Nov. 17, 1953 A. P. JOURDAIN 2,659,208

DRAINAGE PILE

Filed May 22, 1948

Fig. 1.

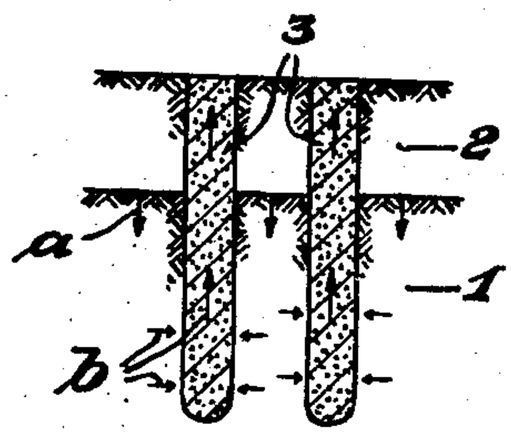



Fig. 2.

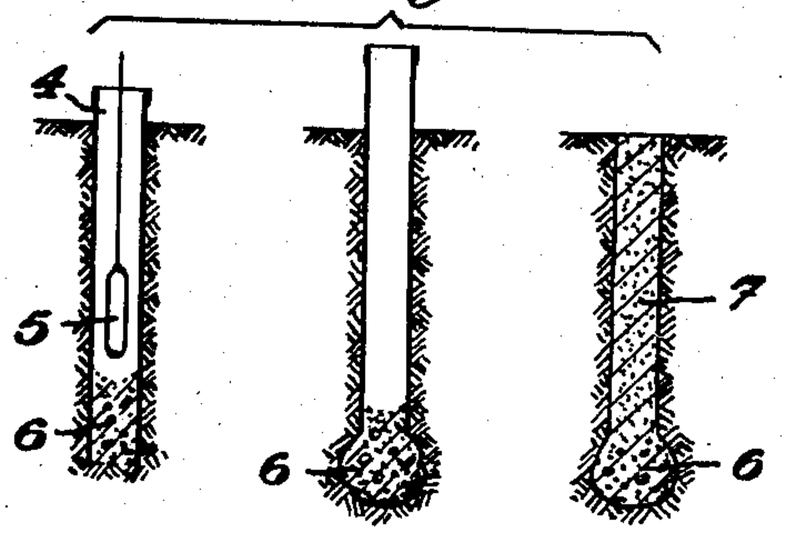



Fig. 3.

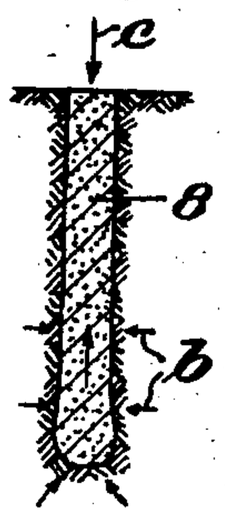



Fig. 4.

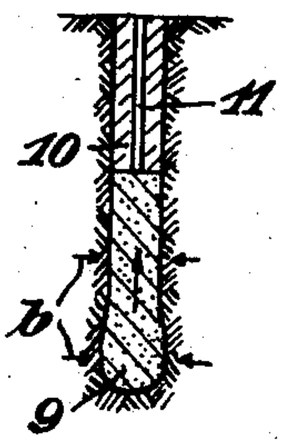



Fig. 5.

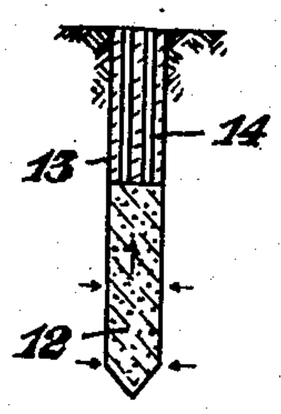



Fig. 6.

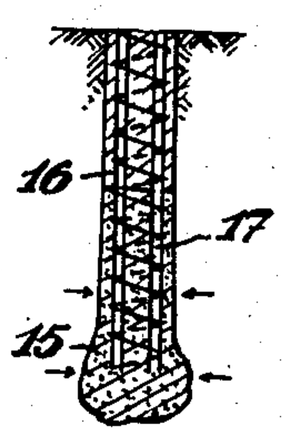



Fig. 7.

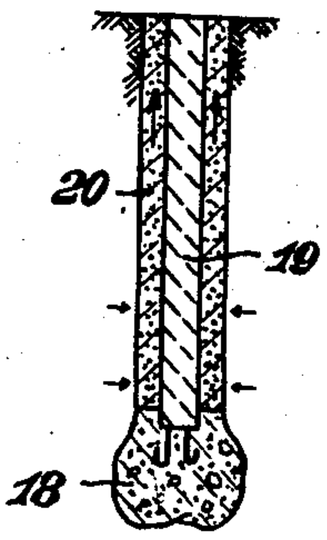



Fig. 8.

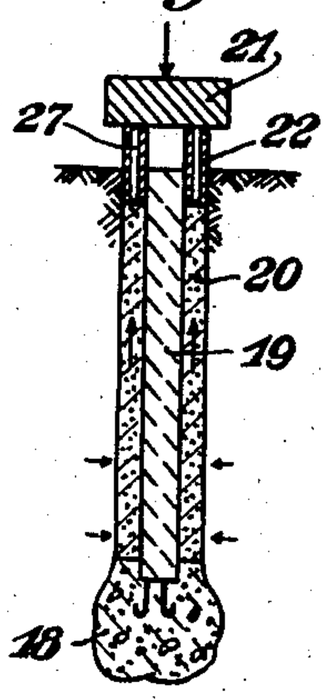



Fig. 9.

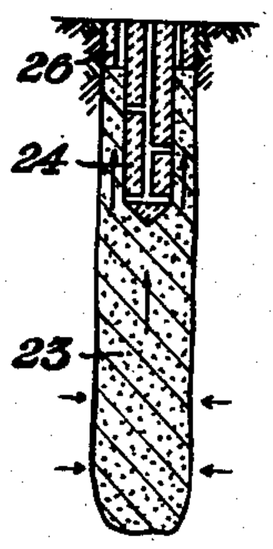
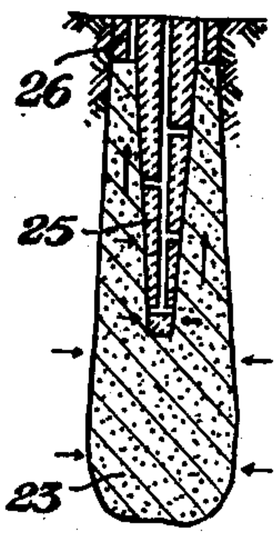



Fig. 10.




Inventor:

André Paul Jourdain

by Michael & Glenn

Attorneys

Patented Nov. 17, 1953

2,659,208

# UNITED STATES PATENT OFFICE

2,659,208

## DRAINAGE PILE

André Paul Jourdain, Brussels, Belgium, assignor to Compagnie Internationale des Pieux Armés Frankignoul, Société Anonyme, Liege, Belgium

Application May 22, 1948, Serial No. 28,695

Claims priority, application France October 21, 1947

3 Claims. (Cl. 61—11)

1

My present invention relates to processes of draining water from a watery ground and to drainage piles for carrying out these processes.

My present invention is particularly adapted for drainage of water from watery soil or ground having a low water permeability, as for instance clay and clay-containing soils.

It is an object of my present invention to expedite drainage of water from ground and soils of the above described type.

It is a further object of my present invention to obtain more complete drainage of water from watery ground or soil than was possible hitherto by known methods.

It is another object of my present invention to provide new means for draining water, particularly new types of drainage piles, by which it is possible to carry out my new processes particularly well.

With the above objects in view, my present invention mainly consists of a process of draining water from watery ground by making within this watery ground at least one porous pile extending downwardly into the ground.

In accordance with a preferred embodiment of my present invention, my new process is carried out by making within the watery ground at least one porous pile extending downwardly within said watery ground, and exerting pressure on said watery ground around said porous pile so as to force said water contained in said watery ground to enter said porous pile and to travel within the same to the surface of said watery ground.

Particularly good results were obtained by making within the watery ground at least one downwardly extending hole, filling the same with a porous material so as to form within said hole a porous pile extending downwardly within said watery ground, and exerting pressure on said watery ground around the thus formed porous pile, thereby forcing water contained in said watery ground to enter said porous pile and to travel within the same upward to the surface of said watery ground.

Various types of drainage piles might be used for my above defined processes. Thus, for instance, it is possible to use a drainage pile which consists entirely of loose porous material. However, better results were obtained by using a drainage pile composed of a porous bottom section, a non-porous top section resting upon said porous bottom section, and longitudinal passages through said non-porous top section reaching from said porous bottom section to the opposite end of said non-porous top section.

2

After the water has been drained from the watery ground by my new processes with the above described drainage piles as proposed by me, it is advisable to prevent undesired shifting of the drained ground due to the loose porous material incorporated therein by injecting a hardening binder fluid into this loose porous material, i. e., into the porous pile or piles after the watery ground has been drained, thereby hardening the loose porous material and the piles composed by it.

The novel features which I consider as characteristic for my invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

Fig. 1 is a vertical section through an arrangement for draining watery soil by means of porous piles of the type proposed by me;

Fig. 2 shows three stages in the production of a porous pile; and

Figs. 3 to 10 show vertical sections through various modifications of the porous piles shown in Figs. 1 and 2.

Figure 1 represents soil reclaimed by filling up a bay at the seashore. The soil formerly under water consists of very fine silt 1. The weight of the fill 2 subjects this to high compression in direction of arrows *a*, but the packing effect is normally very slow because of the low permeability of the soil 1. The manner of construction and application of the porous piles 3 makes it possible to remove the water easily through the drains afforded by the piles, utilizing the pressure in direction of the arrows *a* to accelerate the draining flow of the water as indicated by the arrows *b*.

The compression of the soil resulting from incorporating into it a large quantity of sand, will operate in the same direction as the pressure of the fill 2 and accelerate its action.

The hole made in the soil to receive a pile is

preferably produced by ramming rather than by excavating.

Furthermore, it is of advantage to construct the pile by forcibly ramming the sand into the soil, i. e. by subjecting the sand ot shocks in order to force it into the soil. By temporarily eliminating or reducing internal friction, and by setting up pressure waves in the soil, such shocks may also expedite the expulsion of water.

Figure 2 shows a method of making a porous pile: A pipe 4 is driven into the soil down to the desired depth, preferably by pounding with a ram 5 on a plug 6 arranged at the bottom end of the pipe. This plug 6, which consists of stone or concrete is knocked out when the pipe reaches the desired depth so as to form the base of the pile underground; then sand or similar loose material is introduced into the tube, and the pipe is removed while ramming the same to form the porous pile 7. The sand may be introduced in an aqueous suspension so as to resist the pressure of the soil.

The term "sand" as used above is to be understood to define separate particles of any substance forming a porous mass.

Where the watery soil of low permeability is not already subject to an existing pressure, a load—indicated in Fig. 3 by arrow *c*—may be applied to the porous pile 8 thus exerting pressure on the surrounding soil and accelerating the drainage of water along the paths indicated by arrows *b*.

The pile according to my present invention may also consist of a lower porous section 9 rammed into the soil as shown in Fig. 4 and an upper non-porous section 10 prefabricated, e. g. of non-porous concrete; this upper section 10 is provided with one or more longitudinal passages 11.

It is also possible to prefabricate the entire pile as shown in Fig. 5; this pile consists e. g. of a porous concrete section 12 and a non-porous section 13, the latter being provided with drains 14.

Obviously, a pile may also consist of a still larger number of sections—alternately porous and non-porous; the latter have to be provided with conduits. It may also be prefabricated in one piece.

Figure 6 shows a drainage pile completely rammed into the soil, section 15 being of sand or the like porous material and section 16 consisting of concrete. The perforated pipes 17 are provided for drainage of the water. These last may simultaneously form the longitudinal members of a reinforcing framework.

If the pile is subsequently to carry a permanent load, a binding fluid of a suitable kind may be added after a sufficient degree of drainage of the soil has been obtained, in order to form a foundation pier. This hardening fluid may be introduced through the perforated conduits provided in the porous pile, e. g. through the conduits 11, 14 or the pipes 17.

Figure 7 shows a pile having a base 18 rammed into the soil and a prefabricated non-porous core 19, e. g. of reinforced concrete, anchored by means of projecting prongs into concrete poured on top of the base 18 before removal of a surrounding pipe; this pipe has been previously introduced into the soil as described above. During the removal of this pipe, the free space around the core 19 is filled with sand or like porous material 20, preferably by ramming.

Fig. 8 shows a similar drainage pile, but provided with a load 21 applied through an annular crown 22. In this manner pressure is exerted on the surrounding soil, and the pile, particularly its porous section, adapts itself completely to the packing of the soil. Drainage of the water is effected by means of conduits 27 provided in the crown 22 or in the periphery of the core 19. The centering of the crown 22 is assured by the core 19. Such a drainage pile is especially suited for sustaining a permanent load.



The core 19 may be replaced by a shaft of concrete poured on location, e. g. by means of a tubular mold arranged inside of the above described ramming tube which serves to produce in the soil the hole necessary for the pile.

In case a load is applied to the drainage pile, and the upper layer of the ground is such as to produce a tendency towards excessive lateral displacement of a material such as sand, this disadvantage may be overcome by the use of a rigid element (such as 10, 13, 16, 22) to form the uppermost section of the pile.

It is also possible as shown in Fig. 9 to drive this rigid element into a mass of sand 23 introduced into the hole formed in the soil, using such forms as shown in Figs. 9 and 10, i. e. a plug in the form of a cylinder 24 or a cone 25 topped by a cylindrical head 26, this plug being provided with radial conduits opening into at least one vertical passage.

Obviously the porous piles, according to my present invention, may be designed in a great variety of shapes all constituting porous piles permitting vertical drainage of water from the soil accelerated by pressure exerted upon it.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of processes of eliminating water from materials differing from the types described above.

While I have illustrated and described the invention as embodied in drainage processes, I do not intend to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of my invention.

Without further analysis, the foregoing will so fully reveal the gist of my invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What I claim as new and desire to secure by Letters Patent is:

1. A porous draining pile, comprising in combination, a central non-porous core; a porous body surrounding said central non-porous core except the upper portion thereof; a crown arranged above said porous body and surrounding the upper portion of said central non-porous core; and conduits in said crown.

2. A porous draining pile, comprising in combination, a central non-porous core; a porous body surrounding said central non-porous core except the upper portion thereof; a crown arranged above said porous body and surrounding the upper portion of said central non-porous core; a load resting on said crown; and conduits in said crown.

3. A porous draining pile, comprising in combination, a base rammed into the soil; a pre-

fabricated non-porous central core arranged above said base; reinforcements in said core projecting into said base; a porous body surrounding said central non-porous core except the upper portion thereof; a crown arranged above said porous body and surrounding the upper portion of said central non-porous core; and conduits in said crown.

ANDRÉ PAUL JOURDAIN.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 1,355,066 | Smith | Oct. 5, 1920 |
| 1,598,300 | Moran | Aug. 31, 1926 |

| Number |
|---|
| 467,785 |
| 511,013 |
| 515,595 |
| 311,122 |
| 102,311 |

FOREIGN PATENTS

| Country | Date |
|---|---|
| Germany | of 1928 |
| Germany | of 1930 |
| Germany | of 1931 |
| Italy | of 1933 |
| Sweden | of 1941 |