Dec. 23, 1969 L. A. TURZILLO 3,485,052

METHOD AND MEANS FOR FORMING CONCRETE PILES

Filed Aug. 3, 1967

FIG. 1

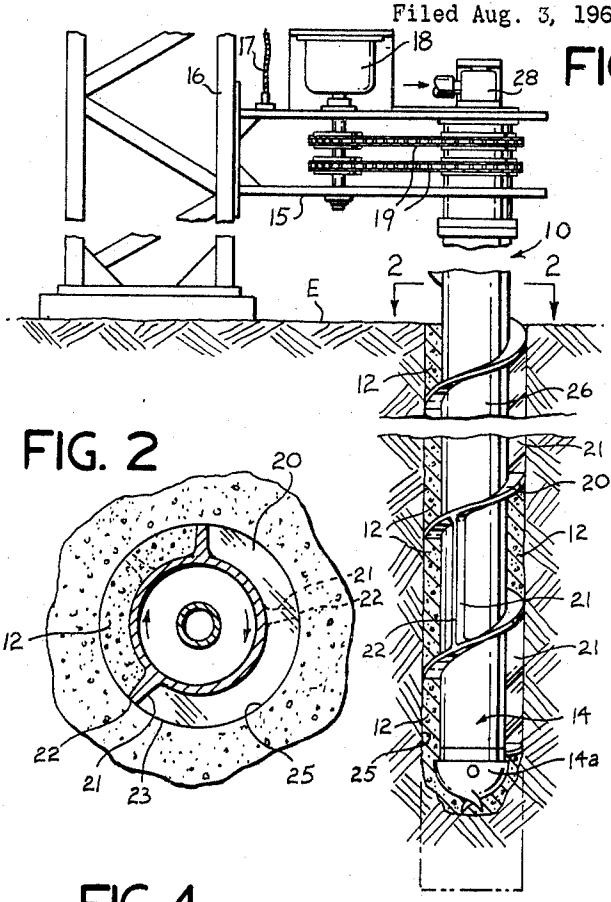



FIG. 2




FIG. 3

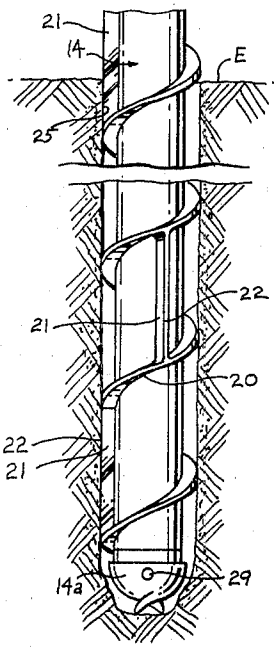



FIG. 4

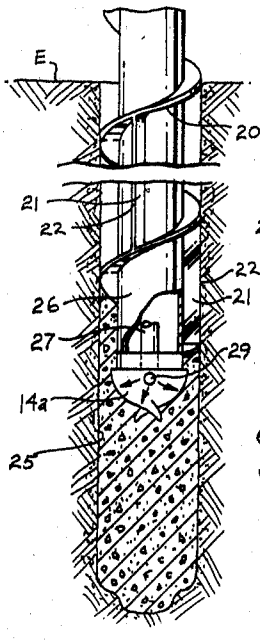



FIG. 5

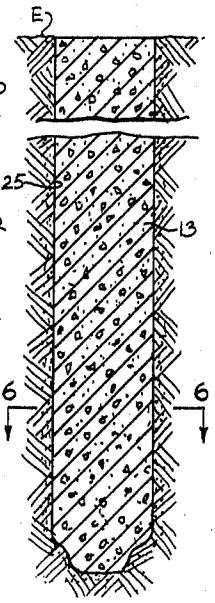



FIG. 6

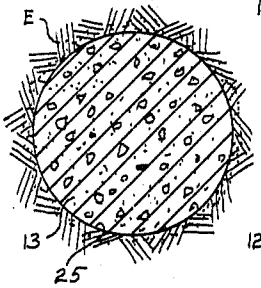
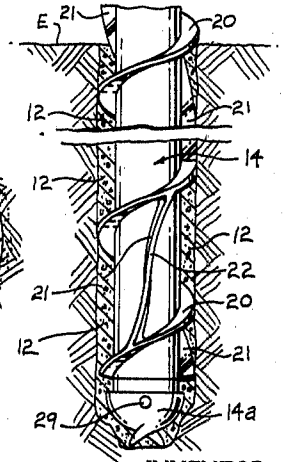



FIG. 7




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# METHOD AND MEANS FOR FORMING CONCRETE PILES

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## ABSTRACT OF THE DISCLOSURE

Method and apparatus for forming a pile in an earth situs, by which pile cavity is formed in a situs by rotation of a spiral-flight auger drill. Augered earth, moving in spiral path reversely of axial movement of drill, is blocked to translate spiral earth movement into radial movement, and to compress augered earth into walls of defined cavity. Fluid hydraulic cement grout forced through drill forms concrete pile in cavity.

### Background of invention

Heretofore, piles have been formed in the earth generally by rotating an auger-type drill into the earth to form a pile cavity, retaining the drill and augered earth in the cavity, and forcing fluid cement grout under pressure into a space below the drill with sufficient pressure progressively to raise the drill and augered earth from the cavity and thereby form the pile therein. This, generally, required retaining the earth in the auger flighting to build up or maintain the pressure of the grout being fed below the retracting auger drill so that the drill rotation could not be reversed without expelling augered earth into the grout being fed into the cavity.

### Summary of invention

In utilizing the improved method and apparatus to provide concrete pile in an earth situs, a hollow-shafted spiral flight auger drill is rotated into the earth to define a cavity of requisite depth, as the drill rotates in screwing direction, moves axially inwardly while the augered earth tends to move reversely in a spiral path. At the same time, impacting means rotating with the drill catches the augered earth along the full earth-contacting extent of the drill and translates the spiral earth movement into radial movement, and compresses the augered earth into the walls of the drilled cavity. As the auger drill is thereafter progressively withdrawn from the cavity, grout or like self-hardening cementitious material is pumped through the auger shaft into the increasing space beneath the drill until the cavity is filled to form the pile body. In other words, the augered earth, instead of being removed in this process, is impacted into the walls of the augered cavity to solidify the surrounding earth and provide vastly increased skin-friction between the subsequently hardened pile body and the cavity walls, and thereby correspondingly to increase the load and tension-bearing capacity of the subsequently hardened pile body.

One object of the present invention is to provide an improved method and apparatus for providing a pile cavity in an earth situs without removing earth from the situs.

Another object of the invention is to provide a method for forming a concrete pile body in an earth situs, by which the skin-friction between the hardened pile and the formed cavity thereof is substantially improved.



Another object of the invention is to provide an improved method and means by which a spiral-flight auger drill may be rotated in reverse directions, either while forming a pile cavity or while filling the same with pile-forming material, without damaging either the cavity or a pile being formed therein.

Other objects and advantages of the invention will be manifest from the following brief description and the accompanying drawings.

Of the accompanying drawings:

FIGURE 1 is a vertical cross-section, partly broken away, illustrating an initial stage of use of auger-drilling equipment for forming a pile cavity in an earth situs in accordance with the method of the invention.

FIGURE 2 is an enlarged horizontal cross-section, taken substantially on the line 2—2 of FIGURE 1.

FIGURE 3 is a vertical cross-section corresponding in part to FIGURE 1, but illustrating a subsequent step in the method by which the pile cavity is fully formed to requisite depth without removal of augered earth from the situs.

FIGURE 4 is a view corresponding to FIGURE 3, and on the same scale, illustrating a further step in the method by which pressurized hydraulic cement grout is pumped into the formed pile cavity, progressively with removal of the auger drill.

FIGURE 5 is a vertical cross-section, on the same scale as FIGURES 1, 3, and 4, illustrating the completed concrete pile formed in the pile cavity.

FIGURE 6 is an enlarged cross-section through the completed pile, as viewed on the line 6—6 of FIGURE 5.

FIGURE 7 is a view corresponding to FIGURE 1 in part, illustrating use of a modified form of auger drill in the method.

Referring particularly to FIGURES 1 and 2, there is illustrated apparatus **10** for drilling a pile cavity **11** in an earth situs E, without removing any of the augered earth **12** therefrom, and for forming a concrete pile **13** therein as shown in FIGURES 5 and 6. The apparatus **10** may include a sectional, continuous flight, hollow-shafted auger **14** rotatably mounted on a conventional carriage **15**, which is vertically movable on guide rails **16**, by power means (not shown), through a cable **17** attached to said carriage. A reversing type hydraulic motor **18**, mounted on carriage **15**, is operable to rotate the auger drill in clockwise direction about a vertical axis, through a suitable chain drive **19**, to penetrate the earth situs E to any predetermined depth. A suitable driving bit **14***a* affixed to the lower end of the auger shaft **14** facilitates drilling use of the same.

FIGURE 1 shows the apparatus **15** operated to turn the auger in clockwise direction into the earth E, toward predetermined depth indicated in chain-dotted lines. In so doing, the continuous auger flighting **20** of auger **14** tends to convey the augered earth upwardly in a spiral stream. To prevent this, however, peripherally spaced, axially extending, impacting blades **21**, **21** may be affixed between vertically adjacent portions of the flighting, to have straight impacting edges **22** aligned with the corresponding peripheral edge portions **23** of the flighting. These blades are outwardly tapered so that with said clockwise rotation of the auger they will block said spiral upward movement of the augered earth **12**, and translate the same into radially outward movement. With continued clockwise movement of the auger **14**, therefore, the rotating blades compress the loose augered earth **12** radially into the pores, crevices and voids of the surrounding soil, as indicated by dotted areas **12***c* in

the situs E outwardly of the wall of cavity **25** defined by the clockwise moved flighting **20** (see FIGURE 3). A greater or lesser number of blades **22** may be provided, depending upon the diameter of the cavities to be drilled and/or the looseness or porosity of the earth of the situs. Compaction of the augered earth can be materially aided by having the flighting relatively shallow so that the hollow auger shaft **26** plays a substantial part in urging the augered earth **12** radially into the wall of the cavity **25**.

For feeding cementitious material, such as fluid hydraulic cement grout, into the cavity **25** from a suitable supply thereof (not shown), a conduit **27** extending within the auger shaft **26**, and rotatable therewith, may connect between the driving bit **14***a* and a fixed coupling device **28** on the carriage **15**, in turn connected to said source of supply. The pressurized grout may be fed through conduit **27**, and through apertures **29** in the driving bit **14***a* for filling the pile cavity in a manner to be described.

For the purpose of forming a concrete pile in the earth situs E, the improved method includes screwing the auger drill **14** in clockwise direction into the situs as shown in FIGURE 1, and until the drill reaches desired depth, such as that indicated in chain-dotted lines in FIGURE 1. Continued operation of the auger drill may be varied considerably. Continued clockwise rotation at full depth, however, will tend continuously to feed the loose augered earth upwardly along the spiral flighting, only to be engaged by the blades **21** and compacted radially outwardly into the earth situs until the loose augered earth **12** is compacted into the wall of the cavity **25**, as shown at **12***c* in FIGURE 3. If, however, the auger drill is reversely rotated, downward movement of the augered earth **12** is stopped by the blades, which again compact the loose earth into the cavity wall as before. Accordingly, in some instances, it may be found more expedient to alternate rotation of the drill in opposite directions.

After the cavity is thus drilled, the auger drill may be slowly withdrawn from the position shown in FIGURE 3, while fluid hydraulic cement grout **30** is simultaneously fed through the conduit **27** and bit apertures **14**, into the cavity below said bit, as shown in FIGURE 4, until the cavity **25** is filled. The grout in due course hardens into a solid pile **13** having an excellent load and tension-bearing frictional bond with the solidly compacted soil **13***c* of the cavity wall, as shown in FIGURES 5 and 6. Means other than conduit **27** may be employed for feeding grout into the cavity **25**. As an example, it may be fed directly through the auger shaft itself.

It should be noted that while the cement grout is being fed into the cavity **25**, the auger drill may be held stationary at various levels of withdrawal to build up pressure in the grout below the bit **14***a*. This is possible because the lowermost impacting blade blocks movement of the pressurized grout upwardly along the spiral flighting **20** to any substantial degree. Rotation of the drill in opposite directions also may be utilized to cause at least the lowermost blades to impact grout layerings into the wall of the cavity **25**, and thereby further increase the load and tension capacity of the finished hardened pile. These features also make it possible to drive the drill in counter-clockwise direction and/or mechanically urge the drill downwardly against the grout already discharged into the cavity **25**, to pack it solidly and thereby further improve the load and tension capacity of the finished pile.

FIGURE 7 is a view corresponding to FIGURE 1, but illustrating a modified form of continuous flight auger drill in which each of the spaced blades **21** is disposed between adjacent flights at a substantial angle or inclination to the vertical for lifting the loosened earth **12** axially upwardly. The successive blades **21** will urge the loose earth **12** upwardly against the tendency of the flighting otherwise to feed the earth downwardly, whereby the loose earth will tend to be more uniformly impacted into the wall of the cavity **25**.



Other modifications of the improved pile-forming method and means may be resorted to without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

**1.** A method of providing a pile or like body in an earth situs, comprising the steps of: rotating a spiral-flight screw auger into the situs progressively tending to lift earth axially along the spiral flighting of the screw auger until a cavity of predetermined depth and cross-section is defined in the situs, while impacting means carried by the rotating screw auger progressively impacts the augered earth from said spiral flighting radially of the screw auger and into the earth of the situs surrounding the wall of the defined cavity; and replacing said screw auger with a filler material fed through the screw auger, to fill the defined cavity.

**2.** A method as in claim **1**, wherein said filler material is of hardenable cementitious material fed into said cavity through passage means in the screw auger to the inner end thereof, progressively with withdrawal of the screw auger from the defined cavity.

**3.** A method of providing a pile or like cavity in an earth situs, comprising the steps of: rotating a spiral-flight screw auger into the situs progressively tending to lift the earth axially along the spiral flighting of the screw auger and thereby define a cavity of requisite depth in the situs, whereby the spiral flighting tends to move the augered earth spirally along the same reversely of the inward drilling movement of auger drill; and simultaneously presenting earth compaction means along the path of spiral movement of the augered earth to block and translate the spiral movement of the earth into radially outward movement thereof, thereby progressively to move the augered earth thereof radially outwardly from said spiral flighting into the wall of said defined cavity.

**4.** A method as in claim **3**, including the step of withdrawing the auger drill, and filling the defined cavity with filler material.

**5.** A method as in claim **3**, including the steps of withdrawing the auger drill from the defined cavity and progressively forcing fluid hydraulic cement grout beneath the auger drill to form a pile in the cavity.

**6.** Apparatus as for providing a pile or like body in an earth situs, comprising a spiral-flight screw auger, rotatable in the situs to define a cavity of requisite depth by movement of the augered earth spirally along a spiral path defined by the spiral flighting, and earth compaction means disposed along said spiral path of said auger drill to present edge portions of said compaction means substantially coincident with the peripheral wall of the defined cavity, said compaction means being operable by rotation of the auger to block and translate spiral movement of the earth into radially outward movement, thereby progressively to impact the augered earth from the spiral flighting into the wall of the defined cavity; said compaction means including a plurality of baffles spaced along a substantial extent of said spiral flighting; said baffles including rigid blades extending generally axially of the auger drill between adjacent extents of the spiral flighting.

**7.** Apparatus as in claim **6** said blades having impacting edges substantially aligned with the peripheral edges of the spiral flighting.

**8.** Apparatus as in claim **7**, said blades substantially closing said spiral path movement at substantially spaced points.

**9.** Apparatus as in claim **8**, including means on said auger drill for supplying filler material to the inner end thereof to fill the cavity upon withdrawing the auger drill therefrom.

**10.** Apparatus as in claim **9**, said auger drill having a hollow shaft for supplying filler material therethrough

from an external source thereof to the inner end of the auger drill, to fill said cavity upon withdrawing the auger drill therefrom.

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U.S. Cl. X.R.

61—36, 53.5; 175—19, 394, 327