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BALL-PILE TUBES

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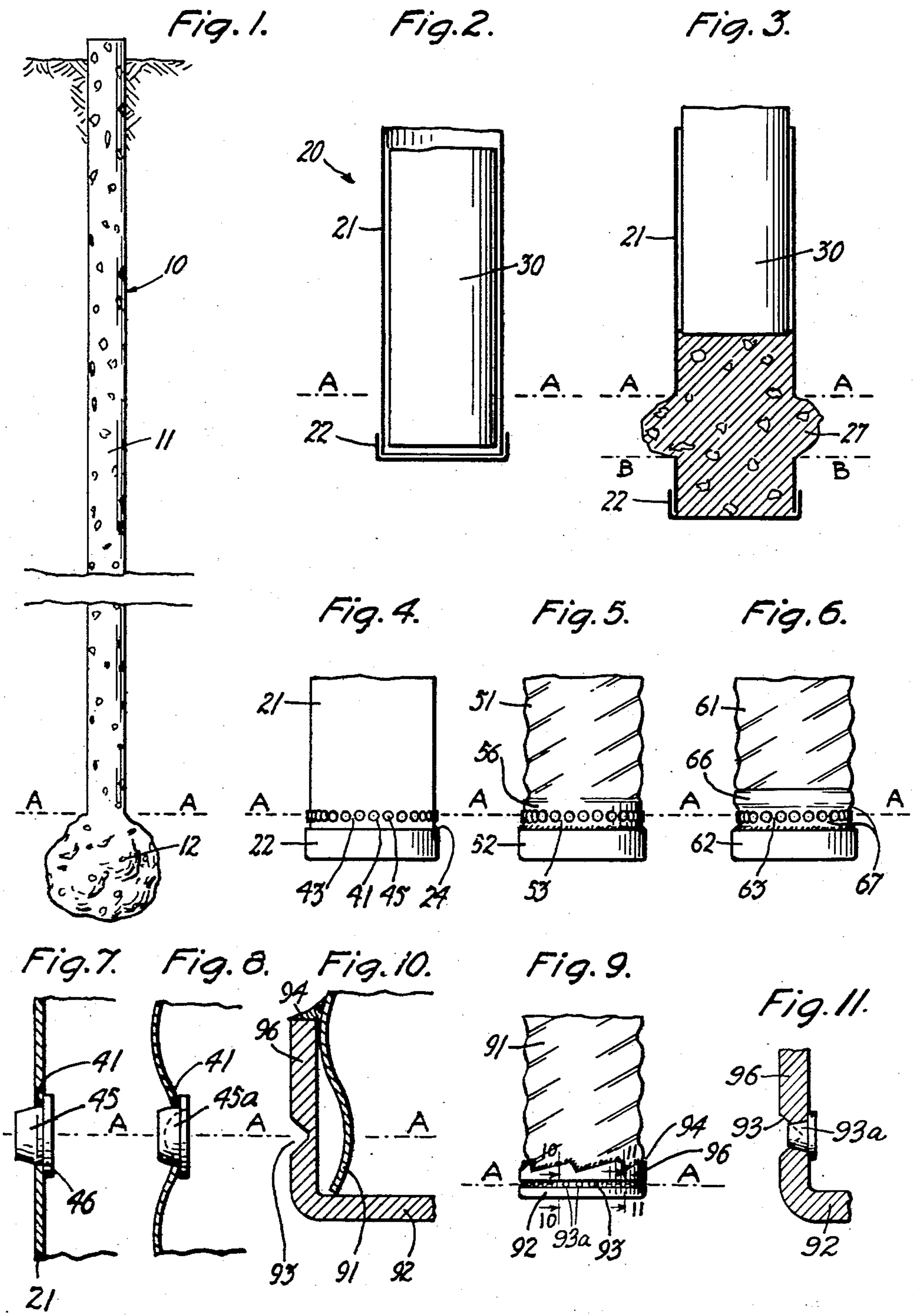

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BALL-PILE TUBES

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This invention relates to concrete piles of the type known as cast-in-place piles and more particularly to piles of this type having an enlarged concrete foundation or footing and sometimes termed ball piles or bulb piles.

The invention particularly relates to the formation of the concrete footing at the time and place of installation of such piles.

Piles of this type are frequently used in the support of superstructures in locations where the solid strata in the ground are covered to great depths by watery or muddy layers of varying densities. In such locations the lower end of the pile may be terminated in a layer at a depth some distance above the solid bottom stratum where the increased footing of the pile may be properly supported as required by the load, thereby often greatly reducing the required length of the pile and the demand for its rigidity.

Such ball piles have been formed by the use of long iron tubes placed to the required depth in the ground, through which concrete may be poured and a ram lowered for forcing the concrete out into a ball shape, so that the surrounding ground may be compacted sufficiently to carry the assigned load.

Before pouring the concrete, which is to form the ball at the bottom end of the pile, the tube must first be positioned in the ground with its lower end in the stratum where the ball of concrete is ultimately to be formed and positioned. This placing of the tube is usually done by forcing the tube downwardly into the soil, thus forming a hole through the ground. In order to keep water and mud out of the tube when the tube is forced downwardly through the ground, the bottom end of the tube is closed by some means to make it watertight. Otherwise, water and mud will creep in and this will contaminate, or dilute, the concrete which is poured into the tube to be forced out of the lower end to form the ball. Such contamination of the concrete would, of course, result in a ball of impaired strength. However, when the tube is placed in its final position in the ground to receive the concrete and permit it to move outwardly from the tube to form an enlarged concrete ball, the lower end of the tube must be open so that the concrete may be forced through it, to form this enlarged concrete foundation ball at the lower end of the pile.

It is a main object of the invention to provide a bottom arrangement for the pile tube which can withstand the strains incident to the placing of the tube in the ground and which prevents external materials such as water and mud, from entering the tube and which, on the other hand, is removable in situ when the tube is ultimately placed, so that concrete may be poured into the tube and forced out through its bottom end to form an enlarged concrete foundation ball; that is, a concrete ball having a diameter greater than the diameter of the tube.

In accordance with a principal feature of the invention the metal wall near the bottom of the tube used in

forming the hole in the ground is weakened along a line around the periphery of the tube.

In accordance with another important feature of the invention the weakening of the tube wall along the line about the periphery of the tube near the bottom thereof is attained by a reduction of material in the metal wall.

In accordance with one specific feature the said reduction of wall material may be attained by reducing the thickness of the metal wall by forming a groove therein partway or all around the tube.

In accordance with an alternative feature the said reduction may be attained by a series of apertures through the wall of the tube along the said line of weakening.

In accordance with a further specific feature the apertures are suitably plugged to make them watertight.

Although the novel features which are believed to be characteristic of the invention will be pointed out in the annexed claims, the invention itself as to its objects and advantages and the manner in which it may be carried out may be better understood by reference to the following description, taken in connection with the accompanying drawings forming a part hereof, in which:

Fig. 1 is a view in elevation illustrating the general arrangement of a ball pile, of the type to which the invention appertains, placed in position in the ground;

Fig. 2 is a view showing in simplified form the bottom portion of equipment used in placing a ball pile, the line A—A indicating the line of weakening;

Fig. 3 shows the same equipment as Fig. 2 but with the bottom end forced off with a charge of concrete;

Fig. 4 shows the bottom end of a tube used in the forming of a hole in the ground for a ball pile, in which the weakening line is effected by a series of plugged holes;

Fig. 5 shows parts similar to those in Fig. 4; the tube in this instance being corrugated and having a smooth cylindrical bottom portion for the line of weakening;

Fig. 6 shows parts similar to those in Fig. 4; the tube in this instance having an attached bottom portion with the line of weakening;

Figs. 7 and 8 show alternative details of the plugging of the holes along line A—A in the preceding figures;

Fig. 9 shows the bottom part of a corrugated tube and a sleeve bottom plate welded thereto, the line of weakening A—A in this case being along a groove in the cylindrical wall of the bottom plate; and

Fig. 10 shows a detailed cross-section of the weakening feature in Fig. 9 taken along line 10—10 of Fig. 9; and

Fig. 11 shows a detailed cross-section of the weakening feature in Fig. 9 taken along line 11—11 of Fig. 9.

Referring now to Fig. 1 the concrete ball pile **10** is shown in position in the ground and as having a long pile section or shaft **11** and a ball shaped foundation **12**. The shaft may extend through different strata more or less watery, into a stratum firm enough to be compacted into a desired consistency.

The long section **11** extending to the depth A—A may be more or less smooth and straight, depending on the manner in which it was installed. This concrete shaft may be in direct contact with the ground for the full length or for part of the length. The concrete shaft may however be encased in a permanent steel casing, not shown in Fig. 1, which may be smooth or corrugated.

Figs. 2 and 3 show the bottom end of an equipment **20** suitable for the installation of a ball pile, such as shown in Fig. 1 or for forming the shell therefor. It comprises a long steel tube **21**, a bottom closure in the form of a plate or boot **22** and an internal ram **30**. Such equipment may take different forms and may be used in different manners. But generally speaking, the steel tube 21 with the boot 22 attached is forced downwardly through the soil by means of ram 30 or by means of driving mandrels known in the art and ultimately is placed at a depth where the separation line A—A will correspond to the depth A—A indicated in Fig. 1, before any concrete is poured through. The separating line A—A in Figs. 2 and 3 indicate the line of weakening of the tube, the tube and boot remaining intact during the installing process.

When the tube is in its final position, the ram 30 is removed and a batch of concrete, of suitable mixture as known in the art, is poured down through the tube to a level a few feet above line A—A. After locking the tube to the surface equipment, or otherwise securing the tube in this position, the ram 30 is lowered and driven by reciprocating motion against the concrete which now forces the bottom closure or boot off the tube, causing a separation indicated in Fig. 3 by lines A—A and B—B and forcing concrete out through the open bottom end of the tube into the comparatively loose or soft ground, as indicated at 27 in Fig. 3, to start the formation of the ball 12. Additional batches of concrete may thereafter be poured into the tube and tamped out by means of the ram to enlarge the ball until a desired packing and compacting of the surrounding stratum is attained.

After forming the ball 12, additional concrete may be poured into the tube and tamped more lightly for the formation of the long shaft 11 up to a level which usually is above ground level, as shown in Fig. 1.

The tubing 21 may be left in the ground to the full depth A—A to serve as the shell of the pile 10. However, if it is desired to form a concrete pile without a permanent steel casing, the tube 21 may be raised a short distance, say a few feet, after the ball has been fully formed and, after raising the tube this increment, an additional batch of concrete may be poured in and tamped into contact with the sides of the hole in the ground, this procedure being repeated, if desired for the full length of the pile, which thus will be left in the ground without a steel casing.

In the latter practice, the tube 21 thus is retrieved and the bottom end closed with a new bottom closure or boot for installation of another similar pile at another location.

In accordance with the invention, the weakened line at A—A of the tube 21 may be formed in different ways.

In the case of the tube 21, as illustrated in Fig. 2, the tube has a bottom plate or boot 22 firmly welded to the bottom end of the tube so that it is watertight, and the weakening of the tube wall is obtained by means of a series of holes 41 as shown in Fig. 4. The holes may be drilled or punched through the tube wall along a line 43 around the periphery of the tube in a plane through the line A—A and located an inch or so above the upturned edge or collar 24 of the boot 22. The distance between the holes will determine the force required to tear the wall part for a given wall thickness.

In order to keep the bottom end of the tube watertight during installation of the tube in the earth the holes 41 are plugged tight by means of plugs or stoppers 45, a sample of which is illustrated in Fig. 7. The plug 45 is preferably solid and is tapered slightly for easy insertion and has a shoulder stop 46 to prevent it from being forced out while the wall is still intact. A slight modification is shown in Fig. 8 where the plug 45*a* is indicated as being hollowed out on the side facing inward. The plug is preferably inserted from the inside to prevent it from flying out under the heavy tamping on the first charge of concrete for breaking the wall of the tube along line 43.

The plugs may be made of any suitable material and should preferably be slightly elastic so that they will lock themselves in position in the holes 41. They may be of metal, such as soft iron, but preferably are made of relatively hard rubber.

By locating the line of plugs 45 just above the outside collar 24 of the boot 22, the projecting ends of the plugs will be protected to an appreciable extent against pressure from the sides of the hole in the ground while the tube is being forced downward to position.

Fig. 5 shows a weakening line 53 applied to a different type of tube 51. The tube 51 is corrugated for maximum rigidity with a minimum wall thickness. It is terminated by a bottom closure or boot 52 welded watertight to the tube 51.

However when the corrugations in the wall of tube 51 run helically, as shown in Fig. 5, it is somewhat inconvenient to drill or punch the circular holes for the plugs, since the plugs should preferably be inserted perpendicular to the wall areas at the different parts of the corrugations, such as hills, valleys and slopes. For that reason, it is desirable that the corrugations along the bottom edge of the tube 51 be hammered or rolled out into a substantially smooth cylindrical wall shape 56 for a distance extending a few inches above the upper edge of boot 52, the boot then being welded watertight into position on this cylindrical portion 56.

The weakening line A—A is located in the smooth cylinder portion 56 an inch or so above the upper edge of boot 52, and may consist of a series of apertures 53 of any effective shaped and closed with plugs made of a suitable material, such as plugs 45.

For tubes of the corrugated type, such as shown in Fig. 5, another arrangement may be provided in accordance with the invention. One such other arrangement is shown in Fig. 6. In this modification the tube 61 is cut off straight at the bottom and is closed by a watertight bottom closure having a weakened line 63, which is similar to weakened line 53 as shown in Fig. 5. This bottom closure comprises a cylindrical wall or sleeve portion 66 and bottom plate 62 is welded thereto. The collar portion of bottom plate 62 is welded to the bottom edge of the cylindrical wall portion 66. The weakened line 63 is formed in the cylindrical wall portion 66 and the upper edge of the portion 66 is welded to the bottom edge of the tube 61.

The tube 61, as shown in Fig. 6, is corrugated but, if desired, it may be a smooth wall tube without corrugations. The sleeve portion 66 of the bottom closure shown in Fig. 6, preferably has corrugations which lie in planes at right angles to the long axis of the tube 61 and the series of holes forming the weakened line 63 are placed in the valley of a corrugation, as illustrated in Fig. 8. When the holes are placed in the valley of a corrugation as shown in Fig. 6, the protruding ends of the plugs, when inserted in the holes, are protected by the adjacent hills of the corrugation, as shown in Fig. 8. This arrangement of bottom closure has advantages in that the entire bottom closure including the sleeve 66, having the weakened line 63 may be assembled in the shop and taken in assembled form to the field, where all that is required is the welding of the sleeve 66 to the bottom end of a length of standard corrugated tube 61; or, if desired, to a length of smooth wall tube, such as 21, illustrated in Fig. 4.

For tubes made of corrugated sheet steel of 16 or 18 gauge the holes 41 may be ½ inch in diameter and ¾ inch apart for use with rams in general use in this art. However, the size and spacing of the holes will be determined by the gauge and strength of the wall of the steel tube and the force utilized to bring about the separation of the bottom closure when it is knocked off the end of the tube.

Fig. 9 shows a method of weakening the bottom end along line A—A below the line of attachment of the bottom plate or boot, to the tube. The tube 91 may be any of the types referred to above. The boot 92 has a closed bottom plate with an upstanding cylindrical collar **96** which fits snugly around the bottom end of the tube. The collar **96** is welded watertight along its upper edge **94** to the wall of the tube **91**. Boots of this type must be of heavy material, with a wall thickness of ¼ inch or more depending upon the size of the tube, since they force the way through the ground for the pile hole. They are of sheet steel and are frequently stamped in one piece and shaped to fit the tube.

In accordance with a specific feature of the invention the weakening line A—A is placed in the cylindrical collar portion **96** of the boot, below the line of welding **94**. With the heavy wall thickness of the collar **96** the weakening by means of apertures is not to be recommended. Hence, a narrow groove **93** is cut, as in a lathe, or otherwise formed in the heavy wall material, deep enough to reduce the thickness at the valley of the groove to provide the desired weakness. As best shown in Figs. 9 and 11, apertures are provided in groove **93**, each aperture being closed by a plug or stopper **93*a***. The plug **93*a*** may be of the type shown at **45** in Fig. 7 or at **45*a*** in Fig. 8. If desired, the inner side of the wall forming the collar **96**, may be turned smooth in the lathe, so that the thickness at the inner surface of the valley of the groove may be accurate and safe. If desired, a groove may be cut in the flat bottom part of the boot **92** at its periphery instead of the collar portion **96** of the boot.

The strength at the line of weakening must, of course, be sufficient to permit easy handling in the field.

When the tube has been placed in final position it becomes necessary to apply disrupting forces by locking the tubing in position in any convenient manner and by striking the bottom from inside with a ram, usually through a charge of concrete. The weakening effect thus must be carried to the point where rupture may be secured with available equipment.

With any of the forms described herein a watertight bottom closure may be assured so that the consistency of the concrete, prior to the time the concrete sets, may be relied upon till the time of rupture when the ball is to be formed.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, and it is to be recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. In an equipment for installation of a ball pile in the ground a long sheet steel tube with a closed watertight bottom having a series of apertures through the wall material to form a line of weakening circumferentially about the tube at the bottom end for rupturing said wall and removal of the bottom by force exerted on the inside of said tube in a direction toward said bottom, and a separate plug in each of said apertures closing said apertures water-tight prior to rupture of said wall.

2. A tube in accordance with claim 1 in which said plugs are of rubberlike material forced ttight into said apertures.

3. A short tubular section of sheet steel having a metal bottom welded watertight to one end thereof and closing one end of said tubular section, a shallow groove disposed circumferentially about said section, a series of holes through the wall of said section closely distributed along a line in said groove and a plurality of shouldered plugs of rubberlike material for watertight plugging of all said holes, said section being adapted for watertight welding along its open other end to a longer tube for the installation of a ball pile in the ground.

4. A metal bottom closure for watertight attachment to a long sheet metal tube for the installation of a concrete ball pile in the ground, said closure comprising a circular bottom plate and a cylindrical wall portion upstanding therefrom for welding said closure watertight to said tube, a groove extending circumferentially around said cylindrical wall portion, a plurality of apertures disposed in said groove, said groove and said apertures forming a line of weakening in said cylindrical wall portion around its periphery in a plane parallel with said bottom plate for separation of said bottom plate from said cylindrical wall along the weakened line by rupturing the metal in said plane by the application of force exerted inside said cylindrical wall against said bottom plate and a filling material closing said apertures watertight.

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