May 28, 1963 L. MÜLLER 3,091,090

PILE SHAFT

Original Filed July 12, 1955 2 Sheets-Sheet 1

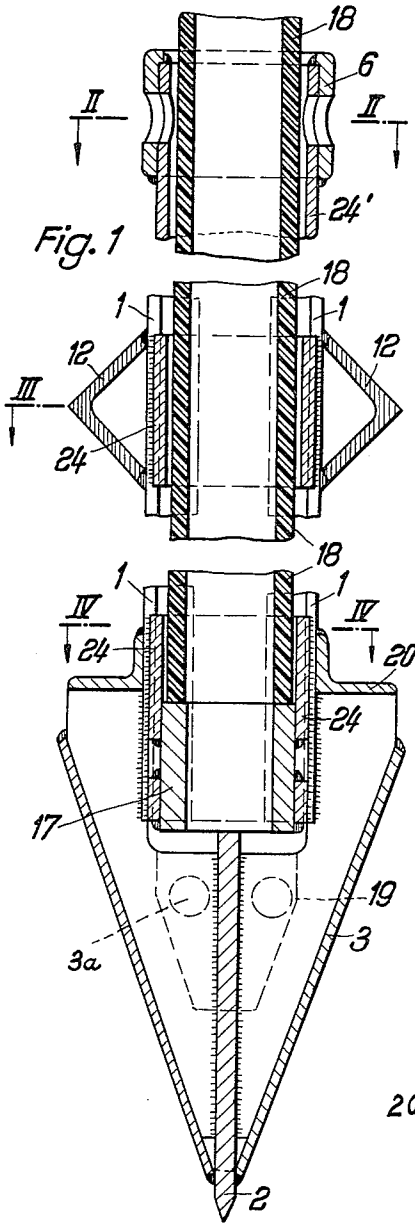


Fig. 1

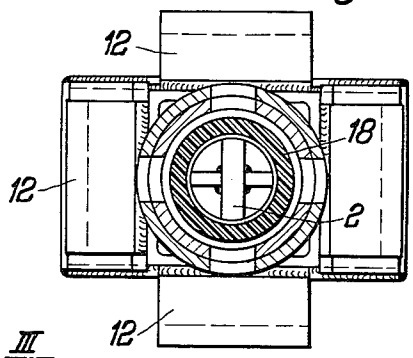


Fig. 2

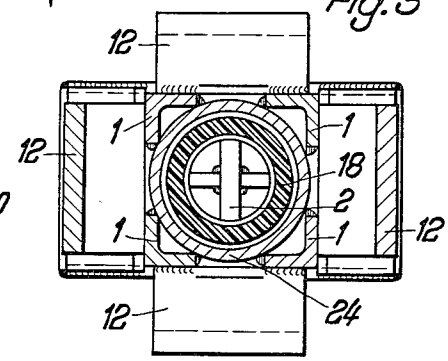


Fig. 3

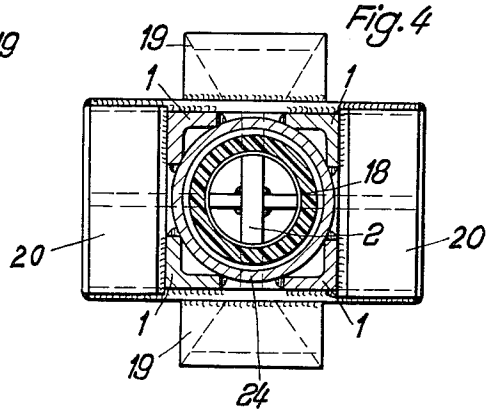


Fig. 4

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PILE SHAFT

Original Filed July 12, 1955 2 Sheets-Sheet 2

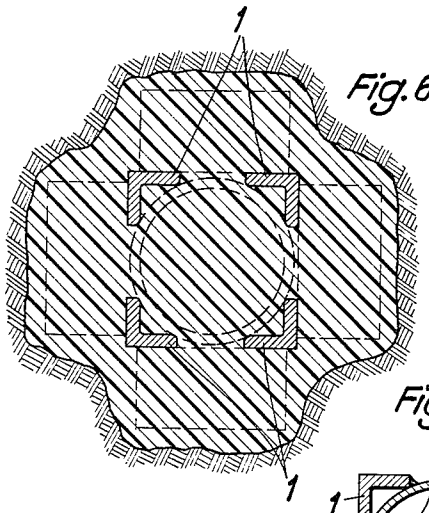


Fig. 6

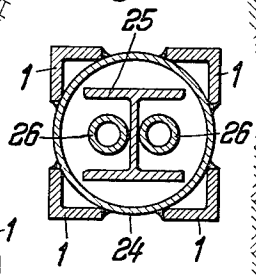


Fig. 8

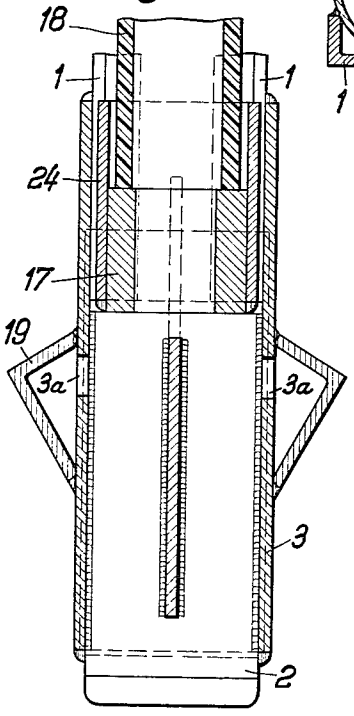


Fig. 5

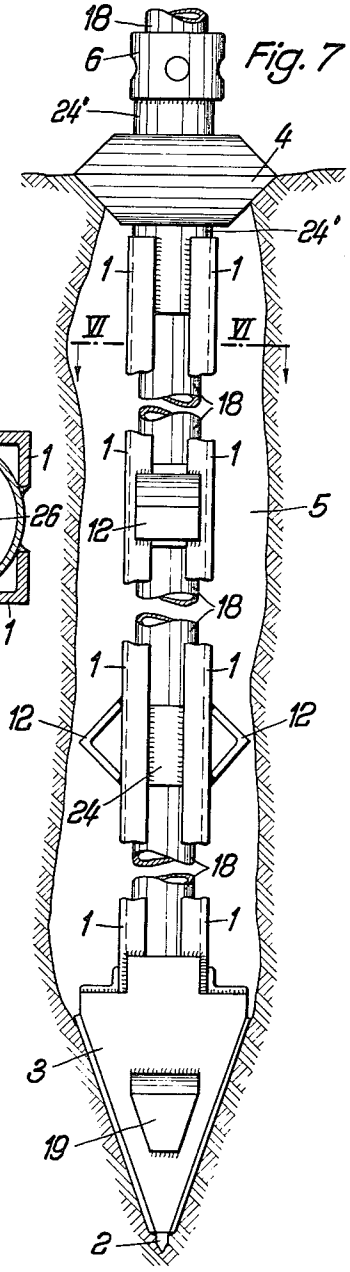


Fig. 7

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PILE SHAFT

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Original application July 12, 1955, Ser. No. 521,571, now Patent No. 2,924,948, dated Feb. 16, 1960. Divided and this application Dec. 21, 1959, Ser. No. 860,872

12 Claims. (Cl. 61—53)

The invention relates to a pile shaft to be driven into the ground such as a foundation pile, and more particularly to a metal pile having at its leading end an apertured foot of wider peripheral outline than the pile shaft proper. This foot serves to form a substantially annular space about the pile shaft during the driving operation by displacing and compressing the penetrated ground strata. This space is gradually filled with cementitious material fed down the pile shaft and extruded therefrom through the foot apertures and lateral openings in the pile shaft proper as the driving operation progresses thus forming a jacket about the pile shaft which anchors the same in the ground.

The present application is a divisional application divided out of my co-pending application Serial No. 521,571 filed July 12, 1955 and issued as Patent No. 2,924,948 on February 16, 1960.

It is an object of the present invention to provide a novel and improved pile shaft of the general kind above referred to, which combines a simplified and inexpensive construction with strong anchorage and loading strength.

Another object of the invention is to provide a novel and improved pile shaft design which affords the advantage of a substantial saving of structural material, generally steel or iron, without a sacrifice in the strength and loading capacity of the pile.

Still another and more specific object of the invention is to provide a novel and improved pile shaft structure in the form of an open framework tied to a central driving shaft which also serves as a feed pipe or a feed pipe carrier for feeding cementitious material to fill the framework and to form the aforementioned jacket anchoring the pile in the ground. With such pile structure, the driving force applied to the central pile shaft is transmitted to the framework as a downwardly directed pulling force rather than as a bending strain. As an open framework has a far greater pulling strength than bending strength, the framework can be made comparatively light. This affords the advantage, in addition to the saving of material, of reduced weight which facilitates transport and erection of the pile shaft preparatory to driving.

A further object of the invention is to provide a novel and improved pile shaft in the form of an open framework which is gradually filled with and jacketed by cementitious material as the driving operation progresses thereby forming a solid pile shaft within the ground and tying the foot to the surrounding soil strata. The use of an open framework affords the further advantage that the components thereof can be longitudinally tensioned prior to being embedded in the cementitious material whereby the pile shaft after hardening of the material has the properties of prestressed reinforced concrete.

A still further object of the invention is to provide a novel and improved pile shaft having clearing means

along its length which impede the penetration of soil and stones into the interior of the pile shaft during the driving operation thereby assuring an unimpeded feed of cementitious material down the framework.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and set forth in the appended claims forming part of the application.

In the accompanying drawings, several preferred embodiments of the invention are shown by way of illustration and not by way of limitation.

In the drawing:

FIG. 1 is a fragmentary elevational view, in section, of a pile shaft according to the invention.

FIG. 2 is a section taken on line II—II of FIG. 1.

FIG. 3 is a section taken on line III—III of FIG. 1.

FIG. 4 is a section taken on line IV—IV of FIG. 1.

FIG. 5 is an elevational section of the leading end of the pile shaft and the pile foot, turned through 90° in reference to FIG. 1.

FIG. 6 is a section of a finished and anchored pile taken on line VI—VI of FIG. 7.

FIG. 7 is an elevational view of a driven pile shaft before feeding the cementitious material, and

FIG. 8 is a sectional view of a modification of the framework of the pile shaft.

Referring first to FIGS. 1 through 7 in detail, the exemplified pile shaft according to these figures comprises an open framework formed of four angle bars **1** made of steel or iron. The angle bars are joined to and held in position by longitudinally spaced ring or sleeve members **24**. The angle bars **1** are fixedly secured to the circumferential outside wall of sleeves **24**, generally by welding, to define a square peripheral outline. The lowermost sleeve **24** mounts a generally wedge shaped pile foot **3** fixedly secured to the lowermost sleeve **24** as by welding. A flat chisel **2** protrudes from foot **3** strongly secured thereto, to facilitate splitting of stones and other obstructions encountered during the driving operation. The uppermost sleeve **24'** is preferably substantially longer than the other sleeves to accommodate a sealing collar **4**. Collar **4** serves as a closure member to seal off the hollow space **5** formed by foot **3** during the driving operation. Both the foot and the collar have maximum peripheral outlines wider than the peripheral outline of the pile shaft proper. The peripheral outline of the collar is preferably slightly wider than that of the foot. The upper end of the elongated sleeve **24'** is preferably reinforced by means of a sleeve or collar **6** welded to sleeve **24'**.

The inside of lowermost sleeve **24** which protrudes into the foot mounts a ring **17** upon which loosely rests a hollow shaft **18** to which the driving force is applied during the driving operation. Shaft **18** is slidable within sleeves **24**. It is made of suitable steel or iron and constitutes a driving shaft.

The framework of the pile shaft formed by angle irons **1** and sleeves **24** mounts a plurality of clearing lugs **12**. These lugs are longitudinally spaced and circumferentially staggered as can best be seen in FIG. 7. They preferably have a triangular cross section lengthwise of the pile shaft and serve to clear and push aside loose soil and stones during the driving operation. In addition to lugs **12** similarly shaped lugs **19** protrude laterally from foot **3**. Lugs **19** impede the penetration of soil and stones into the hollow foot **3** through lateral apertures

3*a* in the foot. For the same purpose, the open top end of the foot is partly covered by means of two angle flanges **20**. As is shown in FIG. 1, these angle flanges are longitudinally spaced from the top rim of the foot to leave peripheral apertures. Angle flanges **20** prevent or at least impede the penetration of soil or stones into the foot from the top thereof.

During the driving operation, the pile driver strikes upon driving shaft **18**. The resulting, longitudinally directed driving force is directly transmitted to chisel **2** and foot **3** through shaft **18** and ring **17**. As a result, the framework formed by the four angle bars **1** and joining sleeves **24** is not subjected to longitudinal pressure and appreciable bending stresses, but is pulled down by the foot into the space gradually formed by the foot about the framework formed by bars **1** and sleeves **24** as the driving operation progresses. In other words, the framework is subjected to tensional stresses only. After the driving operation has been completed or while the same is still in progress, hardening cementitious material such as concrete, in a state of fairly high flowability, is fed through shaft **18**, which now serves as feed pipe, first into the hollow foot and then as shaft **18** is gradually raised into the framework itself and the hollow space **5** surrounding it. The concrete is preferably fed at high pressure whereby the penetrated strata of soil are more or less compressed and the concrete will also be forced into the ground to a certain extent. As is apparent, the concrete keys itself in effect into the ground thereby assuring a strong anchorage within the ground. Just before the completion of the driving operation, collar **4** will engage the ground at the surface level thereby sealing space **5**. Such sealing facilitates a pressure build-up of concrete within space **5** which in turn causes a stronger compression of the surrounding ground and the penetration of concrete into the ground. After the closure of space **5**, the pressure of the concrete feed may be further increased.

While the sleeves **24** have been found to be suitable, bars **1** can also be joined by means of wires, bands or strips made of suitable metal such as iron or steel which are wrapped helically around the bars and are secured to the bars, for instance by electric welding.

The bars **1** may be longitudinally tensioned prior to the feeding of the concrete by any of the many tensioning devices known and suitable for the purpose. If pretensioning of the bars is intended, it is preferable to use comparatively thin bars or even heavy wires. As is apparent, a pile shaft formed of concrete reinforced by embedded pre-tensioned bars will have in effect the properties of pre-stressed concrete.

Instead of providing a tubular driving shaft **18** and using such shaft as feed pipe for the cementitious material, a solid driving shaft may also be used. Feed pipes must be then provided along the lengths of the solid shaft. FIG. 8 shows such an arrangement. According to this figure, a profiled bar in the form of a double **T** bar **25** is provided. Two feed pipes **26** extend along the web of said bar and are preferably suitably secured to the web. The pile shaft structure of FIG. 8 is otherwise the same as previously described.

While the invention has been described in detail with respect to certain now preferred examples and embodiments of the invention it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended, therefore, to cover all such changes and modifications in the appended claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A prefabricated pile shaft for driving into the ground to be permanently anchored therein, said pile shaft comprising several lengthwise parallel rigid bars disposed to define a generally tubular open metal framework, joining means fixedly secured to said bars for securing the same in said generally tubular relationship, a hollow foot having a peripheral outline wider than the maximum peripheral outline of said framework fixedly secured to the leading end of the framework in alignment therewith, an abutment member secured within said framework at the end thereof secured to the foot, and an elongated pile driving member for driving the pile shaft into the ground, said driving member extending into said framework from the trailing end thereof slidable in reference to the framework and abutting with its leading end upon said abutment member whereby a longitudinally directed driving force applied to the trailing end of the driving member is transmitted by said member directly to the leading end of the framework and to the foot secured thereto to exert a downwardly directed pulling force at said leading end of the framework.

2. A pile shaft according to claim 1 wherein said joining means are in the form of several longitudinally spaced, generally sleeve shaped members, and wherein said abutment member is in the form of a generally ring shaped member secured within the lowermost sleeve member in coaxial alignment with said sleeve members, the outer wall of said lowermost sleeve member being secured to said foot and the leading end of said pile driving member resting upon the trailing edge of said ring member.

3. A pile shaft according to claim 1 wherein said pile driving member is in the form of a tube open at its inner end for feeding cementitious material into said framework and foot by raising the tube in reference to the framework during the feeding of material.

4. A pile shaft according to claim 1 wherein said pile driving member is in the form of a profiled bar having a web, and a feed pipe extends along the length of the web of said bar secured thereto for feeding cementitious material into said framework and foot, said profiled bar being axially slidable within the framework for raising the bar and the pipe in reference to the framework during the feeding of material.

5. A pile shaft according to claim 1 wherein lugs for clearing obstructions are secured to said bars laterally and outwardly protruding therefrom, said lugs being longitudinally spaced and peripherally staggered.

6. A pile shaft according to claim 1 wherein said foot has side walls including apertures, and wherein hollow lugs having lateral openings are secured on said side walls to cover said apertures for impeding ingress of loose ground into the foot.

7. A pile shaft according to claim 5 wherein said lugs have a triangular cross section longitudinally of the bars.

8. A pile shaft according to claim 4 wherein said profiled driving bar is a double **T** bar.

9. A prefabricated pile shaft for driving into the ground to be permanently anchored therein, said pile shaft comprising an open metal framework composed of several bars and several sleeve members, said bars being fixedly secured to the outside wall of said sleeve members in parallel and circumferentially spaced relationship, said sleeve members being spaced lengthwise of the bars, a foot having a peripheral outline wider than the maximum peripheral outline of said framework fixedly secured to the leading end of the framework and in alignment therewith, an abutment member fixedly secured within the lowermost sleeve, and an elongated pile driving member extending within said sleeve members from the trailing end of said framework slidable in reference thereto and abutting with its leading end against said abutment member whereby a driving force longitudinally applied to the trailing end of said driving member is transmitted by said member directly to the leading end of said framework and the foot secured thereto to exert a downwardly directed pulling force upon said leading end of the framework.

10. A pile shaft according to claim 9 wherein said bars

are in the form of angle bars secured with their longitudinal flange edges to said sleeve members to define an outer substantially rectangular outline of the framework.

11. A pile shaft according to claim 9 wherein said pile driving member is in the form of a tube open at its leading end for feeding cementitious material into the framework by raising the driving tube in reference to the framework during the feeding of material.

12. A pile shaft according to claim 11 wherein the lowermost sleeve member extends into the foot and is secured at its outside wall thereto, and wherein said driving member is in the form of a ring member secured within the lowermost sleeve member coaxially therewith.

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