Dec. 8, 1970 J. GRAZEL 3,545,214

CONCRETE PILE SECTIONS AND JOINTS THEREFOR

Filed Oct. 2, 1968 3 Sheets-Sheet 2

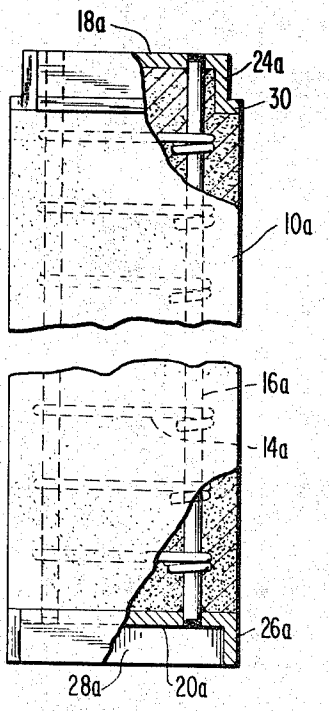


FIG. 4

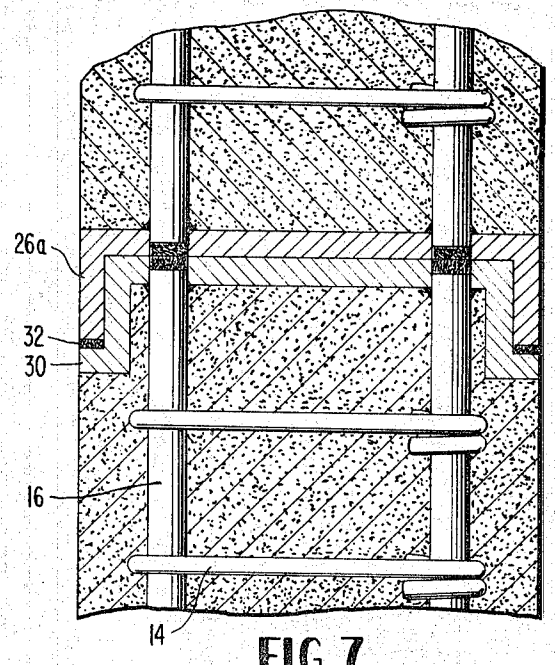


FIG. 7

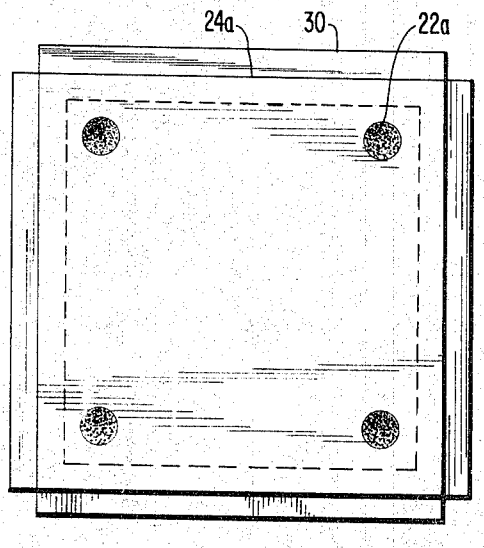


FIG. 5

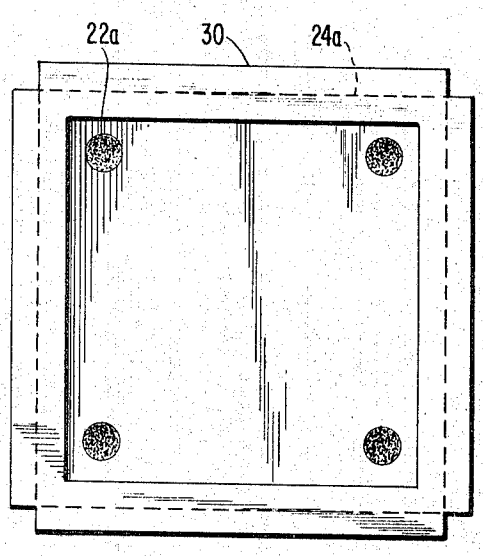


FIG. 6

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3,545,213

STRUCTURE FOR LINING UNDERGROUND SPACES

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Claims priority, application Czechoslovakia, Mar. 22, 1967, 2,115/67
Int. Cl. E01g 5/08, 5/10
U.S. Cl. 61—45 6 Claims

ABSTRACT OF THE DISCLOSURE

A structure for lining underground spaces such as tunnels and the like. The structure engages the underground surface which defines the underground space and includes a number of layers made up of elastic and concrete layers which engage each other. The elastic layers are preferably asphalt rubber while the concrete layers are preferably Gunite, and they are alternately arranged in engagement with each other to form a strong elastic multilayer crust body.

BACKGROUND OF THE INVENTION

The present invention relates to structures for lining underground spaces.

In particular, the present invention relates to lining structures for reinforcing underground installations, particularly by providing a strong lining for an underground surface which defines an underground space.

Structures of this type have been used, for example in tunnels or mine galleries, and the lining structures can extend horizontally, or they may be inclined or even vertical. In general such structures are intended to distribute uniformly the pressure of the ground which surrounds the underground space.

It is possible to obtain a suitable distribution of pressure by utilizing a lining structure of suitable profile, and, for example, known lining structures of this type can be made of brick. Reinforcements of this latter type have proved to be particularly advantageous in vertically extending spaces where the stress is applied to the reinforcing structure primarily in a horizontal direction with the stress being located at an elevation lower than in the case of underground spaces which are inclined or horizontal. It is customary to build a panel of molded bricks to form the reinforcement in such a way that the rear surface of the panel contacting the surface of the excavation, particularly in the case of mining operations, so that it is possible to obtain in this way, within certain limits, a given degree of pressure distribution. However, reinforcements of this latter type are extremely expensive, and there are undesirable inconveniences and costs involved not only in the structure itself but also in the transportation of the panels and in the professional skills which are required to manufacture the reinforcing lining.

It has also become customary in recent times to use, for reinforcements of this general type, Gunite which forms a concrete which can be delivered in fluent form to the required location where it sets. Thus, this particular type of reinforcement enables an exceedingly good bond to be achieved with rock in the event that the excavation surface is formed of rock. The space of the excavation is used in this case to the maximum extent, the air resistance is reduced, and the possibility of settling of harmful dust is also reduced. In addition, a reinforcement of this type has refractory properties. Such Gunite reinforcing structures have also been used in combination with reinforcements for roof bolts.

However, linings made of Gunite, of panels of suitable profile, or of bricks all have the common drawback of being incapable of providing sufficient resistance to bending and tension stresses so that the result is that undesirable ruptures are frequently encountered, such ruptures leading to a lessening or even a complete loss of the load-carrying capacity of the lining structure.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide for underground spaces a lining structure which will avoid all of the above drawbacks.

In particular, it is an object of the invention to provide a lining structure which not only will have a large load-carrying capacity but which in addition will have a relatively great degree of elasticity enabling forces to be reliably absorbed and uniformly distributed throughout the structure.

Also, it is an object of the invention to provide a lining structure of this type which will seal the interior space off from any fluids such as gases or liquids which might otherwise have access to the space.

Furthermore, it is an object of the invention to provide a lining structure which can be easily and inexpensively manufactured and which will conform without difficulty to the configuration of the underground space which is to be lined.

In accordance with the invention, the structure for lining the underground space includes a number of layers made of elastic and concrete layers engaging each other. These layers alternate with each other so that except for the innermost and outermost layers, each elastic layer is sandwiched between a pair of concrete layers and each concrete layer is sandwiched between a pair of elastic layers. The innermost layer can take the form of a concrete layer, while the outermost layer can be either elastic or concrete, the thickness of the several layers and the choice as to whether the outer layer is elastic or concrete depending upon the particular conditions which are encountered in the underground cavity.

BRIEF DESCRIPTION OF DRAWING

The invention is illustrated by way of example in the accompanying drawing wherein:

FIG. 1 is a schematic transverse section of a lining structure of the invention which in the illustrated example is composed of cylindrical layers; and

FIG. 2 is a partial section on an enlarged scale of the structure illustrated in FIG. 1.

The structure illustrated in the drawing forms a lining structure for an underground space which may be any tunnel, pit, well, mine gallery, etc., such excavations in general having either a circular or an elliptical cross section. In the illustrated example the outermost layer 2 is an elastic insulating layer applied directly against the surface of the excavation which is, in the illustrated example, formed in rock 1, and preferably the elastic layer 2 is made of asphalt rubber. The thickness of the layer 2 and of the subsequent layers described below will be determined by the geological structure of the rock where the excavation is situated. Thus, the outermost layer 2 will constitute an elastic base for the next layer, which is a layer of concrete, this latter layer preferably being a layer 3 of Gunite. It is to be noted that in addition to forming a base for the concrete layer 3, the outer elastic layer 2 also seals the concrete layer 3 so as to protect it against water or other fluids which might attack the concrete, and in addition the interior space is sealed so that gases will not escape therefrom into the ground. Thus, there is situated upon the inner exposed surface of the elastic insulating layer 2, which is preferably of asphalt rubber,

CONCRETE PILE SECTIONS AND JOINTS THEREFOR

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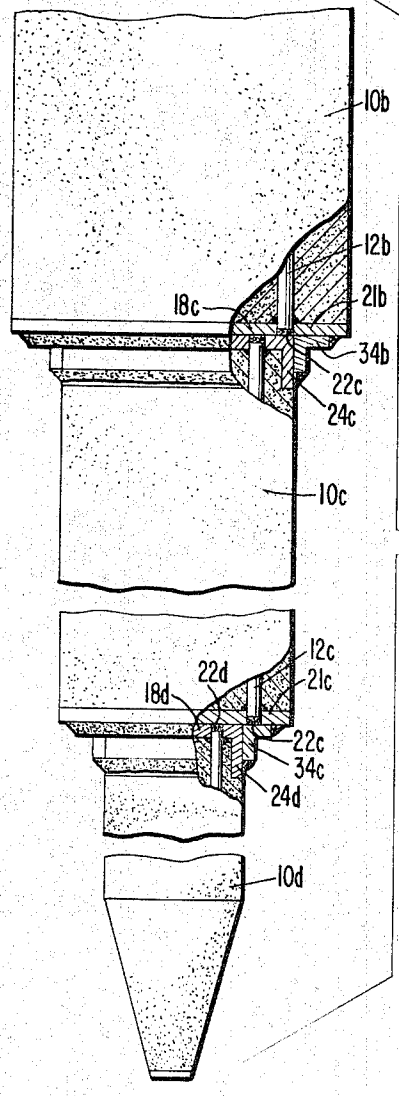


FIG.8

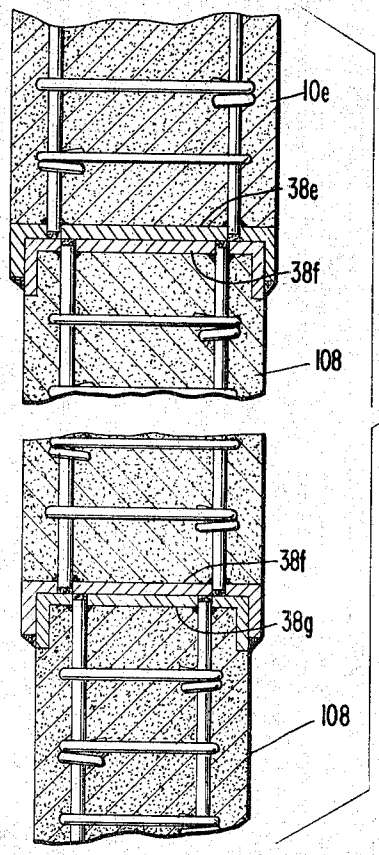


FIG.10

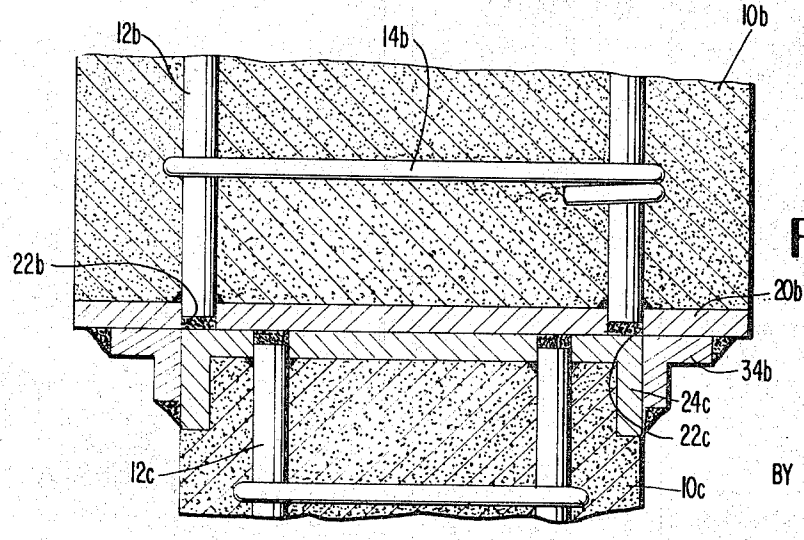


FIG.9

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CONCRETE PILE SECTIONS AND JOINTS THEREFOR

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Int. Cl. E02d 5/12, 5/30
U.S. Cl. 61—53 12 Claims

ABSTRACT OF THE DISCLOSURE

Each cast concrete pile section has longitudinally extending reinforcing rods, the opposite ends of which are partially received within openings formed through normally disposed end plates. The rod ends extend intermediate the lengths of the openings and are welded to the end plates along the inside faces of the plates about the openings. Weld is also applied within the openings from the outer faces of the plates. The end plates have flanges which extend in like axial directions. To secure the pile sections in end-to-end relation, the end plate of one pile section is received within the recess formed by the flanges of the end plate of the adjoining pile section.

The present invention relates to concrete pile sections and the joints therefor. Particularly, the present invention relates to precast concrete pile sections having end plates uniquely formed to provide ready connection with an adjoining pile section whereby a continuous cast concrete pile may be provided.

Cast reinforced concrete piles are widely used as foundations in the construction of buildings, bridges and other structures. Due to their extremely heavy weight and for reasons to be described presently, concrete piles are most often formed in short lengths or sections at a casting or fabrication yard and these sections are then normally transported to the construction site whereupon they are disposed vertically and driven into the ground as by a suitable hammer. For heavy construction, it is customary to join the precast concrete pile sections one to the other in end-to-end relation to form an elongated continuous pile and this may be accomplished either prior to or during the pile driving operation.

Certain problems, however, have remained in the construction and use of concrete pile sections, particularly with respect to the forces on the pile sections encountered during transport and handling of the pile sections prior to driving the same into the ground as well as problems associated with joining the pile sections in end-to-end relation prior to or during pile driving operations. The widespread employment of concrete piles as foundation structures has resulted largely from the high load bearing capability of concrete in compression. However, a concrete structure, particularly an elongated concrete pile, exhibits comparatively little load bearing capability in tension and under lateral loading. It will be appreciated that a precast concerete pile section acts as a beam when handled or stored or when loaded otherwise than in axial compression. Such pile sections, particularly those having large cross sections, are extremely heavy and, when transported from the casting yard to the construction site or otherwise handled prior to being driven into the ground, are subject to tensil and lateral loadings. These loadings, if excessive, tend to crack and otherwise damage the pile sections rendering the same unsuitable for use. Reinforcing rods are normally employed to improve the load bearing characteristics of concrete pile sections. This has to some extent limited the damage to the pile sections during handling, but such damage still occurs and remains

a problem. Moreover, problems in joining the discrete pile sections one to the other to form a continuous pile have occurred and such known methods have not proven completely satisfactory.

Prior precast reinforced concrete pile sections have been employed previously and provided with metal end connecting devices. In one such precast concrete pile, cylindrical rings are formed about and are axially spaced from the opposite end portions of the concrete pile sections. The end portions of the reinforcing rods are bent or flared outwardly such that the rod ends are welded to the respective inner faces of the rings. To join the concrete pile sections in endwise butting relation one to the other, a cylindrical sleeve or a pair of half sleeves are disposed about the adjoining ends of the pile sections with opposite ends of the sleeve or half sleeves being welded to the respective rings. Thus extensive welding is necessary at the construction site to join the pile sections one to the other. Another known type of precast concrete piling section provides outwardly flared or bent reinforcing rods which are welded to the inside faces of annular end plates and to the inner faces of metal rings which are, in turn, welded to the associated annular end plates. To join the pile sections one to the other in endwise butting relation, the annular end plates at opposite ends of the sections to be joined are butted one to the other and welded about their common periphery.

The foregoing known pile sections have only limited load bearing characteristics, particularly in tension, and are accordingly subject to damage during handling. Moreover, the pile sections must be axially aligned one with the other prior to welding. When the foregoing and other pile sections are lifted or otherwise handled, the loadings are characteristic of a beam with one side of the pile sections being subject to loading in tension and the other side being subject to loading in compression. Since the reinforcing rods of the foregoing described known pile sections on the side thereof in tension are bent or flared outwardly, it will be seen that their tension bearing characteristics are seriously impaired and the concrete is thus subject to cracking along their tensioned sides. The rod-to-end plate connections, where applicable, of such known prior pile sections afford limited weld areas whereby the joints are not particularly strong and often rupture. Since these connections are internal of the pile sections, visual inspection of the same prior to driving the sections is impossible. Moreover, in those pile sections employing outwardly bent or flared reinforcing rods, the axial force applied to the sections as the latter are driven into the ground tends to further deflect the flared or bent ends of the rods outwardly such that the rods tend to crack the concrete cover between the rods and the outer surfaces of the sections.

Such prior pile sections also must be manhandled during installation to achieve coaxial alignment of the adjoining sections. Such alignment is necessary to properly transmit the load to the adjacent ground strata and to preclude loadings in the finished pile other than compressive loadings.

The present invention provides reinforced concrete pile sections and joints therefor which minimize the above-discussed and other shortcomings of prior concrete pile sections and their associated joints and provide various advantages in construction, mode of use and result over such prior pile sections and joints. Generally this is accomplished by forming concrete pile sections in the usual manner and providing plates at opposite ends of the sections with holes bored or otherwise formed therethrough to receive the associated ends of the longitudinally extending reinforcing rods. The rod ends are partially received within the plate openings and terminate short of the outer faces of the plates to form recesses within the

remaining portions of the openings. The rods are welded to the plates internally of the pile sections about the rods and along the inside face of the plates about the openings as well as externally in the recesses about the side walls of the openings and the associated end faces of the rods. In this manner, the rod ends are welded at two areas thereby providing a large weld area and hence improved and stronger rod-to-end plate connections. Equally as important, the rods extend longitudinally in parallel relation to the corresponding axes of the pile sections throughout the full lengths of the latter. By increasing the weld area and hence the strength of the weld joint as well as forming the rods parallel to their respective axes of the pile sections throughout their full lengths, there are provided concrete pile sections having improved load bearing characteristics, particularly in tension, whereby cracking and other damage to the pile sections during handling is substantially eliminated.

Another significant feature of the present invention resides in the unique formation of the end plates of the pile sections in a manner to facilitate connection one with the other and ready coaxial alignment of the superposed pile sections. To this end, the end plates are provided with flange portions which extend axially in like directions whereby a metal end cap is formed at one end of the pile sections and an axially outwardly opening recess is formed by the end plate at the other end of the pile section. The cross sections of each of the pile sections may be constant in diameter or progressively increased in diameter to form a tapered or step tapered continuous pile. In either case, the end caps and recesses are formed such that the end caps on the underlying pile section are receivable within the recesses formed in the end plates in the superposed pile sections whereby a continuous pile is formed.

Accordingly, it is the primary object of the present invention to provide improved concrete pile sections and joints therefor.

It is another object of the present invention to provide concrete pile sections and joints therefor having improved load bearing characteristics during handling.

It is still another object of the present invention to provide improved concrete pile sections having end plates adapted for nesting engagement with the end plates of adjoining pile sections.

It is a further object of the present invention to provide improved pile sections having end plates adapted to join pile sections having different lateral dimensions whereby a continuous tapered pile may be formed.

It is still a further object of the present invention to provide improved joints for concrete pile sections. It is a related object of the present invention to provide concrete pile sections and end plates therefor for forming step tapered concrete piles.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specifications, appended claims and drawings wherein:

FIG. 1 is a fragmentary side elevational view of a concrete sectional pile constructed in accordance with the present invention with portions broken out and in cross section for ease of illustration;

FIG. 2 is an enlarged fragmentary cross-sectional view of a joint formed between the ends of a pair of the pile sections shown in FIG. 1;

FIG. 3 is a plan view of the end plate located on the upper end of the lowermost pile section illustrated in FIG. 2;

FIG. 4 is a fragmentary side elevational view illustrating a pile section employing an end plate constructed in accordance with another embodiment of the present invention;

FIGS. 5 and 6 are top and bottom plan views, respectively, of the upper plate of the pile section illustrated in FIG. 4;

FIG. 7 is an enlarged fragmentary cross-sectional view of a joint formed between a pair of pile sections employing the end plate construction illustrated in FIG. 4;

FIG. 8 is a fragmentary side elevational view with portions broken out and in cross section of a step tapered pile employing pile sections having end plates and joints formed in accordance with another embodiment hereof;

FIG. 9 is a fragmentary enlarged cross-sectional view of a joint between a pair of pile sections illustrated in FIG. 8; and

FIG. 10 is a fragmentary longitudinal cross-sectional view of a step tapered pile constructed in accordance with another form of the present invention.

Referring now to the drawings, particularly to FIG. 1, there is illustrated a reinforced concrete pile section **10** which may be formed in the usual manner as by pouring concrete into forms, molds or the like and which is preferably rectangular in cross section although it will be appreciated that the present pile sections may be formed to other and different cross sections, for example, circular. Pile section **10** comprises a plurality of laterally-spaced longitudinally extending steel reinforcing rods and preferably arranged to form an elongated cage having a rectangular cross section. A plurality of longitudinally spaced cross ties **14** are wrapped about and encompass rods **12** at longitudinally spaced positions along the pile section and are secured to the rods **12** by light wires **16** in the usual manner.

A pair of plates **18** and **20** are provided on opposite ends of the pile section **10** and each plate has a plurality of openings **22** which receive the corresponding ends of the rods **12**. The rod ends extend partially within openings **22**, preferably about half-way, leaving outwardly opening recesses formed by the end faces of rods **12** and the sidewalls of opening **22**. The rods are then welded to each end plate at two different places, i.e., about the rods and the inner faces of the end plates about openings **22** forming an interior weld and within the outwardly opening recesses defined by the rod end faces and the sidewalls of openings **22** in the end plates **18** and **20**. In this manner, a large weld area is provided whereby the concrete pile sections have increased load bearing characteristics particularly in tension which preclude cracking or otherwise damaging of the concrete pile sections during handling and prior to driving the latter into the ground, all of which is described and illustrated in my copending application Ser. No. 764,384, dated Oct. 2, 1968.

To provide a nested type connection between the discrete pile sections when disposed vertically in endwise butting relation one to the other to form an elongated concrete pile of selected length, a plurality of flanges are provided on each of the end plates **18** and **20** and are preferably formed by bending over lateral edge portions of the plates **18** and **20**. It will be appreciated, of course, that the flanges may be formed separately and welded or otherwise secured to plates **18** and **20**. Particularly, the flanges **24** of plate **18** extend axially inwardly and are formed such that they are inset from the sides of the pile section **10**. The flanges **26** of end plate **20** extend from plate **20** in an axial direction away from the other end plate **18** and preferably form continuations of the side of pile section **10**, thus forming an outwardly opening recess **28**. The lateral dimensions of end plate **18** and recess **28** are such that when a pair of pile sections thus formed are disposed in end to end relation, end plate **18** may be received within recess **28** of the end plate **20** of the adjacent pile section **10** as seen in FIG. 2. The lower edges of the outer flanges **26** are welded along the outer faces of flanges **24** as at **29** to form a substantially peripheral weld. In this manner, a strong and readily formed joint is provided and axial alignment of the adjoining pile sections is automatically assured. It will be noted that in the form of the present invention illustrated in FIGS. 1–3, the pile sections are constant in

cross-section and when joined one to the other in endwise relation form a concrete pile constant in cross-section throughout its full length.

Referring now to FIGS. 4–7, there is illustrated another embodiment of the present invention. In this embodiment, pile section **10***a* including rods **16***a*, ties **14***a* and end plate **20***a* are formed similarly as in the previous form with the exception that plate **18***a* is provided with a laterally outwardly extending shoulder or lip **30** projecting from the lower edge of each of the axially extending flanges **24***a*. When end plate **18***a* and flange **24***a* are received within the recess **30** of the next superposed piling, the flanges **26***a* of end plate **28***a* are slightly spaced from and directly overlie shoulders **30**. The lower edges of flanges **26***a* are then welded to the shoulders **30** securing the pile sections in endwise butting relation each to the other.

Referring now to FIGS. 8–9, there is shown a step tapered pile formed of discrete pile sections **10***b*, **10***c* and **10***d*. Each pile section **10***b*, **10***c* and **10***d* has a constant diameter throughout its length with pile sections **10***c* and **10***d* having smaller diameters than pile section **10***b* and section **10***d* having a smaller diameter than section **10***c*. Each of these pile sections has opposite end plates. For example, pile section **10***c* has end plates **18***c* and **21***c* with only the end plates **21***b* and **18***d* being illustrated and forming a part of the connection between pile sections **10***b* and **10***c*, and **10***c* and **10***d* respectively. As illustrated, the end plates **21***b* and **21***c* on pile sections **10***b* and **10***c* respectively, comprise flat plates having a plurality of openings **22***b* and **22***c* respectively formed therethrough at predetermined laterally spaced positions to receive the ends of the associated reinforcing rods **12***b* and **12***c* respectively. It will be seen that the lateral dimensions of end plates **21***b* and **21***c* are such that the edges thereof form continuations of the sides of the associated pile sections. End plates **18***c* and **18***d* have peripheral flanges **24***c* and **24***d* respectively which extend axially inwardly, the outer faces of which lie coextensively with the sides of the respective pile sections. Plates **18***c* and **18***d* are also provided with a plurality of openings **22***c* and **22***d* respectively to receive the corresponding ends of the reinforcing rods **12***c* and **12***d* of the associated pile sections. The connections between the reinforcing rod and the various end plates in this embodiment are similar to the connections formed between reinforcing rods **12** and end plates **18** and **20** in the previously described embodiment illustrated in FIGS. 1–3.

To secure the different diameter pile sections in end to end relation one to the other, angled brackets **34***b* and **34***c* are disposed about the outer faces of end plates **21***b* and **21***c* respectively to form axially outwardly opening recesses with the associated end plates **21***b* and **21***c*. Preferably, the base portions of angle brackets **34***b* and **34***c* are welded to the respective end plates **21***b* and **21***c*. To secure the pile sections in step tapered fashion one to the other, the next larger pile section is disposed over the lower pile section such that the end plate associated therewith, for example, end plate **18***d* is received within the recess **28***c* formed by the end plate **21***c* and associated angle brackets **34***c* of the superposed pile section **10***c*. The pile sections **10***c* and **10***d* are then secured one to the other by welding along the outer edges of angle brackets **20***c* and the exposed outer face portions of the flanges **24***d*. In this manner, axial alignment of the columns is assured. It will be appreciated that the brackets **34***b* and **34***c* could be first welded to the end plates **18***c* and **18***d* respectively whereby the end plates **21***b* and **21***c* of the superposed pile sections would butt and be welded to the end plates **18***c* and **18***d* respectively.

A step tapered pile formed of different diameter discrete pile sections may also be formed utilizing end plates similar to those described and illustrated in connection with the form illustrated in FIGS. 1–3. To this end, each pile section is provided with end plates **38** having openings for partially securing the ends of the associated reinforcing rods and the internal and external welded connections as in the previous embodiments hereof are provided. The end plates of each pile section are formed identically one with the other and the flanges thereof preferably form continuations of the sides of the associated pile sections. For example, the end plates **38***f* formed on opposite ends of pile sections **10***f* are identical one with the other and have flanges **40***f* which extend axially in like directions, the lower end plate and flanges forming an axially outwardly opening recess. The pile sections are formed having different lateral dimensions such that, when the sections are vertically disposed in end to end abutting relation, the end plate of an underlying section is received within the recess formed by the axially outwardly extending flanges of the end plates of the next superposed pile section. The adjoining end plates, for example, **38***e* and **38***f*, and **38***f* and **38***g* are welded one to the other. In this manner, a continuous elongated step tapered pile is formed.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other, each of said recesses and said second plate flange portions receivable in said recesses having complementary polygonally shaped cross sections in planes normal to the axes of said sections to preclude relative rotational movement of said pile sections about said axes when said second plate flange portions are received within said recesses and said sections lie in final securement one with the other.

2. A pile construction according to claim **1** wherein each pile section is constant in cross section throughout its length with the flange portions of each of said first plates forming continuations of the sides of the associated pile section, the flange portions of each of said second plates being insert from the sides of the associated pile section.

3. A pile construction according to claim **1** wherein the flange portions of said first and second plates of each of said pile sections form continuations of the sides of the associated pile section.

4. A pile construction according to claim **1** wherein the flange portions of said second plates have laterally outwardly extending shoulders, said shoulders being adapted

to underlie the flanges of said first plates when said pile sections are disposed in end to end butting relation.

5. A pile construction according to claim 1 including means securing said pile sections in butting end to end relation each to the other with the flange portions of the first plates of the sections at least partially encompassing the flange portions of the second plates of the adjoining sections.

6. A pile construction according to claim 1 wherein said securing means includes weld material applied to said first and second flange portions.

7. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, the flange portions of said first and second plates including a plurality of flanges bent about laterally extending axes and forming integral extensions of the respective plates, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other.

8. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the flange portion of said first plate comprising a plurality of laterally extending angle members having base and projecting leg portions, and means securing one of said base and projecting leg portions to one of said first and second plates, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other.

9. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other, said first and second plates having a plurality of openings for receiving the corresponding ends of said rods, said rod ends being disposed partially within said plate openings and being welded to said plates about said rods and inner face portions of the associated plates about said openings, and about the respective sidewalls of said openings and the end faces of said rods, said rods extending parallel to the axes of the corresponding sections throughout their full lengths.

10. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other, means for securing said pile sections in butting end to end relation each to the other with the flange portions of the first plates of the sections at least partially encompassing the flange portions of the second plates of the adjoining sections, each pile section being constant in cross section throughout its length with the flange portions of each of said first plates forming continuations of the sides of the associated pile section, the flange portions of each of said second plates being inset from the sides of the associated pile section.

11. A concrete pile construction comprising a plurality of elongated concrete pile sections disposable in end to end butting relation one to the other, said sections having a plurality of laterally spaced reinforcing rods extending parallel to the longitudinal axes thereof, first and second plates disposed at respective opposite ends of said pile sections substantially normal to the longitudinal axes thereof, and means associated with each of said sections securing opposite ends of said rods to the corresponding plates, the first plate of each pile section having a peripheral flange portion extending therefrom in a substantially axial direction away from the second plate at the opposite end of the associated pile section and defining an axially outwardly opening recess, the second plate in each pile section having a flange portion extending therefrom in a substantially axial direction toward the first end plate of the associated pile section, said second end plates having lateral dimensions as to be receivable within the recesses of said first end plates whereby the pile sections are disposable in end to end relation with the adjoining end plates in at least partially nested relation one to the other, means for securing said pile sections in butting end to end relation each to the other with the flange portions of the first plates of the sections at least partially encompassing the flange portions of the second plates of the adjoining sections, the flange portions of said first and second plates of each pile section forming continuations

of the sides of the associated pile section thereby forming a composite tapered pile.

12. A pile construction according to claim **11** wherein each pile section is constant in cross section throughout its length, thereby forming a step tapered composite pile.

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JACOB SHAPIRO, Primary Examiner

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52—301, 601, 725; 61—56; 287—103

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,545,214 Dated December 8, 1970

Inventor(s) JOHN GRAZEL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 67,"insert" should read -- inset --. Column 7, line 9, "1" should read -- 5 --.

Signed and sealed this 13th day of July 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER,
Commissioner of Pat