

[54] **METHOD FOR CONSOLIDATING IMPERMEABLE SOILS AND PILE PROVIDED THEREBY AS FITTED WITH SPACED APART ENLARGEMENTS**

[76] Inventor: **Rosanna Taranto**, Corso Vittorio Emanuele 167/c, Napoli, Italy

[22] Filed: **Apr. 19, 1972**

[21] Appl. No.: **245,600**

[30] **Foreign Application Priority Data**

Dec. 14, 1971 Italy 40450/71

[52] U.S. Cl. 61/35, 61/53.52, 61/53.6

[51] Int. Cl. E02d 3/04, E02d 3/08, E02d 5/34

[58] Field of Search 61/35, 36 R, 53.68, 53.52, 61/53.6

[56] **References Cited**

UNITED STATES PATENTS

1,265,164 5/1918 Barry 61/53.6
1,404,925 1/1922 Blumenthal 61/36 R

2,025,948 12/1935 Jorgensen 61/36 R
2,196,211 4/1940 Hartman 61/36 R
3,099,911 8/1963 Turzillo 61/53.6
3,184,924 5/1965 Staunau 61/56.5
3,492,823 2/1970 Lamberton 61/53.6
3,518,834 7/1970 Gnaedinger et al. 61/36 R

FOREIGN PATENTS OR APPLICATIONS

703,654 2/1954 Great Britain 61/35

Primary Examiner—W. C. Reynolds

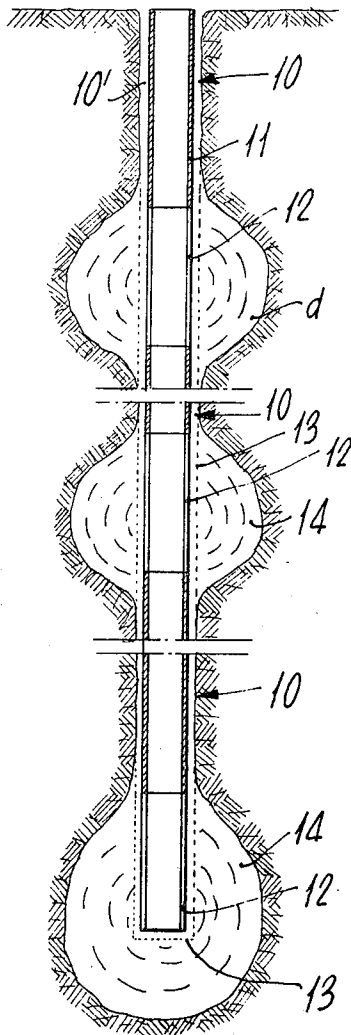
Assistant Examiner—Alex Grosz

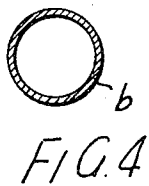
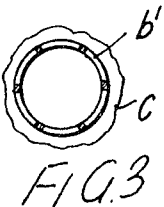
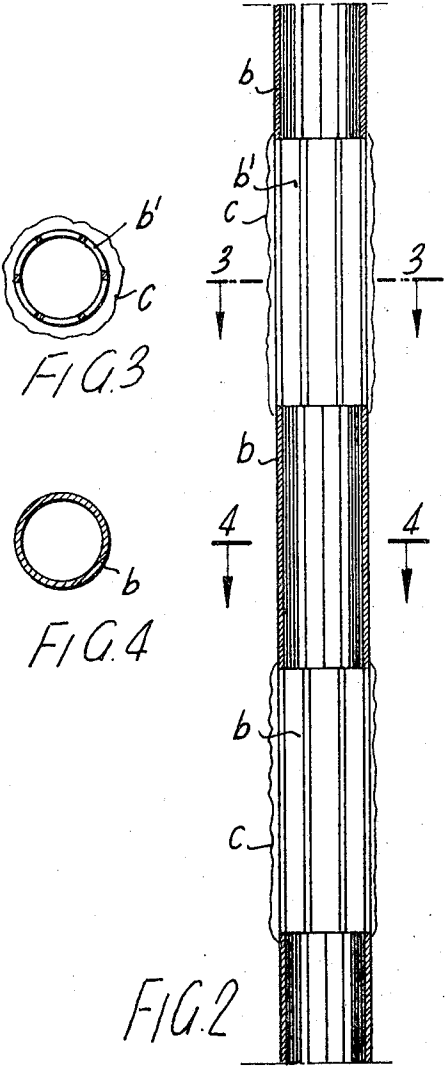
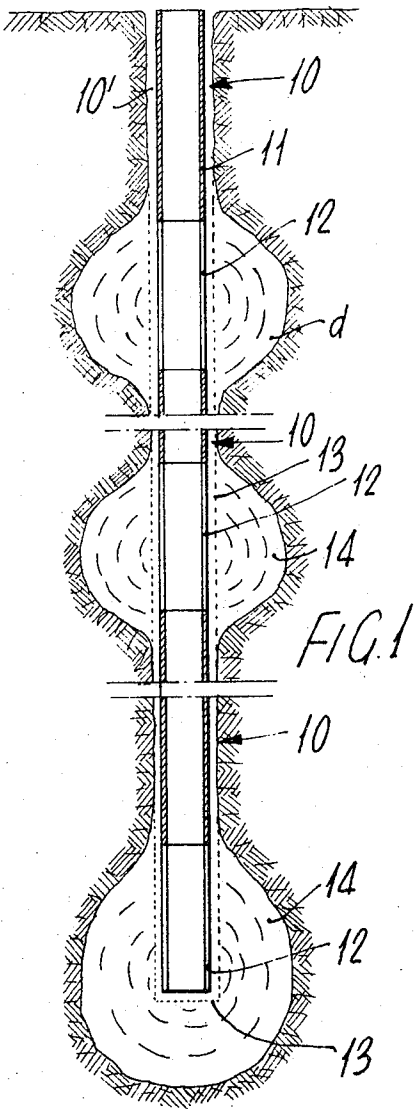
Attorney, Agent, or Firm—Bacon & Thomas

[57] ABSTRACT

A method for consolidating impermeable soils. Mixes of binding materials are pressure injected into the sub-soil through pipes alternately formed of blind wall sections and apertured wall sections, through the latter said binding mixes laterally pressing the soil and forming therein consolidation enlargements which are spaced apart from one another along the vertical axis of the guiding tube.

3 Claims, 4 Drawing Figures





METHOD FOR CONSOLIDATING IMPERMEABLE SOILS AND PILE PROVIDED THEREBY AS FITTED WITH SPACED APART ENLARGEMENTS

Methods are known for subsoil consolidation by means of pressure injecting proper mixes (such as cement, chemical mixes and the like).

It is also known that said methods are based on intergranular penetration of the mixes into the soil mass or body; however, when the soil granules are very small (clayey, slimy, muddy and the like soils), said penetration would be impossible and the operation would be ineffective. In other terms, soils having a very low permeability cannot be consolidated by means of usual pressure injections, i.e. based on an intergranular penetration of binding mixes. However, there is frequently the need of consolidating just slimy-clayey soils which are almost impervious and sometimes extremely soaked with water and having a very low strength from geotechnical standpoint.

In such soils, not being feasible to provide for injection consolidation, other technical processes (such as pilings, sand drainages, vibroflotation, etc.) are resorted to.

However, there are cases where also the above systems are unadvisable, that is difficult to be carried out.

The object of the present invention is a method for tamping and hence consolidating the above soils, which method is preferably carried out by static action, therefore free of shakings, vibrations or other violent perturbations to the soil. Obviously, where a dynamic action is advisable, nothing prevents from using it.

This method is characterized by providing tamping piles provided with enlargements in the soil, as obtained by injecting mixes of pressure binding materials into the subsoil through pipes alternately formed of blind wall sections and apertured wall sections, through the latter said binding mixes laterally pressing the soil and forming therein consolidation enlargements which are vertically spaced apart from one another along the axis of the guiding pipe.

By way of not limiting example, an arrangement embodying the invention features is shown in the accompanying drawing, in which:

FIG. 1 is a vertical section through the soil after the method has been carried out;

FIG. 2 is a vertical section on an enlarged scale relative to FIG. 1, showing a portion of the operating tube as formed of blind wall tube sections and apertured or anyhow permeable sections;

FIG. 3 is a cross-section taken along line 3—3 in FIG. 2; and

FIG. 4 is a cross-section taken along line 4—4 in FIG. 2.

First, a borehole 10 is drilled of a depth suiting the problem being involved. A so-called operating tube is fitted in this hole 10, the operating tube comprising blind sections 11 and widely apertured sections 12, the latter being externally coated with a protective shell 13 of jute cloth and/or plastic material, or rubber in one or more layers.

The gap 10' between hole 10 and tubes 11 and 12 can be filled with more or less resistant binding mixes. This filling can be effected separately, or by supplying the low pressure mixes through said operating tube.

The liquid mixtures, as statically supplied to the operating tube, for example by means of a pressure pump, will provide at said apertured sections 12 pressure enlargements 14 which are more or less extended dependent on the pressure rates. Thus, rather than stressing the soil through narrow passages as in ordinary injections, the mixtures will instead be effective as distributed on extended areas, such as those corresponding to the apertured tube sections 12.

On completion of a first tamping operation with building up of still reduced size pressure enlargements 13 and following a suitable consolidation such that partial hardening of the supplied mixes occurs, the operating tube 11, 12 is washed or scavenged (or drill again where the consolidated mix should have become too hard) and therefore readied for a further operation and so on, which operation can be repeated for an indefinite number of times, obviously increasingly raising the pressure rates and obtaining further more extended enlargements 14. By such operations and where the soil should exhibit some permeability, an intergranular penetration of the mixes would also be provided in addition to the formation of tamping enlargements (the effect of which in connection with the soil consolidation requires no discussions); conversely, where impermeable soils are concerned, only a tamping enlargement would be formed. However, it should be pointed out that in slimy-clayey or quite muddy soils, substantially impervious to conventional injections, the tamping effect will be provided at the expense of porosity water ejection, which water is forced to migrate outwardly of the operation zone.

This effect is the more stressed as the higher the volume of soil "pressed" by the "enlargements" 14. At the same time, due to the building up of said "enlargements" 14, a soil chamber or quite a substantial soil raising can be obtained under a suitable pressure.

For example, an embankment founded on soft grounds can be stabilized to the design dimension without requiring to cause or tolerate settlements, as in the case of sand drainages, vibrofloatation, etc.

Among the system advantages, the capability should be added of indefinitely repeating the process.

The above described device also lends itself to carry out actual foundation piles, wherein the tube acts as a reinforcement and the casting, as effected by cement conglomerate, has extensions at the base and along the trunk which are thoroughly tamped against the soil.

What I claim is:

1. A method for consolidating impermeable clay or muddy soils which comprises:

1. forming a borehole in the soil extending into the impermeable subsoil;

2. inserting into said borehole a rigid tube formed of alternating solid and apertured wall sections having a plurality of apertures therein, said tube being externally coated with a casing formed of deformable material in the areas of said apertured wall sections;

3. pressure injecting a hardenable binding material into said tube and through said apertured wall sections thereof into said deformable casing, whereby said deformable casing is deformed and laterally presses against the subsoil, thereby providing a plurality of vertically-separated consolidation enlargements along the tube in the areas of said apertured wall sections thereof;

3

- 4. permitting said binding material to at least partially harden and washing or scavenging said tube and repeating said step (3) at least once to further enlarge the consolidation enlargements provided in said step (3); and
- 5. permitting the binding material in said tube and in said consolidation enlargement to completely harden and leaving said tube in the soil to thereby

4

- consolidate the same.
- 2. A method as claimed in claim 1, wherein said casing is made of jute cloth.
- 3. A method as claimed in claim 1, wherein the mixture is statically introduced into the tube and hence the soil, by means of a pressure pump.

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65