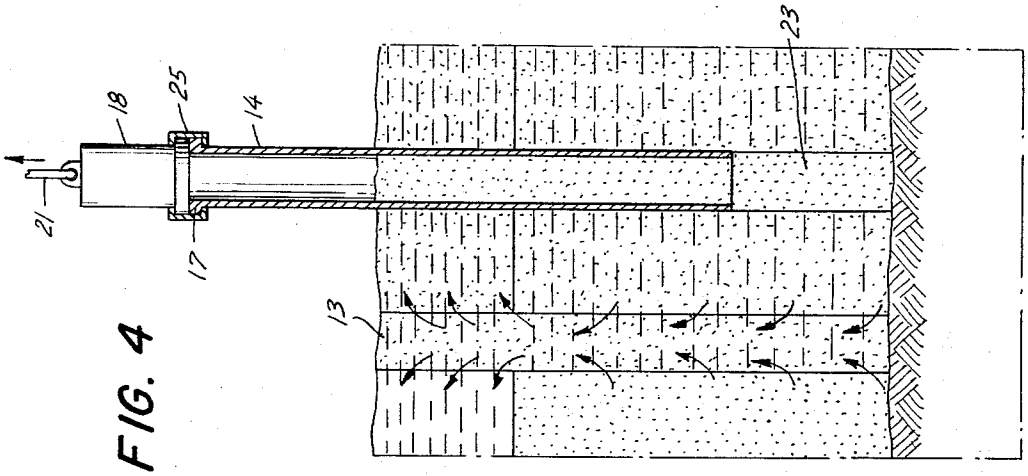

FIG. 4

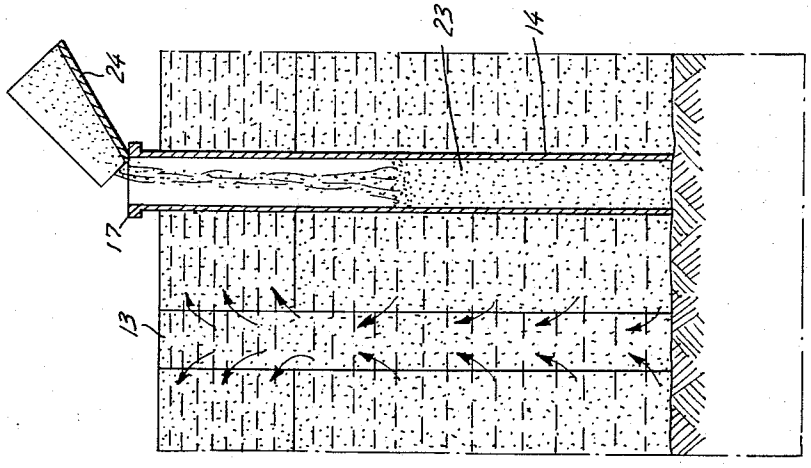

FIG. 3

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FIG. 7

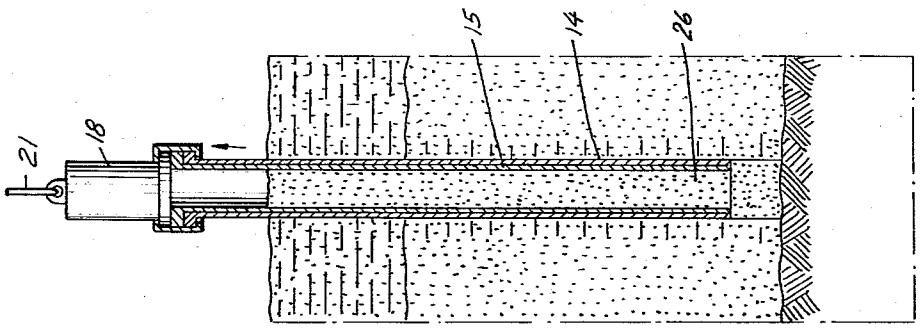


FIG. 6

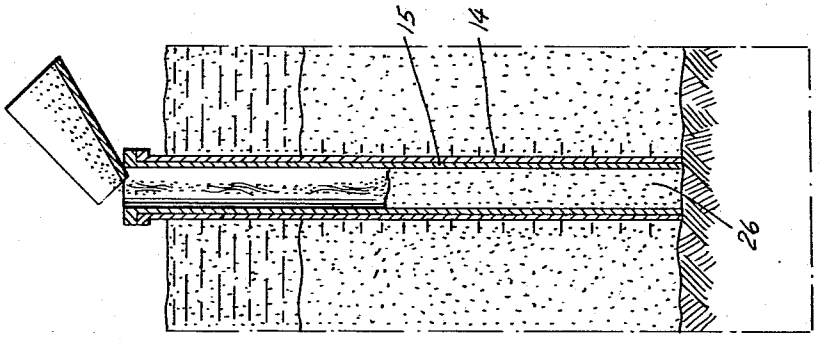
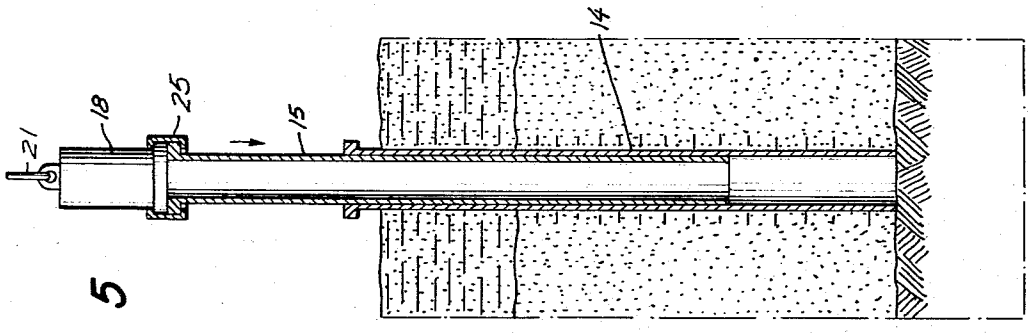


FIG. 5



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METHODS FOR INSTALLING NONDISPLACEMENT SAND DRAINS

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5 Claims. (Cl. 61—10)

This invention relates to methods and equipment for installing so-called "sand drains."

Sand drains comprise columns of sand installed in boggy or water-saturated earth and they are used extensively for the removal of water from silty, sandy or other soil deposits which would not otherwise be sufficiently stable properly to support installations such as highways, air fields, etc. By applying a so-called surcharge or extra load to the general area, the ground is caused to settle as the water therein flows upward through the sand drains and out of the area. The usual method of installing such sand drains consists of driving as by the use of a pile driving hammer, a casing into the ground to the desired depth of the sand drain, such casing being closed at its lower end during driving by providing some form of closure plate at the bottom end of the casing hingedly mounted so that after the casing has been driven, the closure plate may be opened and as the casing thereafter is withdrawn from the earth, sand is poured therein and caused to be deposited in the ground as the casing is drawn upwardly.

Such sand drains are usually installed with spacings between centers thereof of from 5 to 10 feet or thereabouts. As the drains are installed by this usual method, the ground tends to be displaced and oftentimes moves laterally. Some heaving of the ground surface may also occur. Such ground movements due to displacements caused by the casing being driven into the ground, oftentimes may disturb to some degree or tend to destroy the adjacent sand drains previously installed. In some cases, the effect of these displacements has been so severe as to shear off adjacent sand drains as the earth is moved horizontally. Also, with this customary method of installing sand drains, the earth displacing effects caused by driving the closed end casings into the ground tends to compress or remold the soil adjacent to the casing, thereby reducing the water percolating properties of the soil and the dewatering effect desired of the sand drains.

The method of the present invention makes possible the avoidance of the above described difficulties and shortcomings of the usual method. In accordance with the present invention, and outer casing is used together with an inner casing fitting quite closely inside the outer casing and the two casings, one inside the other, are as an assembly caused to penetrate into the ground to a desired depth preferably by means of a suitable known type of vibrator or vibrating hammer. During the driving of the casings, the bottom ends thereof are left open so that a mass or plug of earth is allowed to remain therein and to rise up inside the assembly. After the casing assembly has been lowered or driven down to the desired depth for the sand drain, the inner casing is then withdrawn carrying with it, its contained plug or mass of earth. Thereafter the outer casing is filled with sand and the casing removed using the vibrator means as a tool aiding in such withdrawal.

With the method of the present invention utilizing two tubes, one inside the other, the displacement effects against the earth as above described are substantially overcome by reason of the fact that the lower ends of the tubes are left open so that the material which would otherwise be displaced will remain in the inner casing and tend to rise inside the double tube casing to the extent necessary to displace that amount of earth which becomes displaced

by the presence of the walls of the casings. Such avoidance of the displacement effects in the surrounding earth is particularly effective when the casings are installed by the use of vibrating means. Apparently the vibrating effect tends to destroy any friction or arching action of the earth plug inside the inner casing thereby allowing it to rise more easily than would be the case if the double wall casing were driven by conventional pile driving hammer means. Also when the double tube casing is installed by utilizing vibrator means, allowing the material which would othewise be displaced to rise up inside the tubing, the material adjacent to the outside of the assembly does not tend to become nearly so compressed or remolded as would be the case if the tubular assembly were installed with a closed lower end as has heretofore been the common practice. Accordingly, the present invention substantially eliminates the danger of damage to previously installed adjacent sand drains which heretofore occurred because of earth displacement effects and at the same time greatly reduces the remolding or compressing that would normally be experienced in the adjacent earth, thereby leaving the adjacent earth in a condition in which it will readily yield up its moisture or water content allowing same to flow into and upwardly within the sand drains.

Another advantage of carrying out the present invention by the use of a vibrator hammer means for driving the casings into the earth resides in the fact that the so-called leaders necessary on usual pile driving hammer equipment are not required and instead the vibrator means may be rigidly affixed to the upper end of the double wall casing assembly and may be guided quite accurately with the hoisting lines from a crane boom. Due to the absence of such leaders, much lighter equipment may be utilized thereby reducing the time and expense of installing the sand drains. However, pile driver leaders may be used if desired in carrying out the present invention.

In practicing the present invention, particularly with the use of vibrator and crane boom equipment, it will be apparent that upon removing the inner casing containing a plug of earth, it will later be necessary, after removing such earth, to reassemble the two casings for use in installing the next sand drain of the project. Any difficulties of reassembling the two casings in telescoping relation may readily be avoided and the reassembling expedited according to a further aspect of the invention or variation of the method. That is, after the inner casing has been withdrawn and the earth plug removed thereform, the inner casing may, while still in a vertical position, be reinserted into the outer tubular casing which is still in the earth after which the sand may be admitted into the interior of the inner casing while embraced by the outer casing. Then finally the two casings while in assembled relation may be withdrawn leaving the desired sand drain in position in the earth and with the two casings now assembled in telescopic relation ready for use for forming the next sand drain.

Various further and more specific objects, features and advantages of the invention will appear from the description given below taken in connection with the accompanying drawings, illustrating by way of examples preferred methods for carrying out the invention and the equipment therefor.

In the drawings:

FIG. 1 is a view showing in vertical section a plurality of sand drains which have been installed in the earth and also showing equipment being used to install another sand drain;

FIG. 2 is a view illustrating the withdrawal of the inner casing containing the plug of earth;

FIG. 3 is a view illustrating the filling of the outer casing with sand to form the sand drain;

FIG. 4 is a view illustrating the withdrawal of the outer casing leaving the sand forming the sand drain in place;

FIG. 5 is a view illustrating one step in an alternative embodiment of the invention and according to which the inner casing after withdrawal and removal of the plug of earth therefrom is being reassembled by telescopically lowering same into the outer casing again;

FIG. 6 is a view illustrating the next step of filling the casing assembly with sand according to such alternative method; and

FIG. 7 is a view illustrating the final step of the alternative method of removing the assembly of the inner and outer casings leaving the sand for forming the sand drain in place.

Referring to the drawings in further detail, there is shown in FIG. 1, somewhat schematically, a vertical sectional view through masses of earth in which sand drains are being installed. For example, there is here indicated a mass of water-saturated earth **10** which in the usual situation may extend down to a considerable depth, for example from 50 to 75 feet before reaching a firm base as at **11** of solid earth or rock. A blanket comprising a layer of coarse sand as at **12** is shown spread over the top of the water-saturated mass and on which construction work may later be done, for example, the building of a road. Several of the completely installed sand drains are indicated as at **13**, extending down from the top of the sand blanket to the firm earth below the saturated material. It may be noted that for clearness the sand drains are here shown of larger diameter in proportion to their length than those usually installed, particularly if the saturated soil extends to a very considerable depth. As indicated by the arrows at each of the sand drains, the water or moisture within the saturated earth **10** flows into the sand drains, thence upwardly into the sand blanket or out onto same from which the water may flow away.

As further shown in FIG. 1, a tubular outer shell or casing **14** of sheet steel or other metal or reinforced plastic material is shown in a position closely fitting or embracing an inner shell **15**, this shell assembly having been installed in the water-saturated earth and down to the firm base, and the inner shell meanwhile having become filled with a plug of the saturated earth such as indicated at **16**. The upper end of casing **14** may be formed with a protruding annular flange **17**. A vibrator or vibrator hammer of some suitable known type is somewhat schematically indicated at **18**. This should be of a construction such as will impart to a flange or base **19** thereof, vibratory action sufficient for causing the casing assembly rapidly to be lowered or driven down through the soft water-bearing earth. The flanges at **17** and **19** may be removably secured together as by suitable flange clamping means, somewhat schematically indicated at **20**.

As shown in FIG. 2, the inner casing **15**, now containing the plug of earth **16**, is being pulled up along the vibrator means by suitable hoisting means (not shown) which may be connected as at **21** to the vibrator hammer means **18**. Here, a clamping means as at **20'** which connects the base of the vibrating means to the top of the inner casing **15** has been put in place so as to connect these parts together, and by replacing the clamping means **20** of FIG. 1. That is, the clamping means **20'** connects the vibrating means only to the top of the inner casing, leaving the outer casing **14** and its flange **17** down in place.

It may be noted that as the inner casing is being withdrawn as shown in FIG. 2 with the plug of moist earth **16** therein, any tendency for this plug of earth to slide down back into the outer casing will be checked not only because same will have been to some degree compacted within the inner casing, but also since the upper end of this casing may be provided with a small valve **17'** (see FIG. 1) which will be open during the lowering or sinking operation so that air pressure will not build up in the upper part of the casing as the plug rises in the casing, but after the lowering or sinking operation has been completed, the valve will be closed so that any sliding down of the earth plug will tend to be checked by the reason of creation of vacuum conditions within the upper end of the casing. Then when the casing **15** is completely withdrawn, the valve will be opened releasing any vacuum effect therein and allowing the plug of earth more readily to be removed.

FIG. 3 shows the next step according to which the outer casing as left in place is being filled with a body of sand **23** as discharged from any suitable form of filling spout **24**. When the outer casing is thus completely filled with sand, it is removed by withdrawing same upwardly as shown in FIG. 4, where the upper end of the casing **14** is shown as again interconnecting by clamping means as at **25**, with the vibrating means **18** and being pulled up by the hoist connection **21**. During this step, the body of sand **23** will remain lodged in the cavity in the earth from which the outer casing **14** is removed, thereby completing the sand drain.

With the somewhat different embodiment of the invention as shown in FIGS. 5–7, after the inner casing **15** with the earth plug has been withdrawn as shown in FIG. 2, then the earth plug may be washed out or otherwise removed from the casing **15** while it is still being suspended vertically if desired by the hoisting means. Thereafter in order to reassemble the casings, as shown in FIG. 5, the inner casing **15**, now empty, may be again lowered into the outer casing **14** which has remained in the earth. Then, as shown in FIG. 6, the inner casing may be filled with a body of sand **26** for forming the sand drain. Finally, as shown in FIG. 7, the assembly of the inner and outer casings **14** and **15** may be withdrawn from the earth leaving the body of sand **26** in place, thereby forming the completed sand drain. Then the assembly of the inner and outer casings will be ready for use over again as in FIG. 1. This method of using and reassembling the inner and outer casings while having both remain in vertical positions may be more readily carried out by using a vertically moving hoisting means than would be the case if it were attempted to reassamble the inner casing again with the outer casing after both had been used and removed and were for example placed in horizontal positions.

Although certain particular embodiments of the invention are herein above disclosed for purposes of explanation, further modifications thereof after study of this specification may be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. Method for installing sand drains in water-bearing earth which comprises: lowering into such earth an outer shell surrounding an inner shell while allowing a plug of the water-bearing earth freely to enter up into the inner shell through the lower ends of the shells; then withdrawing the inner shell containing said plug removing said plug from the withdrawn inner shell and reinserting the inner shell into the outer shell; thereafter introducing sand into space within the outer shell; and finally withdrawing the assembled shells while, leaving said sand to provide the desired sand drain.

2. Method in accordance with the foregoing claim **1** wherein said shells are lowered into such earth by the aid of vibratory forces.

3. Method in accordance with the foregoing claim **1** wherein said assembled shells are finally withdrawn by the aid of vibratory action.

4. Method for installing sand drains in water-bearing earth which comprises: lowering into such earth an outer shell surrounding an inner shell while allowing a plug of the water-bearing earth to enter up into the inner shell through the lower ends of the shells; then withdrawing the inner shell containing said plug while retaining the upper portions of the inner shell closed, thereby providing a

vacuum effect therein tending to check the plug against sliding down during such withdrawal of the inner shell; thereafter introducing sand into space provided within the outer shell; and finally withdrawing the outer shell, leaving said sand to provide the desired sand drain.

5. Method for installing sand drains in water-bearing earth which comprises: lowering into such earth by the aid of vibratory action an outer shell surrounding an inner shell while allowing a plug of the water-bearing earth to enter up into the inner shell through the lower ends of the shells and while allowing air to escape from the upper end of the inner shell; then withdrawing the inner shell containing said plug while retaining the upper portions of the inner shell closed, thereby providing a vacuum effect therein tending to check the plug against sliding down during such withdrawal of the inner shell; thereafter introducing sand into space provided within the outer shell; and finally withdrawing the outer shell by the aid of vibratory action, leaving said sand to provide the desired sand drain.

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EARL J. WITMER, *Primary Examiner.*