Aug. 1, 1939. C. A. ORR ET AL 2,168,269

PILE FOUNDATION SUPPORT

Filed Oct. 12, 1932 2 Sheets-Sheet 1

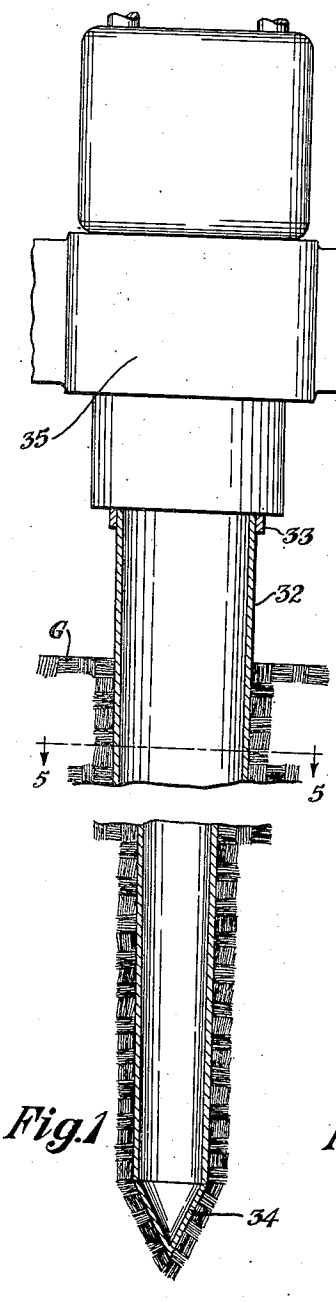


Fig.1

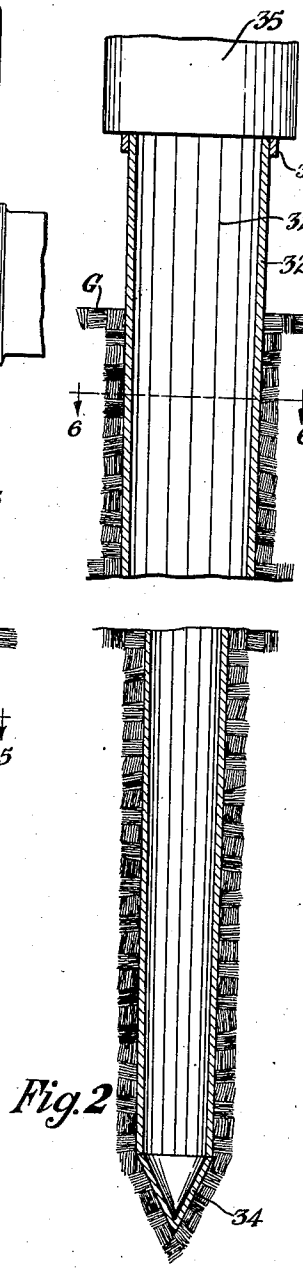


Fig.2

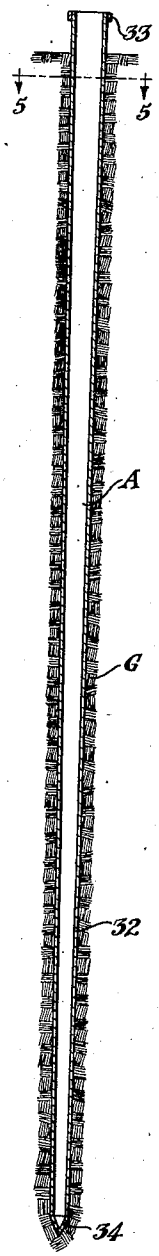


Fig.3

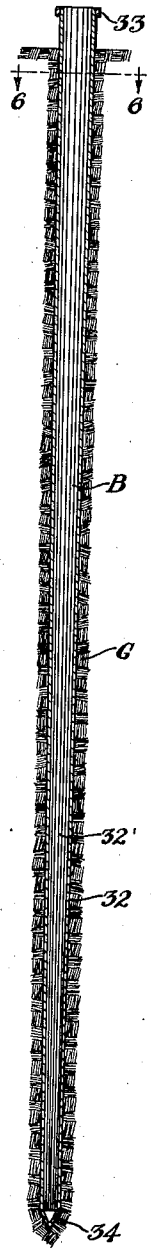


Fig.4

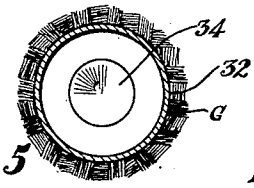


Fig.5

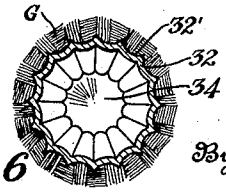


Fig.6

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PILE FOUNDATION SUPPORT

Filed Oct. 12, 1932 2 Sheets-Sheet 2

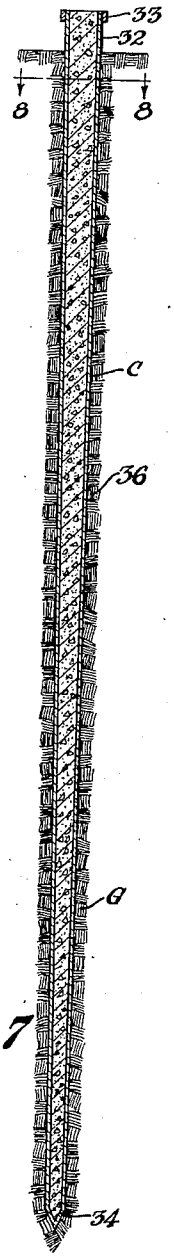


Fig.7

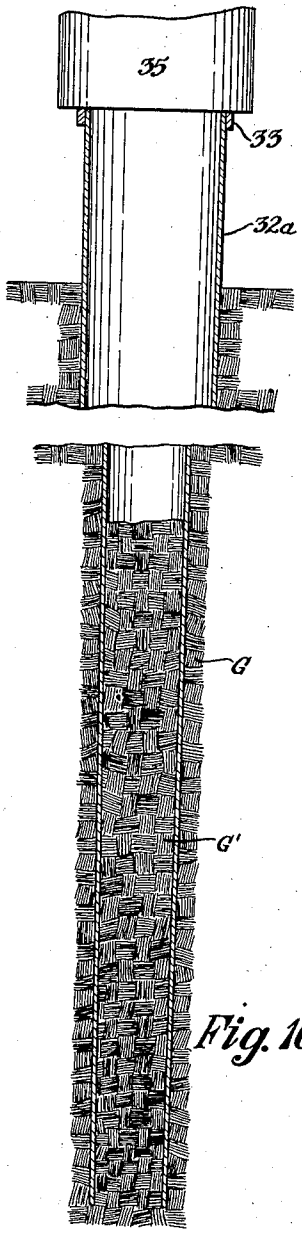


Fig.10

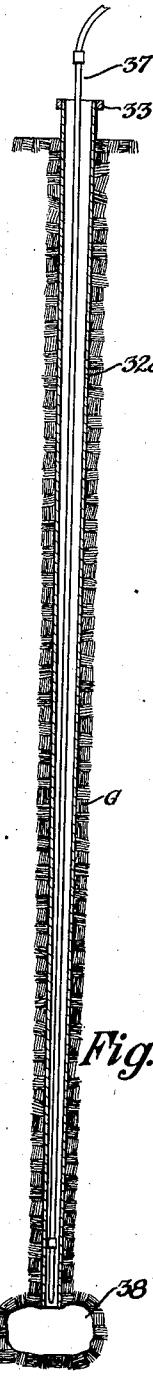


Fig.11

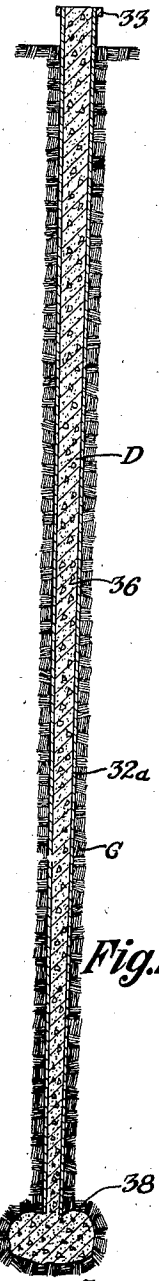


Fig.12

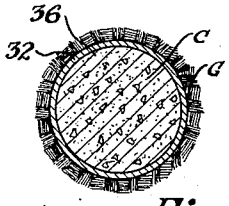


Fig.8

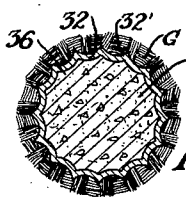


Fig.9

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UNITED STATES PATENT OFFICE

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PILE FOUNDATION SUPPORT

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Application October 12, 1932, Serial No. 637,454

4 Claims. (Cl. 61—53)

The invention relates to piles and more particularly to the driving and setting of piles in which a hollow, tapered, metal shell is sunk into the ground, by utilizing the shell itself as a driving mandrel, after which the shell itself remains in situ in the ground to form the pile, or after which the shell in situ is filled with suitable bearing material, preferably concrete, to form a pile foundation support.

Wooden piles have been utilized for years, but there are limits to the lengths of wooden piles that may be driven into the ground, to the type of ground into which wooden piles may be driven, and to the life of wooden piles.

Piles made from cylindrical pipe driven into the ground have also been utilized, but, again, there are limits to the lengths of cylindrical pipe piles that may be driven into the ground, and to the type of ground into which cylindrical pipe piles may be economically driven.

Pre-cast concrete piles have also been utilized, but extreme care must be exercised and great difficulties are encountered in driving the same into certain types of ground, and excessive expense is also encountered in splicing or cutting precast concrete piles to the required length, because the required length cannot be accurately determined until the pile is driven.

Cast-in-place concrete piles have also been utilized by sinking a form into the ground and then filling the form with concrete. In this type of pile, the forms are composed of sheet metal sections, or sheet metal sections lined with concrete, usually tapered, which are successively assembled upon and then driven into the ground by a tapered mandrel, the tapered surface of which engages the internal surfaces of the form sections to transmit the driving force to the sections.

In driving such pile shell sections, a collapsible mandrel must be utilized in order that the mandrel may be removed after the sectional forms have been sunk to the desired depth; or if a solid mandrel is utilized, it has been necessary to provide means, usually hydraulic means, for applying to the sectional shell a reaction equal to the upward pull required to remove the mandrel from the shell. In either case, the cost of the mandrel or of the means for removing the mandrel is usually large, with the result that this type of pile is relatively expensive.

Another type of cast-in-place pile has been used, in which a temporary form, usually a very heavy cylindrical pipe, is driven into the ground, and is then filled with concrete and removed before the concrete hardens, leaving the concrete confined only by loose earth. This type of pile is relatively expensive and the strength of the pile is uncertain.

Still another type of cast-in-place pile has been utilized in which a temporary form, usually a very heavy cylindrical pipe, is driven into the ground, a transversely corrugated tube is then telescoped within the pipe and filled with concrete, and the pipe is then withdrawn and the space occupied by the same filled with concrete. This type of pile also is quite expensive to set and requires a considerable number of extra operations to be performed. A composite pile has also been used where an extremely long pile is required. In setting such a pile, a wooden pile is first driven into the ground and a pre-cast pile or a shell for a cast-in-place pile is then spliced thereto and driven to the required depth. However, such a pile has the disadvantages enumerated above with reference to its constituent parts.

It is therefore a general object of the present invention to overcome the difficulties encountered in driving and setting piles according to prior practice and to avoid the disadvantages thereof and incident to the driving and setting of the same.

We have discovered that a substantially rigid, tapered tube may be readily driven as a mandrel into the ground, and left therein, in situ, to form a pile. The preferably continuous tapered tube may be any desired length and because of its taper it more readily penetrates the ground and therefore may be more readily driven than a cylindric tube. Moreover, the taper of the tube affords a better load carrying capacity than a cylindric tube of the same length, which would be more expensive due to its greater weight. Likewise, the substantially rigid tapered tube as it is being driven, and as a pile, withstands the crushing effect of the ground, the tendency of which is to cause a collapse of the tube.

And finally, a tapered tube, driven with its small end down, is strongest at its upper end against failure during driving, which enables the same to be driven further than a cylindric tube pile having an even greater wall thickness. Such a substantially rigid, tapered tube may then be filled with a core of concrete or other suitable material.

We have also discovered that the tube may be longitudinally corrugated, ribbed or fluted for strengthening the same not only against distortion or crushing during driving, but also for strengthening the same against crushing or failure as a pile, for producing a greater bearing

surface with respect to the volume of ground displaced, and for assisting in ease of driving.

It is therefore a further object of the present invention to provide a new and improved tapered, tubular metal pile, preferably with a nose integral with its small end, which is driven as a substantially rigid mandrel into the ground by the usual driving means, where it is left in situ to form a pile.

It is a further object of the present invention to provide a longitudinally ribbed, corrugated or fluted, substantially rigid tapered, tubular pile, preferably with a nose integral with its small end, and to drive the same as a substantially rigid mandrel, into the ground wherein it is left in situ to form a pile.

Moreover, it is an object of the present invention to provide a tapered, tubular pile either plain or longitudinally ribbed, corrugated or fluted, and to drive the same as a substantially rigid mandrel into the ground where it is left in situ to form a pile shell, and to then fill the shell with a core of suitable material such as concrete.

In certain cases, the lower or smaller end of the tapered tube mandrel may be left open so as to reduce the effective amount of ground displaced during driving. After driving, the ground within the tapered tube may be removed and the interior of the tube filled with a core of suitable material such as concrete.

It is therefore a further object of the present invention to drive a tapered, either plain or longitudinally ribbed corrugated or fluted, pile as a mandrel into the ground and leave it there in situ to form a pile, and to then remove the ground therein and fill the mandrel with a core of suitable material such as concrete.

These and other objects may be obtained by the piles, elements, combinations, structures, methods, and apparatus, preferred embodiments or steps of which are hereinafter claimed and described in detail, and are likewise shown in the drawings, in which:

Figure 1 is a longitudinal sectional view of an improved tapered, tubular, metal pile, utilized as a substantially rigid mandrel, and being driven into the ground by diagrammatically indicated driving means;

Fig. 2 is a view similar to Fig. 1, of a modified form of improved tapered, fluted, tubular, metal pile;

Fig. 3 is a longitudinal sectional view of the improved pile shown in Fig. 1 after the same has been driven into the ground;

Fig. 4 is a view similar to Fig. 3 showing the improved tapered, fluted pile of Fig. 2 after the same has been driven into the ground;

Fig. 5 is a transverse sectional view of the improved pile shown in Figs. 1 and 3, taken on the line 5—5, Figs. 1 and 3;

Fig. 6 is a transverse sectional view of the improved pile shown in Figs. 2 and 4, taken on the line 6—6, Figs. 2 and 4;

Fig. 7 is a longitudinal sectional view of either of the improved piles shown in Figs. 3 or 4, filled with a core of concrete;

Fig. 8 is a transverse sectional view of the improved pile shown in Fig. 3 filled with concrete as in Fig. 7, taken as on the line 8—8, Fig. 7;

Fig. 9 is a transverse sectional view of the improved pile shown in Fig. 4 filled with concrete as in Fig. 7, also taken as on the line 8—8, Fig. 7;

Fig. 10 is a view similar to Fig. 1, of a modified form of improved tapered, tubular, metal pile being driven into the ground without providing a nose on a lower small end thereof;

Fig. 11 is a longitudinal sectional view of the pile shown in Fig. 10 after the same has been driven, and after the ground present within the tube has been removed by pressure or hydraulic means diagrammatically illustrated;

Fig. 12 is a view similar to Fig. 11, showing the improved pile filled with a core of concrete.

Similar numerals refer to similar parts throughout the drawings.

Referring to Figs. 1 to 6, inclusive, a substantially rigid, tapered tube **32** preferably is provided with a reinforcing collar **33** at its upper large end and an integral, preferably pointed nose **34** at its lower small end and utilized as a mandrel and axially driven downward into the ground G by the usual pile driver drop-head driving means indicated generally at **35** which applies the driving power or force to the upper large end of the tube **32** as shown in Fig. 1.

The tapered tube **32** may have any desired length and because of its taper its small end more readily penetrates the ground and may therefore be more readily driven to the necessary depth. The taper of the tube likewise affords additional load carrying capacity when the tube is set as a pile, and the tapered tube **32** is preferably made from one piece of heavy gauge sheet or plate metal, the rigidity of which prevents the ground from crushing the tube as and after it is driven.

However, the tube may be made from a plurality of tapered tubular sections welded or otherwise joined together end to end to form a substantially rigid, tapered tube in order to obtain a tube of the desired length.

Moreover, the tapered tube **32** is strongest at its upper end against failure during driving so that the same may be driven further and faster than a cylindrical tube having an even greater wall thickness.

In certain cases it may be desired to strengthen the tube **32** against distortion during driving, to strengthen the ultimate pile driven, to provide a greater bearing surface for the ultimate pile, and to assist in obtaining ready penetration of the pile in the ground G. This may be accomplished by providing the tube **32** with longitudinal corrugations, ribs or flutes **32'**, as shown in Figs. 2, 4 and 6.

After the tapered tube **32** has been utilized as a mandrel for being driven into the ground, the same is left therein in situ to form a plain pile or foundation support A, as shown in Fig. 3, or a fluted pile or foundation support B, as shown in Fig. 4.

In certain cases it may be desired to further strengthen the pile and increase its load bearing capacity, and in such event, the pile A, shown in Fig. 3, may be filled with a core of suitable material such as concrete, indicated at **36** (Figs. 7, 8 and 9) to form a solid pile C shown in Fig. 7, which may be either plain, as shown in Fig. 8, or fluted as shown in Fig. 9.

In certain cases, it may be desirable to utilize a tapered tube **32*a*** as a mandrel for being driven into the ground by power applied to the upper large end thereof, without providing a nose on the lower small end thereof, and this may be accomplished, as shown in Fig. 10, by driving the open ended tapered tube **32*a*** directly into the ground so that the effective amount of ground displaced is reduced by the amount indicated at G', which collects within the tapered tube **32*a*** as the tube is being driven.

After the tube **32***a* has been sunk to the desired depth, the same is allowed to remain in situ, and the ground G' collected within the same may be readily removed by air or hydraulic means generally indicated at **37**, which may also be utilized to provide an enlarged cavity **38** in the ground G at the base of the tube, as shown in Fig. 11. The tube **32***a* and cavity **38** are then preferably filled with concrete **36** to form the pile D shown in Fig. 12, and the tube **32***a* may either be plain, as shown in Figs. 1, 3, 5 and 8, or fluted as shown in Figs. 2, 4, 6 and 9.

The terms "rigid" or "substantially rigid" or "solid" utilized herein as distinguished from "collapsible", refer to tapered tubes having sufficient rigidity and strength to be driven into the ground and/or removed therefrom without collapsing due to ground pressure or failing under normal working conditions; the terms "one-piece" or "integral" utilized herein, with reference to a shell, refer to elements, which may be originally made of a plurality of pieces and joined together in any suitable manner so that they may be driven or sunk into the ground as a unitary structure; and finally, the terms "ribbed", "corrugated" and "fluted" are used herein more or less synonymously.

We claim:

1. A foundation support which consists in a substantially rigid, tapered, metal tube, having a nose integral with its small end driven downward into the ground by power applied to its upper end.

2. A foundation support which consists in a substantially rigid, longitudinally fluted, tapered, metal tube, having a nose integral with its small end driven downward into the ground by power applied to its upper end.

3. Pile construction including a substantially rigid, tapered, metal tube having a small end driven downward into the ground by power applied to its upper end, and a core poured within the driven tube.

4. Pile construction including a substantially rigid, longitudinally fluted, tapered, metal tube having a small end driven downward into the ground by power applied to its upper end, and a core poured within the driven tube.

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