Sept. 2, 1969 M. R. ROŠ 3,464,173

TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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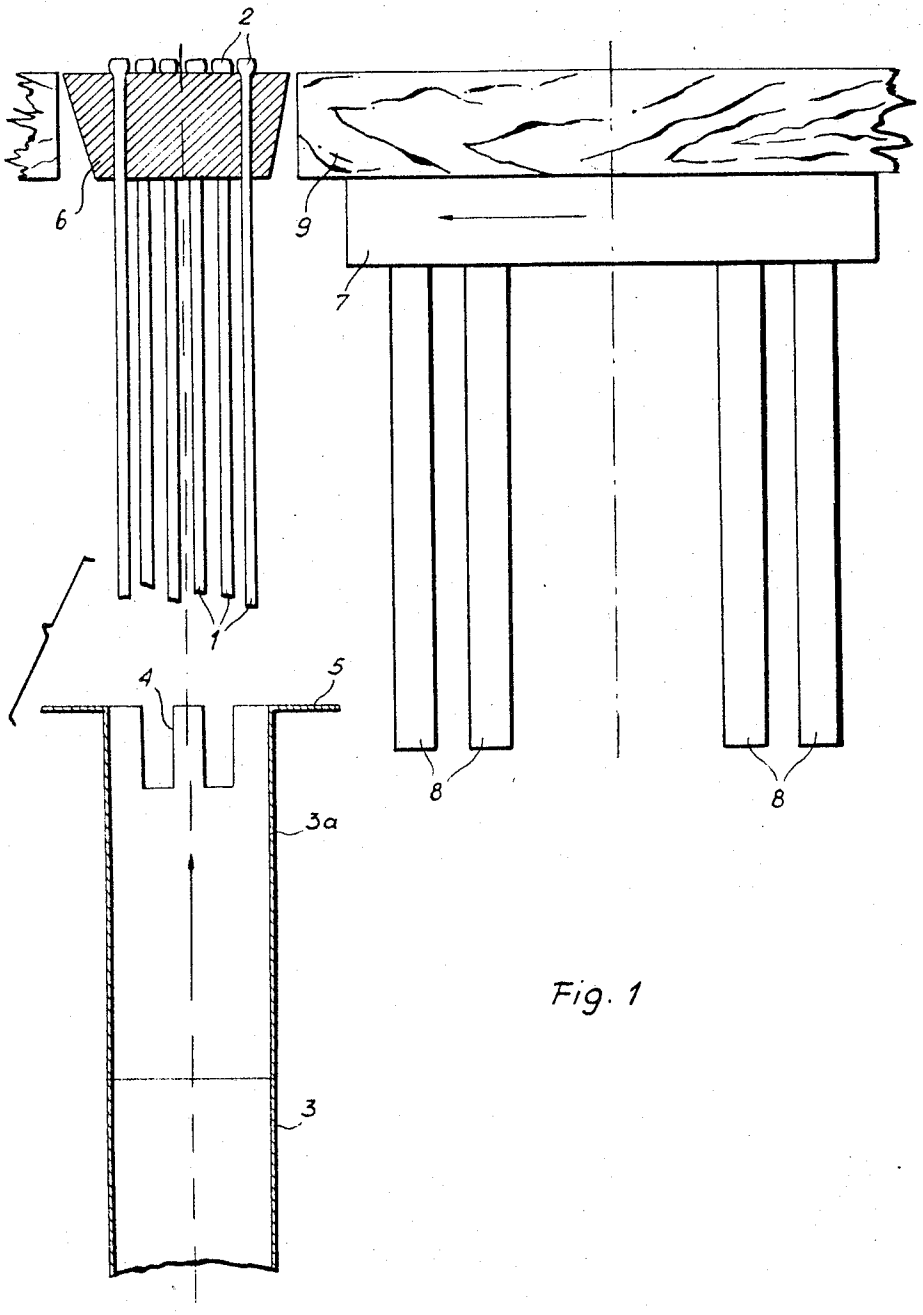
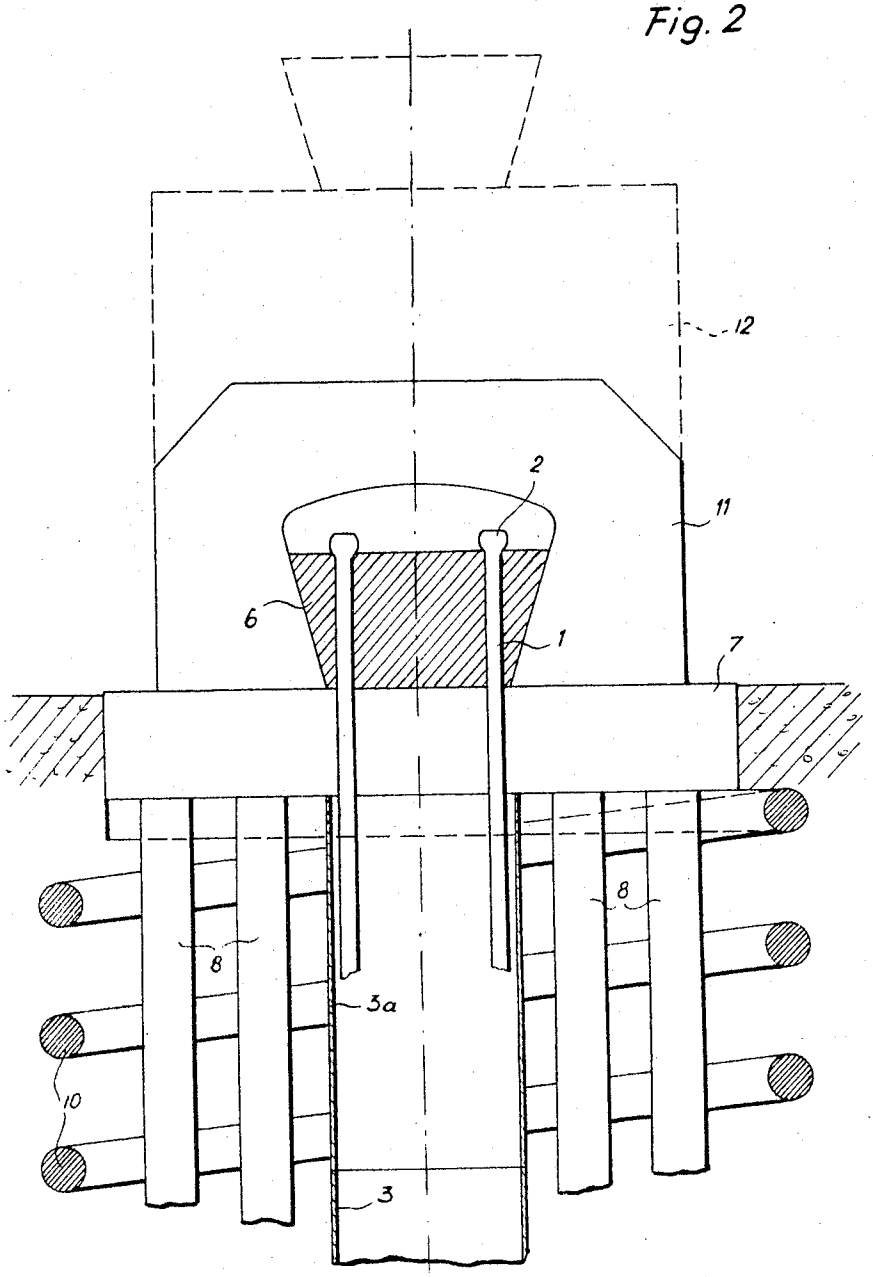


Fig. 1

TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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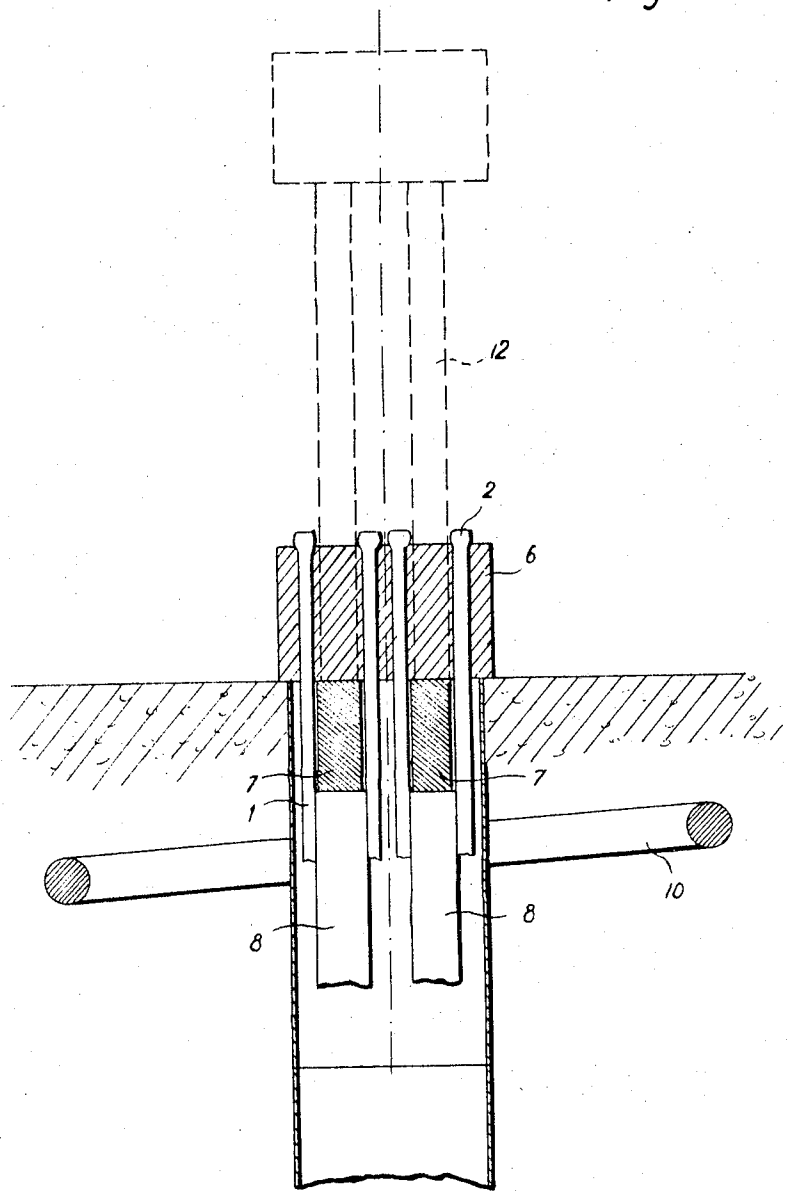
Fig. 2



TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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Fig. 3



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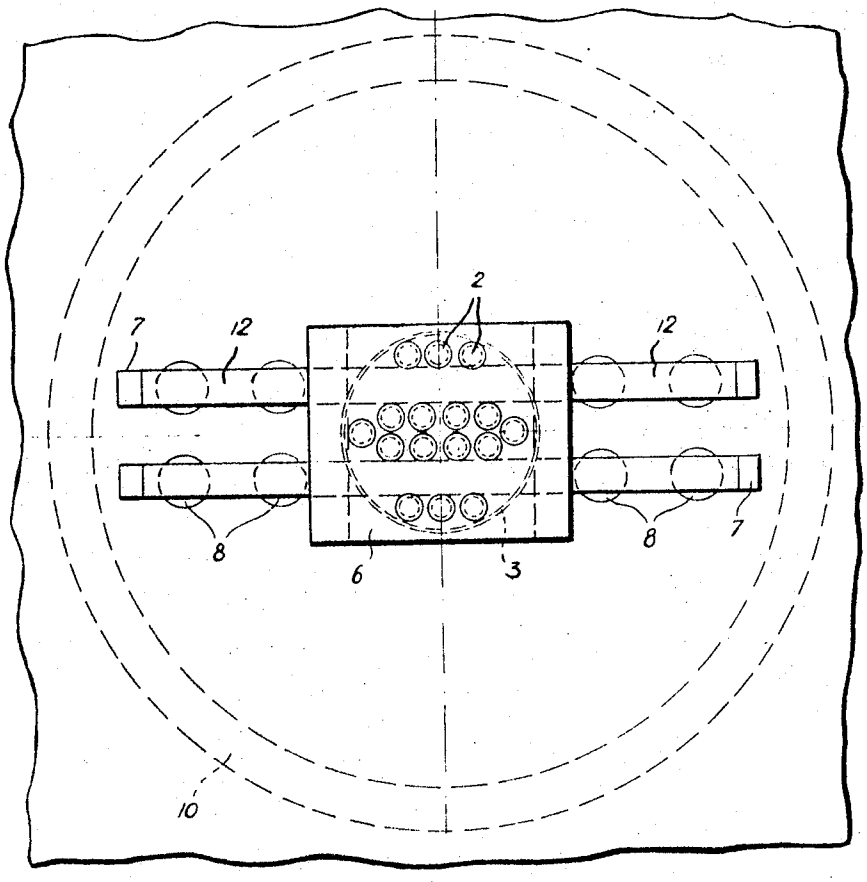


Fig. 4

TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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Fig. 5

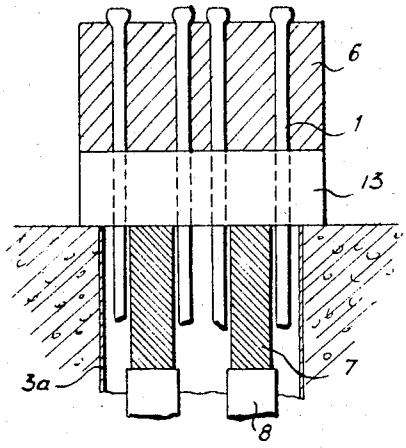


Fig. 6

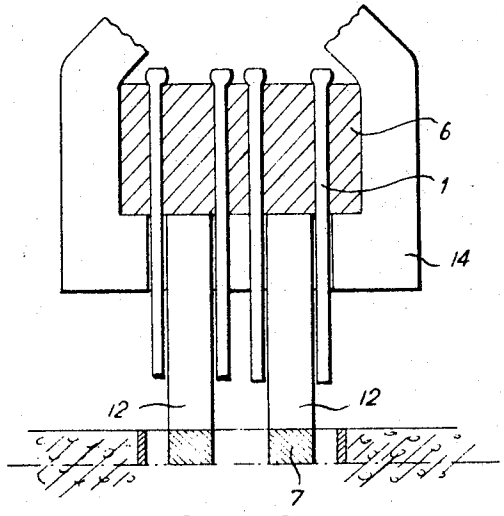
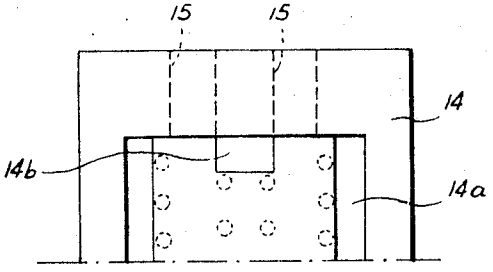


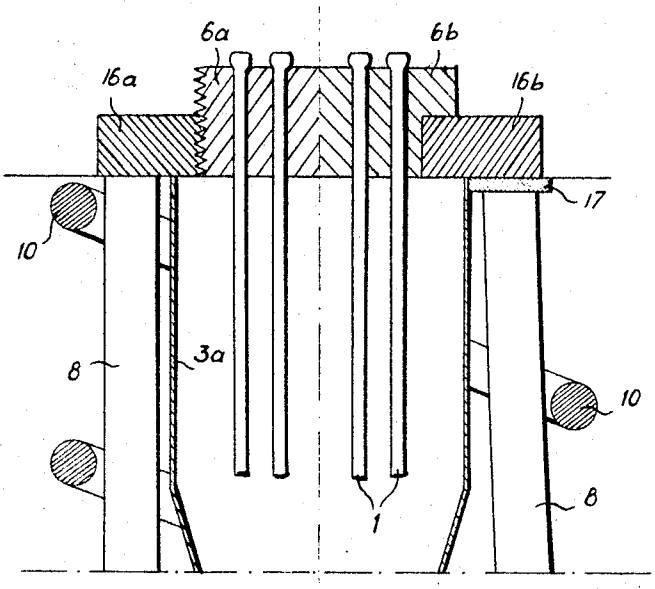
Fig. 7



TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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Fig. 8



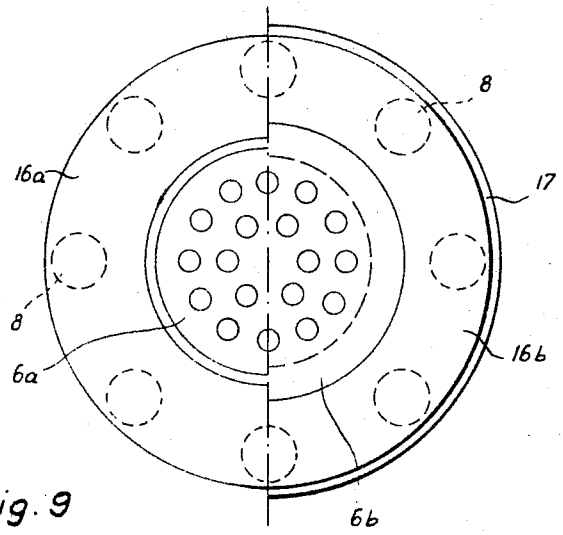


Fig. 9

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TENSIONING APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTIONS

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ABSTRACT OF THE DISCLOSURE

A prestressing arrangement for concrete components is disclosed as including tension elements connected to an anchoring block which bears, either directly or indirectly, on one relatively narrow surface of one or more bearing members each forming a part of a pile cluster including piles imbedded in the concrete and each having an outer end bearing against the opposite relatively narrow surface of an associated bearing member. The anchoring body transmits the prestressing force exerted by the symmetrically positioned tension elements substantially only to the outer ends of the piles which are symmetrically arranged outside the central cluster of tension elements. Thereby the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between the piles and the concrete in which the piles are imbedded.

This invention relates to prestressed concrete constructions and, more particularly, to a novel method of and apparatus for tensioning prestressed concrete constructions.

Tensioning arrangements for prestressed concrete constructions generally involve plural tension wires or elements extending through the concrete body and secured at their ends to anchoring bodies or members. In known arrangements of this type, the anchoring body is made of high grade steel and has dimensions which are as small as possible, in order to save material. In order to transmit the prestressing force from this relatively small anchoring body to the concrete construction, prior art arrangements usually use an anchoring or bearing plate which bears on a surface of the concrete construction, and which has a relatively large concrete engaging surface. Anchoring arrangements of this type are relatively expensive with respect to both material and cost of manufacture, particularly if the anchoring body and its bearing plate are interconnected with each other by fastening components, such as screws. It may thus be stated, as a general principle, that known tensioning arrangements for prestressed concrete constructions involve transmission of the tensioning force or reaction from the anchoring member to a plate or the like which has an extensive surface engagement with an exterior surface of the concrete component.

In accordance with the present invention, the disadvantages of known tensioning arrangements, particularly of the last-mentioned type, are obviated or avoided by providing an anchoring body support arrangement which differs fundamentally from known constructions. In particular, in accordance with the present invention the anchoring arrangement involves supporting the anchoring body, for the tension means, on a pile framing or pile cluster having steel piles embedded in the concrete. These steel piles are arranged symmetrically with respect to the center tension axis of the tensioning means and are positioned laterally outside the tension means.

Advantageously the steel piles of the pile framing or pile cluster may be arranged in substantially rectilinear rows which extend perpendicular to a plane through the center axis of the tension means. The piles in each row

are interconnected at their outer ends by transverse members, in the nature of ribs, which are embedded flush in the concrete. These transverse members or ribs extend through spaces between the tension wires, and the anchoring body is supported on the ribs.

Alternatively, the piles may be arranged in a circle concentric with the center axis of the tensioning means. In order to effect secure anchoring of the piles in the concrete, the latter are advantageously formed of corrugated, ribbed, or otherwise profiled round steel bars or rods. If no threaded anchoring connections are used, small deformations of the anchoring body subjected to the tension are not disadvantageous. Thus, in such instances, an ordinary steel, such as, for example, an ST 37 steel, can be used and the upset heads formed on the wire ends can easily be countersunk into the anchoring body during tensioning or stressing of the tension means, so that an unobtrusive connection and one of great strength is provided.

Accordingly, an object of the present invention is to provide a novel method for tensioning prestressed concrete constructions.

Another object of the invention is to provide a novel tensioning arrangement for prestressed concrete constructions.

A further object of the invention is to provide a tensioning arrangement for prestressed concrete constructions in which anchoring bodies for the tension means are supported on pile assemblies including piles embedded in the concrete.

Still another object of the invention is to provide a tensioning arrangement of prestressed concrete constructions in which piles arranged in rows are embedded in the concrete, with their outer ends interconnected by transverse members, which are likewise embedded in the concrete, and which serve as bearing means for the anchoring bodies for the tension means.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is an exploded elevation view, partly in section, illustrating the individual components of one embodiment of the tensioning arrangement of the invention, during assembly thereof;

FIG. 2 is an enlarged vertical sectional view through the tensioning arrangement shown in FIG. 1 and prior to tensioning of the prestressed concrete construction;

FIG. 3 is a vertical sectional view taken at right angles to FIG. 2 and illustrating the anchoring arrangement before tensioning thereof;

FIG. 4 is a plan view of the tension arrangement of FIGS. 1, 2 and 3 after tensioning;

FIG. 5 is a vertical sectional view, similar to FIG. 3, through a modification of the tensioning arrangement of FIGS. 1–4, prior to tensioning;

FIG. 6 is a view similar to FIG. 5 illustrating the arrangement of FIG. 5 after tensioning;

FIG. 7 is a plan view of one part of a two-part anchor body engaging grip or claw used during tensioning of the arrangement shown in FIGS. 5 and 6;

FIG. 8 is a vertical sectional view illustrating two further embodiments of the tensioning arrangement of the invention, one embodiment being shown to each side of a longitudinal center line; and

FIG. 9 is a plan view of the tensioning arrangement of FIG. 8.

Referring to FIGS. 1–4, the tension means comprises a bundle of parallel wires 1 of high strength steel. Wires 1 have small heads 2 formed thereon by upsetting at their ends. In the usual manner, the bundle of parallel

wires 1 extends through a sleeve 3 inserted into the concrete construction. An end portion 3*a* of sleeve 3 forms a so-called "trumpet," with its radially outwardly extending flange 5 at one end. The outer end of end portion 3*a* of sleeve 3 is also formed with two pairs of chordally aligned slots 4 which are substantially rectangular.

The ends of wires 1, which project from sleeve end portion 3*a*, extend through parallel bores of an anchoring body 6. Anchoring body 6 is substantially rectangular in plan and is trapezoidal in cross section. The upset heads 2 are at the ends of wires 1 and engage the larger end surface of anchoring body 6, which is that surface facing away from sleeve 3.

The bores in body 6, and which extend parallel to each other, are arranged in three groups which are symmetrical with respect to a plane which extends longitudinally of the body and perpendicularly bisects the bases of the trapezoid. In this manner, there are formed a center group of bores and two outer groups of bores, each spaced a substantially equal distance from the center group. Between the center and outer groups, there are zones which are free of bores and which extend parallel to such central plane. As the result of this arrangement of the bores in anchoring body 6, the wires 1 extending through the bores and through the sleeve portion 3*a* are arranged in three groups, including a central group and a pair of outer groups, with the outer groups being spaced from the center group by corresponding wire-free gaps.

In assembling the anchoring arrngement prior to pouring of the concrete, sleeve 3–3*a* including the bundle of wires 1 and anchoring body 6 are positioned in the form or mold. Thereafter, sleeve 3–3*a* is pushed back to such an extent that anchoring body 6 is spaced a predetermined distance from the outer end of end portion 3*a*, as will be noted from FIG. 1. A pile framing or pile cluster is then inserted through the gaps between wires 1 inwardly of anchoring body 6. This pile framing includes a pair of transverse members or ribs 7 each of which is in the form of a relatively elongated and substantially rectangular steel plate. Each transverse member or rib 7 has two pairs of steel piles 8 secured to extend from its edge surface in parallel relation and which are aligned longitudinally of the member 7.

The pile cluster 7–8 is disposed in such a manner that piles 8 are positioned outside the bundle of wires 1, which bundle is disposed symmetrically on both sides of the central plane of the tension means and which contains the rectangular cross section of anchoring body 6. Thereafter, sleeve 3–3*a* is moved forwardly until it abuts against body 6 and, during this movement, the two ribs or transverse members 7 come to have bearing engagement in the slots 4 of sleeve end portion 3*a*. The flange or extension 5 of sleeve end portion 4–3*a* is fixed to the end bell 9 of the form and this end bell is flush on both surfaces with the corresponding surfaces of anchoring body 6.

As can be best seen in FIGS. 2, 3 and 4, the anchoring zone of the tension means 1 in the concrete construction is surrounded by a helical reinforcement 10.

After pouring of the concrete and removal of the form or mold, the tension means can be tensioned. In order to effect such tensioning, anchoring body 6, having the aforementioned trapezoidal cross section, is gripped by means of a tensinging grip or jaw 11 shown in FIG. 2. Grip 11 is connected with a tensioning press (not shown) which, during tensioning of the tension means, is supported at the concrete construction by means of a supporting block with the interposition of a steel plate preferably covered with rubber. Tensioning grip 11, which engages the sloping surfaces of anchoring body 6, draws body 6 away from the concrete construction and outwardly from supporting ribs 7 of the pile framing.

Since the groups of tension wires 1 maintain their spacing, which is limited on the one hand by supporting ribs 7 and on the other hand by the distribution of the bores in anchoring body 6, the spacings between the groups of wires 1 are maintained outwardly of the concrete construction also. This permits spacers, in the form of steel plates 12, to be inserted through these gaps subsequent to the tensioning of wires 1, and these spacers are selected in accordance with the spacing of anchoring body 6 from the concrete construction. Spacers 12 bear on ribs or transverse members 7 of the pile cluster 7–8. After lowering of the tensioning device, anchoring body 6 transmits the prestressing force through spacers 12 to pile cluster or framing 7–8 which in turn, transmit this force to the concrete construction.

The described tensioning arrangement thus comprises an anchoring body which can be gripped by a tensioning grip, jaw or clamp, and which serves as an anchor for tensioning wires 1 by virture of their upset heads 2, the end portions of these wires extending through the anchoring body in parallel groups which are separated from each other by wire-free zones. The arrangement further comprises spacers which are inserted through the wire-free spaces inwardly of the drawn out anchoring body. In addition, there is provided a pile framing or cluster including steel piles embedded in the concrete and which are interconnected with each other by supporting ribs or transverse members. These supporting ribs or transverse members 7, which extend through the wire-free gaps between the tensioning wire groups, and which are also embedded flush into the concrete, serve as supporting or bearing means for the spacers engaged with the inner surface of the anchoring block 6. The elements of the arrangement are of simple construction and do not need any special processing preparatory to their use. Construction steel plates of ordinary quality and dimensions can thus be used for the formation of the anchoring body 6, supporting ribs 7, and spacers 12. The only necessary operations for production of these simple elements comprise cutting and drilling.

It will be understood that anchoring body 6, instead of having the illustrated trapezoidal cross section, could also have an angled cross section or another cross section of a similar type providing lateral shoulders which can be engaged by a tensioning grip or clamp. In the arrangement described with reference to FIGS. 1–4, the tensioning wires 1, adjacent anchoring body 6, are divided into three groups which form two wire-free gaps extending between spaced groups, so that the pile framing can have two supporting ribs on which two spacers are supported. However, wires 1 could also be arranged in only two groups spaced from each other by a central wire-free gap, or more than three groups could be provided, separated from each other by wire-free gaps, and in each case one supporting rib of the pile framing and one spacer would be inserted through each wire-free gap.

It should further be noted that adjacent wire groups, which confine a single spacer, serve to prevent buckling of the spacer so that relatively thin and broad steel plates can be used as spacers, with the thickness of the plates being of the order of the width of the wire-free gaps. It is not necessary that these plates have an exact parallel relation with respect to the adjacent wire bundles. The choice of an ordinary relatively plastic construction steel for formation of anchoring body 6, spacers 12, and supporting ribs 7 furthermore assures that there will be an unobjectionable relative adaption of the supporting surfaces to each other due to the high prestressing forces employed. Due to the high pressures between the anchoring body 6, spacers 12 and supporting ribs 7, these three parts form, from a static standpoint, a uniform cross section which assures uniform distribution of the prestressing force on the pile framing, even if small dimensions are used for the three parts.

In the arrangement shown in FIGS. 5–7, anchoring body 6 has a rectangular cross section, such as a square cross section, and is prismatic. In this case, when ten-

sioning means 1 and sleeve 3–3*a* are inserted into the concrete, anchoring body 6 does not rest directly on transverse members or ribs 7 of the pile framing. Instead, spacers 13, which are in the form of rectangular steel plates, are placed between body 6 and ribs or bars 7 before the pouring of the concrete and are removed after the concrete has hardened. The space thus provided between anchoring body 6 and the concrete construction allows the use of a tensioning tongue or claw 14 which is in two parts and which grips beneath or inwardly of anchoring body 6. FIG. 7 illustrates one part of tensioning tongue 14, and it will be noted that the bottom element of tensioning tongue 14 is provided with inwardly extending projections 14*a*, 14*b*, which, during tensioning of the tensioning means, engage the inner surface of anchoring body 6. The grouping of the bores in body 6, and correspondingly the grouping of the tensioning wires 1, provide wire-free marginal zones on the inner face of body 6 along all four sides of the latter. This inner face is that face of body 6 which is opposite the outer face engaged by upset heads 2 on wires 1.

In the same manner as in the arrangement of FIGS. 1–4, in the arrangement of FIGS. 5, 6 and 7, wires 1 of the tension means are arranged in groups which are separated by through wire-free gaps. In alignment with these wire-free gaps, the bottom portion of clamp of jaw 14 is formed with slots or recesses 15 extending therethrough. By virtue of recesses 15, after the tensioning means has been tensioned, spacers 12 can be inserted through the wire-free gaps and the recesses 15 so that anchoring body 6 is supported in bearing engagement on the pile cluster or framing 7–8 after removal of grip or claw 14. A particular advantage of the construction of FIGS. 5, 6 and 7 is that the stress on the anchoring body 6, during tensioning, is relatively small although the anchoring body is gripped by element 14 along all four sides. This provides for the thickness of anchoring body 6 to be made correspondingly small.

FIGS. 8 and 9 show further embodiments of the pile framing portion of the tensioning arrangement of the invention. In these figures, steel piles 8 of the pile framing or pile cluster are arranged in circles substantially concentric with the axis of the tensioning means. A cylindrical anchoring body is provided and is supported upon a steel ring supported on piles 8 and interconnecting the latter.

In the embodiment shown to the left of the center lines in FIGS. 8 and 9, anchoring body 6*a* has an external thread by means of which it is threaded into an internally threaded supporting ring 16*a*.

In the embodiment of the invention shown to the right of the center lines in FIGS. 8 and 9, anchoring body 6*b* has its outer end formed with a peripheral rim portion in the form of a radially outwardly extending flange. This flange has bearing engagement on a supporting ring 16*b* which, in turn, bears on an intermediate ring 17 directly supported on steel piles 8. It should be understood, however, that the lower or intermediate ring 17 could be omitted.

While in the embodiments of FIGS. 1–7 the steel piles 8 are illustrated as parallel to each other and to the axis of tensioning means 1, the piles can be slightly inclined relative to such axis as indicated in FIG. 8 to the right of the center line.

Furthermore, while the described anchoring bodies have been described as having parallel bores through which end portions of wires 1 of the tensioning means extend, with these wires having bearing on the anchoring block by means of upset heads 2, the tensioning means or wire can also have a different type of connection or anchoring with the anchoring body. For example, the wire ends could be anchored to the anchoring body by means of wedges in the anchoring body.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A tensioning arrangement for prestressed concrete components comprising, in combination, an anchoring body; a plurality of relatively elongated tension elements extending through the component and each anchored at one end thereof to said anchoring body, said tensioning elements being arranged in groups spaced laterally of said anchoring body to provide a clearance gap extending between adjacent groups throughout the extent of the groups; pile cluster means in supporting relation with said anchoring body, and including relatively elongated bearing members, equal in number and disposition to the clearance gaps between groups of tensioning elements, each extending transversely relative to said tensioning elements, embedded flush in the component, and having a relatively narrow edge engaged with the outer ends of respective piles extending inwardly therefrom and embedded in the concrete; and spacer elements interposed between said anchoring body and the edge opposite said relatively narrow edge of each of said bearing members, said spacer elements extending through said clearance gaps between the groups of elongated tension elements and affording direct bearing engagement between said anchoring body and said pile cluster means; said body transmitting the prestressing force exerted by said tension means through said spacer elements and said bearing member substantially only to the outer ends of said piles, so that the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between said piles and the concrete in which they are imbedded.

2. A tensioning arrangement for prestressed concrete components, as claimed in claim 1, said bearing members each extending through one of said clearance gaps; said piles each being secured to a respective bearing member.

3. A tensioning arrangement for prestressed concrete components comprising, in combination, an anchoring body; a plurality of relatively elongated tension elements extending through the component and each anchored at one end thereof to said anchoring body; a substantially cylindrical sleeve extending through the component and enclosing said tensioning elements; said sleeve having its end, adjacent said anchoring body, formed with symmetrically disposed pairs of slots, the slots of each pair being aligned chordally of said sleeve; bearing members in supporting relation with said anchoring body and each extending through a pair of chordally aligned slots and embedded flush in the concrete; and piles extending inwardly from each bearing member and embedded in the concrete, each pile having its outer end engaged with a relatively narrow edge of the associated bearing member; said bearing members providing direct bearing engagement for the stressed anchoring body against the relatively narrow opposite edges thereof; said body transmitting the prestressing force exerted by said tensions means through said bearing members substantially only to the outer ends of said piles, so that the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between said piles and the concrete in which they are imbedded.

4. A tensioning arrangement for prestressed concrete components comprising, in combination, an anchoring body; a plurality of relatively elongated tension elements extending through the component and each anchored at one end thereof to said anchoring body; a substantially cylindrical sleeve extending through the component and enclosing said tensioning elements; said sleeve having its end adjacent said anchoring body, formed with symmetrically disposed pairs of slots, the slots of each pair being aligned chordally of said sleeve; bearing members each having a relatively narrow edge in supporting relation with said anchoring body and each extending through a pair of chordally aligned slots and embedded flush in the concrete; said relatively elongated tension elements being arranged in groups spaced laterally of said anchoring body to provide clearance gaps between groups, each clearance gap extending transversely through the lateral

extent of said tension elements, and each clearance gap being aligned, and laterally substantially coextensive, with a bearing member, whereby adjacent groups of tensioning elements extend on respectively opposite sides of a bearing member; and piles arranged substantially symmetrically relative to said tension elements laterally outside thereof and embedded in the concrete, said piles extending inwardly from the respective bearing members, and each pile having its outer end engaged with a relatively narrow opposite edge of the respective bearing member; said body transmitting the prestressing force exerted by said tension means through said bearing members substantially only to the outer ends of said piles, so that the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between said piles and the concrete in which they are imbedded.

5. A tensioning arrangement for prestressed concrete components comprising, in combination, an anchoring body having substantially parallel inner and outer surfaces and formed with a plurality of bores extending therethrough substantially perpendicular to said surfaces; a plurality of relatively elongated tension elements extending through the component and each having an end extending through one of said bores and anchored to said anchoring body; said bores and said tension elements being arranged in three laterally spaced and relatively elongated groups including a central group symmetrical with a longitudinal center line of said anchoring body and a pair of lateral groups, whereby to provide a pair of clearance gaps extending parallel to such longitudinal center line of said anchoring body on either side thereof; a pair of relatively elongated bearing members each extending along one of said gaps and each embedded flush in the concrete component, each bearing member having one relatively narrow edge in pressure transmitting relation with said anchoring body; and piles extending inwardly from each bearing member and embedded in the concrete, said piles being arranged in rectilinear rows each extending along a respective bearing member, each pile having its outer end engaged with the oppositely relatively narrow edge of the associated bearing member; said body transmitting the prestressing force exerted by said tension means through said bearing members substantially only to the outer ends of said piles, so that the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between said piles and the concrete in which they are imbedded.

6. A tensioning arrangement for prestressed concrete components comprising, in combination, an anchoring body having substantially parallel inner and outer surfaces; a plurality of relatively elongated tension elements extending through the component and each anchored at one end thereof to said anchoring body, the anchoring of said tension elements to said anchoring body leaving clearance areas on the inner surface thereof; pile cluster means in supporting relation with said anchoring body and including bearing members embedded in substantially flush relation in said component and each having a relatively narrow edge engaged with the outer ends of respective piles extending from said bearing members and embedded in the concrete; distance means positioned between the opposite relatively narrow edges of said bearing members and the clearance areas of the inner surface of said anchoring block during pouring of the concrete to space the inner surface of said anchoring block from said bearing members whereby, after hardening of the concrete, said distance means being removable to leave a space between the inner surface of said anchoring block body and the surface of said component; a gripping member arranged to engage the inner surface of said anchoring body to exert an outward stress thereon to tension said tension elements; and spacer means insertable between said bearing members and the clearance areas of the inner surface of said anchoring body as the latter is thus outwardly stressed, to provide direct bearing support for said anchoring body on said opposite relatively narrow edges of bearing members; said body transmitting the prestressing force exerted by said tension means through said spacer means and said bearing member substantially only to the outer ends of said piles, so that the prestressing force is applied to the concrete substantially solely by the frictional surface adherence between said piles and the concrete in which they are imbedded .

7. A tensioning arrangement for prestressed concrete components, as claimed in claim 6, in which the inner and outer surfaces of said anchoring block are rectangular; said clearance areas extending along the marginal zones adjacent the edges of said inner surface; said gripping member comprising a two-part gripping member with each part including a ledge portion insertable between said inner surface and said bearing members to engage said inner surface for such outward stressing of said anchoring block.

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ALFRED C. PERHAM, Primary Examiner

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