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Howlett et al.

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[45] ***Oct. 22, 1974**

[54] **TENDON ANCHORAGE WITH THREADED SUPPORT ELEMENT**

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[73] Assignee: **Conenco International Limited**

[*] Notice: The portion of the term of this patent subsequent to Sept. 20, 1988, has been disclaimed.

[22] Filed: **Mar. 1, 1971**

[21] Appl. No.: **119,711**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 816,583, April 16, 1969, Pat. No. 3,605,361.

[52] **U.S. Cl.** ..... **425/111,** 52/223 L

[51] **Int. Cl.** **B28b 23/04**

[58] **Field of Search** ..... 425/111; 249/91, 97, 43, 249/219 R, 40–43, 216–217; 254/29 A; 29/452; 52/223 L; 24/126

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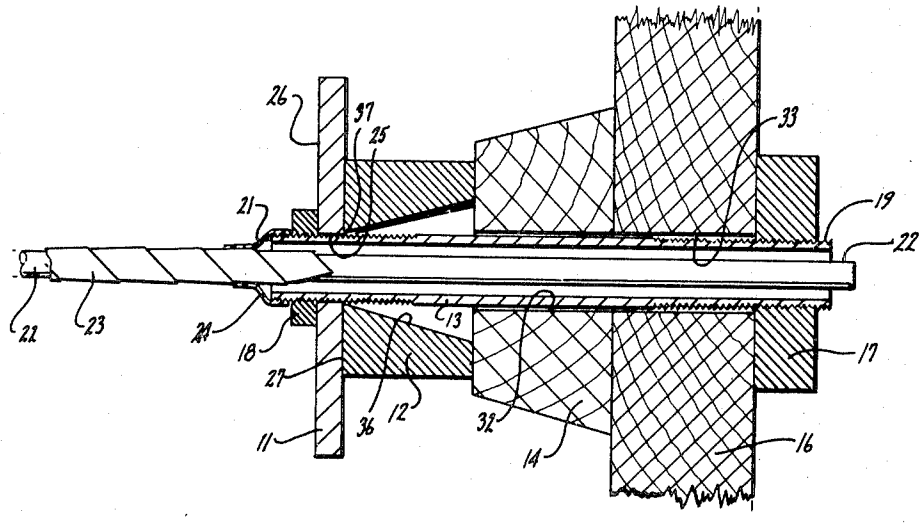
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[57] **ABSTRACT**

A tendon anchorage for use in forming prestressing concrete members which preferably includes a tubular mounting means mounted to extend through a tapered edge supporting bore beyond the wedge supporting surfaces in the anchorage in order to secure the anchorage in fixed spaced relation to a concrete form to seal the small diameter end of the bore against ingress of concrete during casting of the anchorage into the concrete member is disclosed. The mounting tube further preferably is formed to secure the anchorage from the side thereof remote to the concrete form and to urge the anchorage against a spacing means placed between the anchorage and the concrete form. Bearing plates having tapered bores may similarly be secured by the mounting means through a tendon receiving opening from the remote side thereof.

15 Claims, 8 Drawing Figures

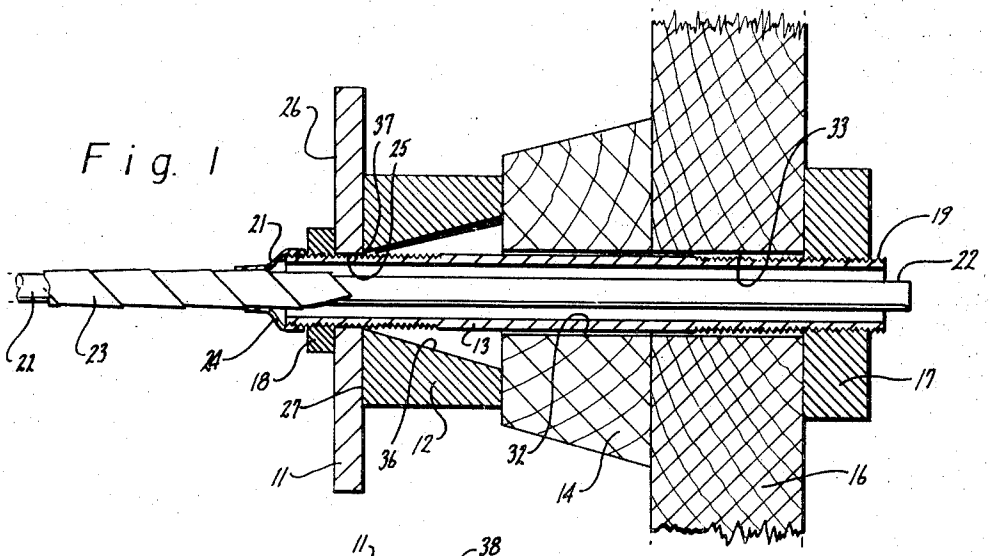


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Fig. 1



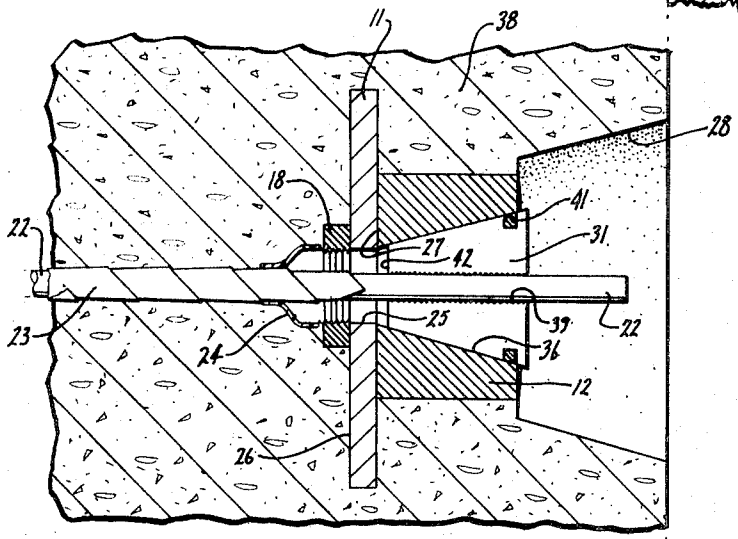


Fig. 2

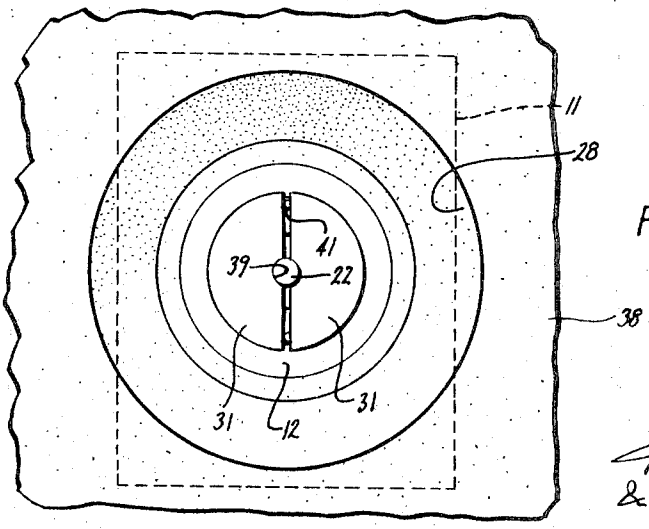
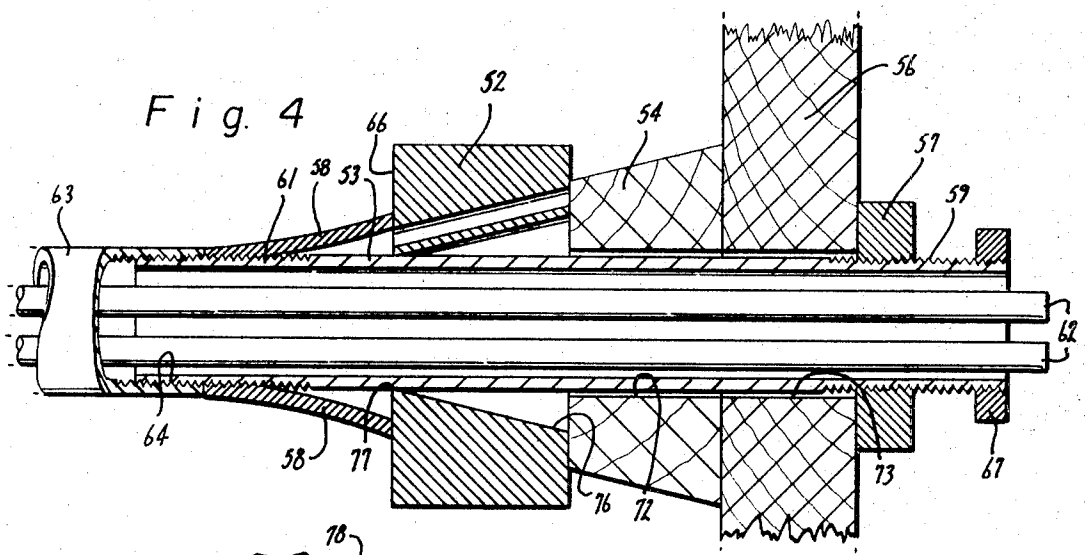


Fig. 3

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Fig. 4



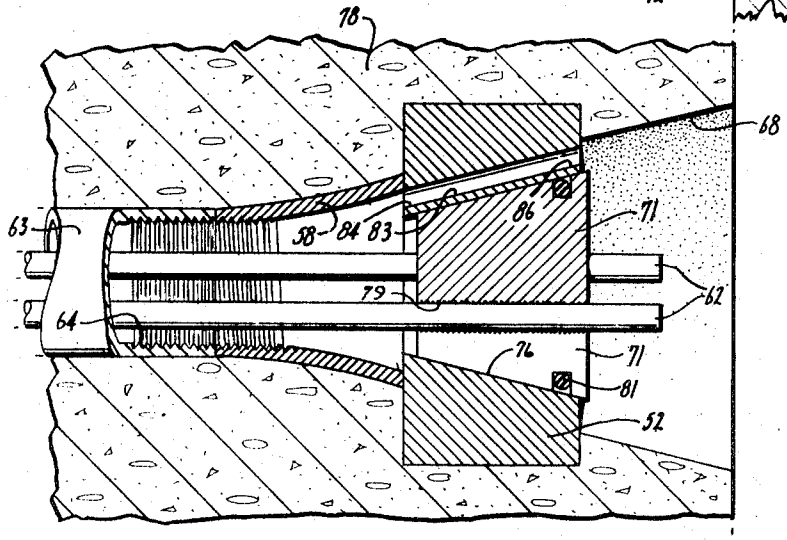


Fig. 5

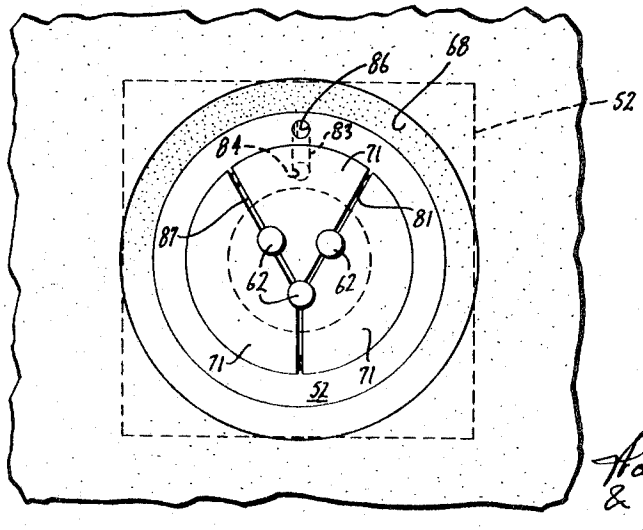
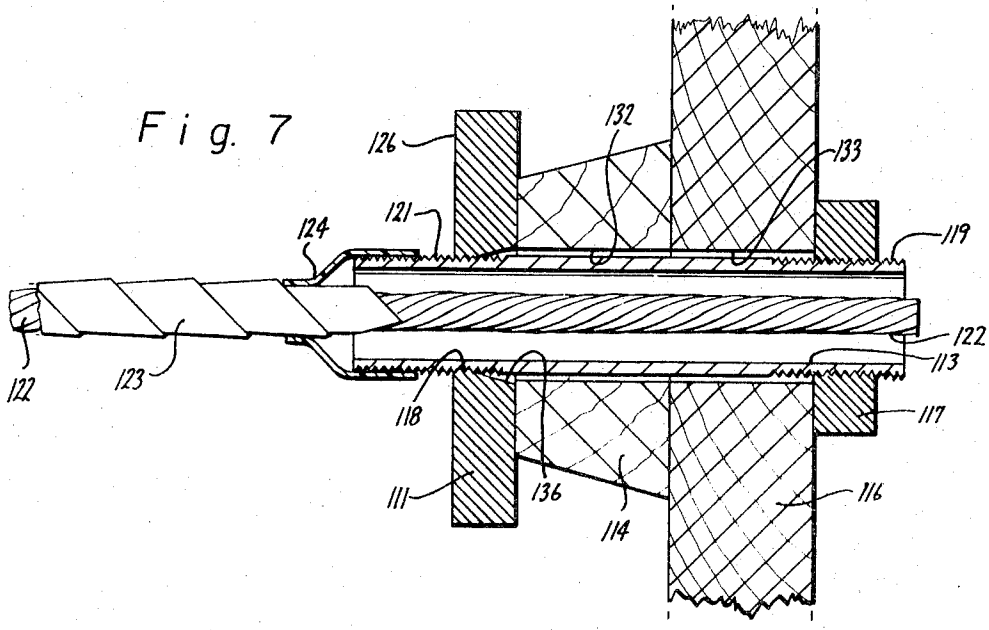


Fig. 6

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Fig. 7



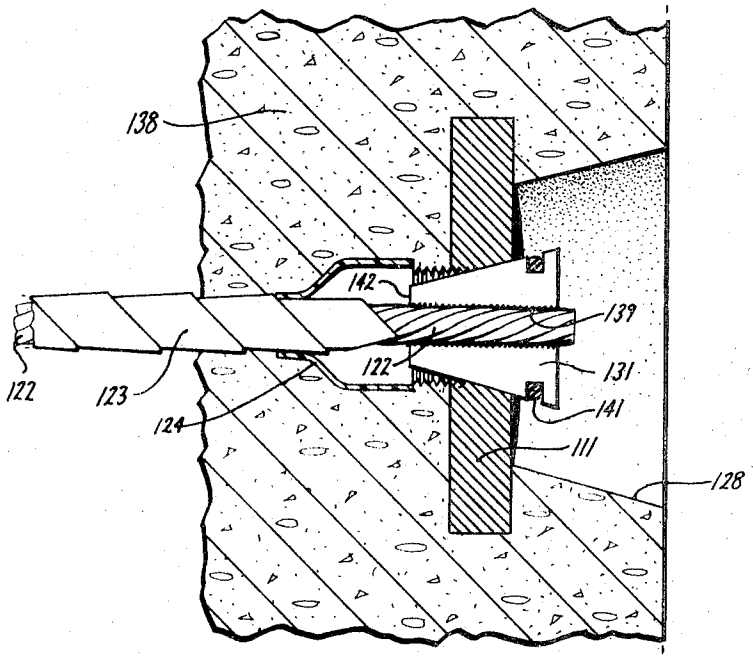


Fig. 8

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TENDON ANCHORAGE WITH THREADED SUPPORT ELEMENT

BACKGROUND OF THE INVENTION

This application is a continuation-in-part application of application Ser. No. 816,583, filed on Apr. 16, 1969 now Pat. No. 3,605,361.

In the construction of many concrete members and particularly floor slabs and slab walls it has been found to be particularly advantageous to use a prestressed concrete construction. Typically, a plurality of tendons and tendon anchorages are placed within the concrete forms and the concrete is then poured with the tendon and anchorage being cast-in-place. The forms are then removed and the tendons are tensioned. It also has been found to be desirable in many applications to have the tendon anchorage located in a recess in the end of the concrete member, which recess is subsequently grouted so that the anchorage is completely contained within the finished prestressed concrete member. When this type of construction is used, the tendon anchorage must be located and positioned in fixed, spaced relation to the concrete form by means of apparatus which, after casting of the concrete member, affords access to the anchorage for tensioning of the tendon.

Several anchorages have been previously employed in order to provide an anchorage construction which can be cast-in-place at a position interiorly of the ends of the concrete member. One type of approach is common to and illustrated in U.S. Pat. Nos. 3,293,811 and 3,399,434.

Another approach has been to provide a unitary anchorage member which is formed with screw threads or a bayonet-type socket on the side of the anchorage facing the form. A mounting member is then screwed into the front of the anchorage and extends therefrom to and through the form. A spacing block is again used, and the mounting member is secured on the outside of the form to urge the anchorage against the spacing block. The concrete member is cast and the form, mounting means, and spacing block removed to allow access to the anchorage.

Prior cast-in-place anchorage systems have been found to have several disadvantages. Primary among these disadvantages is the inflexability of the system for mounting the anchorage in spaced relation to the concrete form. As will be readily understood, the prestressing requirements of various concrete members may differ considerably. For example, the depth to which a cast-in-place anchorage must be placed in the concrete member may under different construction codes vary from state to state or locality to locality. Similarly, tensioning forces may require various sizes or shapes of bearing surfaces in order to properly distribute the axial loading of the tendon or tendons. Moreover, close grouping of tendons may result in special bearing plate requirements. Still further, special wedge containing anchor members may be required for given stress conditions. Thus, prior tendon anchorages have lacked an interchangeability or flexibility of the elements in the systems which would allow the structural engineer maximum flexibility of design. In prior anchorage systems which were formed by casting as unitary anchorage members, necessary changes in anchorage design were accomplished by varying the mold for the castings

in order to meet the design requirements. As will be understood, these systems could only economically accommodate a relatively small number of design variations.

Prior systems have also had other disadvantages. For example, the depth of the spacing block may be so great as to make it impractical or impossible to nail the anchorage to the form. Prior systems have also allowed concrete to leak into the wedge receiving bore of the anchorage during the casting process, resulting in interference with the gripping action of the wedges. Still further, casting the bearing plate and a wedge containing housing as a unitary piece results in a relatively bulky, heavy and inconveniently shaped anchorage which is not conveniently stored or shipped. Since bearing plates can be quite heavy and yet very easy to form, it can be quite advantageous to form the bearing plates at a location relatively close to the construction site and ship only the tendon gripping wedges and containment housing therefor as a separate item from a more remote area. Moreover, casting the wedge receiving bore into the concrete member results in exposing that bore to rust and concrete leakage past the block-out member.

Accordingly, it is an object of the concrete prestressing tendon anchorage of the present invention to provide an improved anchorage construction for anchorage support which affords greater flexibility in meeting design criteria by means of allowing easy interchangeability of the parts while maintaining the characteristic of being rapidly mountable to the concrete form for casting of the concrete member.

It is another object of the present invention to provide a tendon anchorage wherein the parts of the anchorage can be readily and easily formed, stored and shipped.

It is still another object of the tendon anchorage of the present invention to provide an anchorage construction which can be conveniently and easily adjusted under field conditions and minimizes the exposure of the anchorage to damage and corrosion in the field, including leakage of concrete into the wedge receiving bore.

Another object of the tendon anchorage of the present invention is to provide an anchorage construction wherein a multiplicity of side-by-side tendons can be conveniently and easily secured.

Still another object of the tendon anchorage of the present invention is to provide an anchorage structure wherein accessories such as grouting apparatus can be easily added to and positively secured in position relative to the anchorage and concrete form.

SUMMARY OF THE INVENTION

Briefly, the tendon anchorage of the present invention includes, an anchor member having a wall defining a convergently tapered bore dimensioned at the smallest point thereof to receive a tendon to be tensioned, and anchorage mounting means formed to extend from a form board through the tendon receiving bore beyond the wedge supporting surfaces of the bore in order to position the anchor member in fixed spaced relation to the form during casting of the anchor member into the concrete member. The mounting means is preferably a tube which can be removed from the anchor member after casting of the concrete member. The anchorage is used with convergently actuating

gripping means, such as segmental wedges, and with anchor spacing means, such as a spacing block or member formed to prevent entry of concrete between the anchor member and form during casting of the concrete member. Alternatively, the tubular mounting means may extend through a bore located in a bearing plate with the bore being tapered to receive mating wedges or being formed to support a separate anchor member inserted after casting of the bearing plate into the concrete member.

The tubular mounting member is preferably dimensioned on its internal diameter to receive the tendon to be tensioned in order that the anchor member can be cast into the concrete member with the tendon in place. The mounting means is preferably threaded on the end which is secured to the anchor member in order that it may receive a nut or other fastener on the remote side of the anchor member or in order that the mounting means may be threaded directly into the small diameter end of the bore in the anchor member. The mounting means is further preferably formed for securement of accessories used with the tendon anchorage, such as a grouting apparatus or a conduit to allow post tensioning of the tendon.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary, side elevational view, in cross section, of a tendon anchorage constructed in accordance with the present invention and secured to a concrete form for casting of the anchorage into a concrete member.

FIG. **2** is a fragmentary, side elevational view, in cross section, of the anchorage illustrated in FIG. **1** after casting of the concrete member, removal of the concrete form and tensioning of the tendon.

FIG. **3** is a fragmentary end view of the anchorage as illustrated in FIG. **2.**

FIG. **4** is a fragmentary, side elevational view, in cross section, of an alternative embodiment of the tendon anchorage of the present invention suitable for anchoring a plurality of tendons.

FIG. **5** is a fragmentary, side elevational view, in cross section, of the tendon anchorage of FIG. **4** after casting of the concrete member, removal of the form and tensioning of the tendons.

FIG. **6** is an end view of the tendon anchorage as illustrated in FIG. **5.**

FIG. **7** is a fragmentary, side elevational view, in cross section, of an alternative embodiment of the tendon anchorage of the present invention as secured to a concrete form.

FIG. **8** is a fragmentary, side elevational view, in cross section, of the tendon anchorage of FIG. **7** illustrating the wedge and bearing plate configuration of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. **1, 2** and **3,** the anchorage of the present invention can be seen to be comprised of a bearing plate **11,** anchor member **12,** mounting means **13,** and spacing means **14.** The anchorage is secured to extend from concrete form **16** by means of a nut **17** located on the outside of the form and a second nut **18** threadably engaging mounting means **13** on the side of the anchor member and bearing plate remote or furthest from form **16.** Either or both of nuts **17** and **18** can be advanced on correspondingly threaded ends **19** and **21** of mounting means **13** in order to urge the bearing plate and anchor member against spacing means **14.** Extending through mounting means **13** is tendon **22,** which is here illustrated as being wrapped with a paper covering **23.** Covering **23** is typically provided with a layer of grease on the inner side thereof so that the tendon may be post-tensioned within covering **23** after casting of the concrete member. Sealing of the juncture between wrapped tendon **22** and mounting means **23** is preferably accomplished by tape **24** which will bridge across the juncture and prevent flow of concrete into the end of the mounting means.

An important feature of the tendon anchorage of the present invention is to provide a construction which allows improved versatility and interchangeability of the various anchorage parts in order to accommodate variations in design of the concrete member into which the anchorage is incorporated. Accordingly, the tendon anchorage mounting structure of the present invention is constructed so as to reach or extend through the tendon receiving opening in the anchorage to the side thereof remote from the concrete form in order that the anchorage may be urged toward and secure relative to the concrete form from a position on the remote side of the anchorage. Fastening of the anchorage to the concrete form by this technique, affords several substantial advantages. For example, bearing plate **11** can be readily and easily formed to have any one of a number of possible configurations and sizes without the need of providing special openings or sockets to accommodate mounting thereof for casting. Thus, bearing plate **11** may be formed with two or more openings so that anchorages can be positioned in close side-by-side relation. Alternatively, bearing plate **11** may be selected to be of varying lateral dimensions in order to achieve any desired or required distribution of tensioning forces to the concrete member through bearing surface **26.** Still further, while steel is normally employed in formation of the bearing plate, differing heat treatments and formation techniques may result in differing strengths. The structural engineer can select the desired material and strength, which will cause a variation in the thickness of bearing plate **11,** when the anchorage of the present invention is employed.

The ability to interchange bearing plates in the tendon anchorage of the present invention is further important in that it affords greater flexibility in the selection of the tendon anchor member. For example, anchor member **12** may be formed as illustrated in FIG. **1** or, alternatively, a different type of tendon anchorage device could be used which has a much smaller external diameter. This type of anchorage may be dictated from the design requirement that the concrete member be able to withstand stress reversals and accordingly have an anchorage which will not allow the gripping wedges to move backwards out of the anchor member. If the anchor member **12** is of a smaller diameter than illustrated in FIG. **1,** the surface area **27** between the bearing plate and anchor member will be reduced resulting in a greater concentration of the axial tension forces on the bearing plate. This may in turn require that the bearing plate **11** be of a greater thickness in order to accommodate the greater stress concentrations caused by the anchorage. The mounting means construction of the present invention affords the ability to both change the anchor member **12** to meet particu-

lar design criteria and change the bearing plate **11** correspondingly to meet the design characteristics of the anchor member. This versatility is not found in prior devices which are characteristically cast in one piece and secured to the concrete form from the front side thereof so as to inhibit the interchangeability of parts or building up of the desired anchorage to meet exactly the structural design requirements.

Still another important feature of the tendon anchorage of the present invention is to provide an anchorage construction which can readily and easily secure the anchorage at almost any position interiorly of the concrete form while still maintaining the characteristic interchangeability of parts. It may be desirable or necessary under various local and state laws and codes to bury the tendon anchorage at various depths in the end of the concrete member. Accordingly, spacing member or block-out **14** may be formed with various depth dimensions in order that recess **28** is of sufficient depth to allow later grouting of the tendon anchorage in compliance with the state or local code. Still further, anchor member **12** may have various axial dimensions, depending upon the type of anchorage employed. Thus, bearing plate **11** may be disposed at various spaced distances from form board **16,** some of which are far in excess of the length of common fastening means such as nails. The tendon anchorage construction of the present invention, therefore, affords further design flexibility in the location of the tendon anchorage relative to the end of the concrete member. The mounting means can be of virtually any predetermined length and have substantial continuous adjustability from either the concrete form side of the mounting member or the anchor member side thereof. As illustrated in FIG. **1,** threaded outer end **19** and inner end **21** of tubular mounting member **13** are threaded over a substantial distance and would be suitable for use in connection with spacing members **14** of variable axial length. This important feature will allow take-up of the mounting means at the anchorage which is not possible in prior art devices and can be of considerable practical importance in the field.

Another advantage of having a tendon anchorage which can be assembled in the field is that the anchorage can be more conveniently shipped and stored than anchorages which are cast as a single piece. For example, bearing plates **11** can be stacked flat and easily transported. A plurality of anchor members **12,** mounting means **13** and spacing blocks **14** can similarly be easily stacked, handled and transported. Since the bearing plates and anchor members are usually formed of high strength steels and are quite heavy, it may be advantageous to form the bearing plates, which are relatively simple, at a location adjacent to the area in which the anchorage is to be used and form the anchor member **12** and corresponding segmental wedges **31** at a manufacturing facility more remote, where somewhat more complicated forming equipment can be employed. Bearing plate **11** is typically formed with a shear and punch or drill while anchor member **12** and mating wedges **31** may be formed on a screw machine. In addition bore **25** in bearing plate **11** may be tapped, nut **18** eliminated and mounting means **13** threadably engaging plate **11** to secure the anchorage relative to the form. When flexibility in the type of anchorage needed is required, these formation methods compare quite favorably with the prior art technique of casting, which requires a different mold for each anchorage configuration. Moreover, a cast anchorage inherently will have a lower reliability than anchorages constructed from roll-formed material.

The assembly and use of the anchorage of the present invention can be described as follows. Tendon **22** will be located in the concrete member in accordance with predetermined design criteria and will be anchored at the end opposite the end shown in FIG. **1** by any one of a number of techniques, including an oppositely facing anchorage of the type illustrated in FIG. **1.** The wrapping **23** will be removed from the end of the tendon in order that it may be gripped by wedges **31** and yet cover the tendon over the length thereof exposed to concrete. The mounting means **13** with nut **18** positioned thereon may be mounted over the end of tendon **22** and bearing plate **11,** anchor member **12** and spacing means **14** are mounted on member **13.** Spacing block **14** is preferably provided with an axially extending bore or channel **32** in order that it may be readily slipped over the outer end **19** of mounting means **13.** Outer end **19** of mounting means **13** is then inserted in bore **33** in form board **16** until outer end **19** extends from the form and nut **17** is advanced against form board **16** until the anchorage is urged against spacing block **14.** Alternatively, spacing block **14** may be segmented and mounted between anchor member **12** and form board **16** after insertion of end **19** of the mounting means through bore **33** in the form.

As here illustrated, anchor member **12** has a frustoconical bore **36** providing wedge supporting surfaces which terminate in a small diameter end **37.** The smallest point in the bore **36,** namely, end **37,** is preferably dimensioned to receive mounting means **13** and tendon **22** simultaneously therethrough. Once secured in place, concrete member **38** is formed by pouring concrete around the anchorage and allowing it to set up. Spacer **14** abuts anchor member **12** and prevents the entry of concrete into the bore **36** while tape **24** prevents entry into the front end of mounting means **13.** Other techniques can be used to close inner end **21** of mounting member **13** including rubber grommets. Alternatively, nut **18** can be provided with a plastic skirt or sleeve which is formed and dimensioned to extend from the nut to encircle and resiliently grip tendon **22** and prevent entry of concrete into the mounting means.

It is a further important feature of the present invention to provide an anchorage mounting system which minimizes the possibility of failure of the anchorage by reason of entry of concrete into the wedge receiving bore during casting of the concrete member. While the use of a rubber, plastic or tape sleeve, such as tape **21,** to seal the space between the tendon and the anchorage is, if properly placed, adequate to withstand the entry of concrete during pouring, the anchorages typically face very adverse field conditions. It is common, for example, for ironworkers to walk on the tendons and anchorages as they are being installed or as other work is in process. This often results in damage to the tape or plastic closure before the concrete is poured. Thus, tapes as used in the present invention or as used in anchorages of the type illustrated in U.S. Pat. Nos. 3,399,434 and 3,293,811, are often not effective in sealing the front end of the anchorages during casting. Additionally, the sealing tape or plastic sleeve is not always properly positioned under field conditions. Thus,

leakage of concrete into the wedge receiving bore has been a constant problem with prior anchorages. When leakage occurs, the concrete must be chipped out of the wedge receiving bore. This can be particularly troublesome in anchorages of the type which cast the wedges in-place in the anchorage. Additionally, undetected leakage may result in malfunctioning of the anchorage.

In the anchorage of the present invention leakage into bore **36** is prevented since mounting means **13** extends through bore **36** and past the wedge supporting surfaces thereof to small diameter end **37.** Thus, leakage around tape closure **21** will merely travel down the inside of tube **13** and not into bore **36.** Moreover, leakage onto tendon **22** is not important since the tendon typically elongates **6** inches or more, and the surface of the tendon finally gripped by the wedges is underneath wrapping **23.** Concrete cannot leak around nut **18** and between plate **26** and mounting tube **13** since nut **18** is used to cinch the assembly against form board **16.** The assembly illustrated in FIG. **1** is relatively heavy and might induce 40 to 50 inch-pounds of torque about the point of departure from the form board. Accordingly, nuts **17** and **18** typically are tightened to about 50 to 100 foot-pounds of torque in order to secure the assembly to the form board. The axial force between nuts **17** and **18** is sufficient to effect seal between bearing plate **26** and nut **18,** bearing plate **26** and wedge housing **12,** and wedge housing **12** and spacer **14.** The seal created between these planar surfaces under the axial load will not completely prevent the entry of water between the assembled members, but it does effectively present entry of concrete. In the remaining forms illustrated in FIGS. **4–8** a seal is effected between a grouting funnel and the bearing plate or between threads in the mounting means and threads in the bearing plate. In each instance, however, the mounting tube extends beyond the wedge supporting surfaces of the wedge containing member and leakage, if any, tends to go down the inside of the mounting tube and not down the tapered bore.

As shown in FIG. **2,** the mounting means **13** and form **16** have been removed from the anchorage. This is accomplished by unscrewing nut **17** and removing form **16** and spacing block **14.** Still further member **13** may be unscrewed from nut **18** which remains cast into the concrete member. This is done by gripping the mounting means **13** by end **19** (pliers or other gripping tools may be used) and may be accomplished either before or after removal of form **16** and spacing block **14.** Wedges **31** are preferably formed with serrated internal gripping surfaces **39** and are held together for convenience of handling in the field by an O-ring **41.** Tendon **22** is then tensioned by jacking the end thereof, causing the tendon to move relative to the paper wrapping **23.** Wedges **31** will advance into bore **36** and, due to the frictional engagement of tendon **22** by serrated surface **39,** will convergently grip tendon **22.** Once the wedges have taken the full predetermined tension load of the tendon, the end of the tendon may be cut off by a shearing tool or welding torch so that it is within recess **28.** If the tendon is to be grouted, recess **28** will then be filled with grout (not shown). It should be noted that the thickness of wedges **31** at end **42** must be sufficient to accommodate mounting means **13.** That is, when a tubular mounting means is employed, the small diameter end **37** of bore **36** is larger than would be required simply to allow tendon **22** to pass through anchor member **12.** Accordingly, this extra dimension will result in wedges **31** having an overall thickness which is greater than might otherwise be employed.

It should be noted further, however, that mounting means **13** need not be tubular in shape and wedges **31** can be formed of a thinner construction. This can be accomplished if the tendon **22** is not cast into the concrete member but is inserted after casting of member **38.** Insertion of the tendon after casting can be accomplished if a tendon receiving conduit is cast into the concrete member. In such a configuration, member **13** could be formed as a solid rod substantially the same diameter as tendon **22** with threaded ends **19** and **21.** The rod would extend through bearing plate **26** with bore **25** now being only slightly greater than the tendon diameter. End **21** of the solid member **13** would be threaded and a conduit (not shown) could screw onto the exterior threads of member **13** and have an internal diameter dimensioned to receive tendon **22.** In effect, the conduit would replace greased paper **23.** In this configuration removal of mounting means **13** would be followed by insertion of tendon **22** through the conduit, which was positioned and fixed in relation to the concrete form by the mounting means. Such a conduit is illustrated in FIG. **4** in which three side-by-side tendons are contained.

As above set forth, in order to reduce the number of elements in the anchorage of the present invention nut **18** can be eliminated from the anchorage construction of the present invention simply by threading internal bore **25** of the bearing plate. Thus, member **13** could be screwed into the bearing plate which would again urge the bearing plate, anchor member and spacing means against concrete form **16.** This construction would similarly allow the interchangeability of various parts in order to meet a variety of design criteria. Similarly, bearing plate **11** could be formed integrally with anchor member **12** or permanently secured thereto (this could be accomplished in the manufacture of the piece or in the field by spot welding) and the smallest diameter portion of bore **36,** namely, end **37,** could be internally threaded to receive threads on end **21** of the mounting tube. This type of construction is illustrated in the anchorage in FIGS. **7** and **8.**

Referring now more particularly to the anchorage illustrated in FIGS. **4, 5** and **6,** an alternative embodiment of the anchorage of the present invention may be described. Anchor member **52** and spacer **54** are mounted on tubular mounting member **53** and secured by nut **57** and frusto-conical sleeve **58** against concrete form **56.** Ends **59** and **61** of member **53** are externally threaded as above described. The anchorage, as set forth in FIGS. **4 – 6,** is formed to secure a plurality of tendons **62,** which in this case can be seen in FIG. **6** to be three tendons. The tendons are preferably mounted inside conduit **63** which is provided with internal threads **64** in order that the conduit may be threadably mounted onto mounting means **53.** In this configuration, it is possible to cast the concrete member **78** with tendon **62** being pulled through conduit **63** after the concrete member had been cast and the forms removed.

In this form of the tendon anchorage, anchor member **52** has an integrally formed bearing surface **66** and a separate bearing plate has been eliminated. Mounting member **53** is formed to extend through frusto-conical

bore 76 in member 52 and particularly through the small diameter end 77 thereof to the remote side 66 of the anchor member. As will be set forth in detail hereinafter, anchor member 53 extends beyond surface 66 and through a funnel shaped grouting member 58 in order to secure the anchorage in fixed spaced relation to form 56.

The anchorage of FIGS. 4, 5 and 6 is used in a manner similar to that described in connection with the anchorage of FIGS. 1, 2 and 3. In this embodiment of the anchorage, however, a nut 67 is provided which is secured to end 59 of member 53 (by brazing, for example) so that it may not be either advanced or removed from member 53. This nut can then be used in rotating member 53 so as to release it from the internal threads 64 of conduit 63 and the threads of funnel member 58. When nut 67 is permanently mounted on end 59 of the mounting member, the anchorage may be assembled by inserting the tendons into end 61 of member 53 and then inserting end 61 through bore 73 in form 76, bore 72 in spacer 54, bore 76 in anchor member 52, and finally the bore in member 58 and the internal diameter of conduit 63. The anchorage can be adjusted into a fixed rigid position by cinching down on nut 57 and/or advancing grouting funnel 58. As illustrated in FIGS. 4, 5 and 6, the tendon anchorage of the present invention demonstrates how mounting means 53 can be used in order to support and secure accessories which are commonly employed in prestressing concrete members. Thus, member 53 supports a grouting funnel 58 and supports a tendon containing conduit. It is an important feature of the present invention that the mounting means may be secured to the tendon conduit since this results in a fixed alignment of the tendon anchorage and the tendon. Alignment of the tendon and anchorage is extremely important and reliable since tensioning forces are very high and malalignment can result in serious detrimental stress concentrations in the concrete member and tendon.

Again the versatility of the present invention is illustrated since anchor member 52 can be formed with various configurations including bearing surfaces 66 which are of a larger or smaller area. Upon removal of the form, mounting means and spacing block, recess 68 in member 78 affords access to the anchor member for insertion of tapered segmental wedges 71. The wedge configuration suitable for gripping a plurality of side-by-side tendon 62 is best seen by reference to FIG. 6. The individual wedges are again preferably held together for convenience by an O-ring 81 and formed with internal serrated tendon gripping surfaces 79.

In order to facilitate the grouting of the anchorage of the present invention, a grouting bore 83 is formed in member 52. Grouting bore 83 terminates in an opening 84 which is 52. Grouting bore 83 terminates in an opening 84 which is disposed radially inwardly of the internal diameter of funnel 58 in order to be in communication with funnel or sleeve 58 and conduit 63. The other end of bore 83 terminates in an opening 86 which communicates with recess 68. Thus, grout may be introduced through opening 86 into funnel 58 and conduit 63 with air escaping through the other end of the tendon conduit through a vent opening or through the slotted openings 87 between opposed faces of wedges 71.

Other forms of grouting apparatus are suitable for use with the anchorage of the present invention. For example, funnel 58 may be replaced by a T-shaped pipe and a grouting tube which extends around member 52 to an exposed end of the concrete member 78. Again, however, a T-shaped member could be internally threaded so as to be mountable on conduit 53 to urge anchor member 52 against spacer 54. Similarly, conduit 63 could threadably engage mounting member 53.

Referring now to FIGS. 7 and 8, there is illustrated an alternative embodiment of the tendon anchorage of the present invention which is particularly well suited for use as a cast-in-place type of anchorage and further useful in other prestressing applications. The anchorage is comprised of a bearing plate 111 and bearing plate locating device consisting of tubular member 113 and spacing or block-out member 114, which are urged against form 116 by nut 117 and threads 118 at the small diameter end of bore 136 in the bearing plate. As above described mounting member 113 is formed with externally threaded ends 119 and 121. Tendon 122 is here illustrated as a strand type of prestressing tendon having a cable-like construction. The strand can be wrapped in paper 133 and conveniently taped or otherwise blocked by member 134 against entry of concrete into the end 121 of mounting means 113.

Bearing plate 111, which in this configuration acts as an anchor member, is provided with a bearing surface 126 facing away from the concrete form which will allow transfer of axial tensioning forces to concrete member 138. The bearing plate is also formed with a frusto-conical bore 136 terminating in threads 118 at the bearing surface or remote side of the bearing plate. As above described, mounting means 113 can be inserted through bores 132 and 133 in the spacing member and form, respectively, and mounting means screwed into the teeth 118 in bearing plate 111.

It is preferable and an important advantage of the anchorage of the present invention that the mounting means be further formed in order to form a recess in the concrete on the bearing surface side of the anchorage sufficient to accommodate axial advancement of wedges 131 beyond surface 126. Thus, the mounting apparatus of the present invention functions additionally to provide a recess into which the tendon gripping wedges may move in advancing to a position of maximum radial gripping force.

FIG. 8 illustrates the concrete member with the anchorage of the present invention in place. Form 116 and block-out member 114 have been removed, resulting in recess 128 allowing access to bearing plate 111. As here illustrated bearing plate 111 is formed with a frusto-conical bore into which segmental wedges 131, having ends 142 held together by O-ring 141, are inserted. The segmental wedges are again preferably provided with tendon gripping serrated surfaces 139.

The versatility of the anchorage of the present invention can further be illustrated in that bearing plate 111 can alternatively be formed with a cylindrical bore dimensioned to receive tendon 122. Spacing block-out member 114 can be dimensioned to have a sufficient thickness so that recess 128 is of sufficient depth to accommodate the later insertion of a wedge containing housing or anchor member of the type illustrated in FIG. 1 as member 12. Thus, the mounting means would be used to locate the bearing plate and upon removal of the spacer and form an anchor member and tendon gripping wedges could be slipped over the end of ten-

don **122** to allow tensioning of the tendon and later grouting of recess **128.** An anchorage construction wherein the anchor member is subsequently inserted as a separate unit can be highly advantageous. When this approach is used the problem of entry of small amounts of concrete around block-out member **114** into frusto-conical bore **136** is eliminated. Similarly the problem of rust forming in or corrosion of the wedge receiving bore can be controlled and eliminated since the anchor member, if not cast into the beam, can be kept in a controlled environment and properly treated to prevent rust and corrosion.

The spacing or block-out members as illustrated throughout the drawings are formed of wood. Several other materials and constructions, however, will suffice for the apparatus of the present invention. For example, block-out members have previously been formed of rubber, sheet metal and plastic. Moreover, while the spacing members are preferably removable from the concrete member in order that they may be reused in the subsequent placement of anchorages, the block-out and spacing member may consist of a sleeve, as opposed to a solid member, which is permanently left in the concrete member with the interior diameter of the sleeve providing an access recess to the bearing plate or anchor member.

By way of example, bearing plate **111** can be formed of C**1040** steel having a Rockwell hardness of between about **15** to about **28** on the Rockwell C scale. In order to grip a strand having a nominal diameter of 0.60 the bearing plate may be formed with a thickness of about ¾ to 1 inch, with bore **136** having a diameter at the small end of about 1-¼ inches and a taper of about 10°. The wedge material was C1117 steel, case hardened to about 0.015 to 0.020 inches and having a Rockwell hardness of about **62** on the Rockwell C scale. The wedges were stressed relieved at 350° F to avoid delay failure. Under these conditions, the strand could be tensioned to substantially its yield point by the anchorage without deformation of the bearing plate or failure of the wedges. Teeth **118** were tapped into the front end or small diameter end of the bearing plate, and since they diverge away from the 10° taper of the wedges, they did not interfere with the advancement of the wedges. The wedges were 2 inches in length with approximately one-quarter of their length or one-half inch projecting forwardly of surface **126** at maximum loading thereof. The diameter of end **142** of the wedges was about 1-1/16 inches with the large diameter of the wedges being about 1-¾ inches.

We claim:

1. An anchorage assembly for casting an anchorage means into a concrete member for receipt of a tendon for formation of a prestressed concrete member, comprising:

a. a concrete form having an opening therein to receive assembly mounting means therethrough;

b. assembly mounting means removably mounted in said opening in said form and extending from an exterior side thereof through said opening and interiorly of said form a distance sufficient to allow mounting of spacing means and anchorage means thereon;

c. spacing means mounted on said mounting means and positioned in abutting relation to said form, said spacing means being of a predetermined thickness to position an anchorage means in spaced relation to said form;

d. anchorage means having a wall defining an axially convergently tapered bore dimensioned at the smallest point thereof to receive said assembly mounting means and a tendon to be tensioned and formed to receive convergently actuating tendon gripping means, said anchorage means including bearing plate means formed with a bearing surface to allow transfer of axial tensioning forces to said concrete member, said anchorage means being releasably mounted on said mounting means with said mounting means extending through said tapered bore and said anchorage means being positioned thereon in abutting relation to said spacing means, said spacing means further preventing the ingress of concrete into said tapered bore in said anchorage means as mounted in abutting relation therewith and being removable from said concrete member to afford access to said tapered bore for insertion of tendon gripping means therein;

e. securement means releasably mounted on said mounting means on the exterior side of and bearing upon said form and releasably mounted adjacent the inner end of said mounting means, said securement means and mounting means urging said assembly of said anchorage means and spacing means against said form and securing said assembly in close abutting relation thereto during the casting of said concrete member.

2. In a tendon anchorage assembly to be cast-in-place in a concrete member, said assembly including: a form board having an opening therein to receive assembly mounting means therethrough; spacing means formed to space anchorage means from said form board and to prevent ingress of concrete into anchorage means from the side adjacent said spacing means and further formed to be removable after casting said concrete members and formed with a channel to allow passage of assembly mounting means therethrough, said spacing means being positioned in abutting relation with said form board and with said channel in alignment with said opening; and anchorage means having a wall defining an axially convergently tapered bore to provide wedge supporting surfaces and dimensioned at the smallest point of said bore to receive assembly mounting means and a tendon to be tensioned, said anchorage means including bearing plate means formed with a bearing surface to allow transfer of axial tensioning forces to said concrete member and said anchorage means being positioned in abutting relation to said spacing means with said bore being in alignment with said channel; the improvement comprising:

assembly mounting means removably mounted in said opening in said form board and being formed to and extending from an exterior side of said form board through said opening, through said channel in said spacing means, and into said tapered bore in said anchorage means and beyond said wedge supporting surfaces, said mounting means further including securement means formed to bear upon and releasably secure said mounting means to said form board on the exterior side of said form board and releasably secure said mounting means to said anchorage means adjacent the inner end of said mounting means, said securement means further being formed to allow said assembly to be urged

into close abutting relation against said form board.

3. In an anchorage assembly as defined in claim 2, the further improvement wherein,

said tapered bore converges in a direction away from said form board, said mounting means extends through said tapered bore to the remote side of said anchorage means, and said securement means is formed to prevent ingress of concrete into the front end of said tapered bore between said mounting means and said tapered bore.

4. In an anchorage assembly as defined in claim 2, the further improvement wherein,

said mounting means is provided by an elongated generally cylindrical member, and said securement means is provided by continuously threaded portions over a substantial length of the inner and outer ends of said cylindrical member, said threaded portions being formed to engage and be secured by mating threaded elements provided at said form and said anchorage means to allow continuous axial adjustment of the distance at which said bearing plate is secured to said form board at both ends of said cylindrical member.

5. In an anchorage assembly as defined in claim 4, the further improvement wherein,

said mounting means is formed with threads on the external diameter of the inner end thereof, and said fastening means is comprised of internally facing threads formed in said anchorage means at the small diameter end of said bore and formed to mate with said threads on said mounting means.

6. In an anchorage assembly as defined in claim 2, the further improvement wherein,

said mounting means extends beyond said anchorage means to a position to provide a recess in said concrete member after casting of said concrete member and removal of said mounting means, said mounting means being dimensioned to extend so that said recess is of a depth to allow advancement of said gripping means upon loading of said tendon to a position for maximum gripping of said tendon.

7. In an anchorage assembly as defined in claim 2, the further improvement wherein,

said bearing plate means is provided by a separate bearing plate, said bearing plate being formed with an opening therein for passage of said tendon therethrough and being mounted on the side of said anchorage means facing away from said form with said opening in alignment with said tapered bore, said mounting means extending through said opening in said bearing plate and formed for securement of said bearing plate and anchorage means in abutment and in fixed spaced relation to said form during casting of said concrete member.

8. A post-tensioning assembly for concrete slabs and beams, including an elongated tube having one end portion threaded and the other end portion formed and adapted to receive a protective sheath thereover, said tube having an intermediate portion thereof threaded, an anchorage plate positioned over said tube and having at least one bore threaded on said intermediate portion, an elastomeric hole defining block positioned over said tube adjacent said anchorage plate and between said anchorage plate and said threaded end portion, means on said threaded end portion for rotating said tube within said anchorage, and bearing means between said last named means and said block, said bearing means being threaded on said threaded end portion, whereby the position of said bearing means relative to said block may be adjusted axially of said tube.

9. The structure of claim 8 characterized by and including frictional gripping means on the other end portion of said tube.

10. The structure of claim 9 wherein said anchorage plate has plural bores therein extending parallel to one another and a tube is received within each bore, each tube being identical and having a hole defining block of the type defined thereon adjacent said anchorage, each tube having said rotating means and said bearing means thereon.

11. A post-tensioning assembly for concrete slabs and beams, including an anchorage plate having a pair of hubs positioned alongside one another and extending from one side of said plate, said hubs having generally parallel bores therein and extending through said plate, an elongated tube extending through each bore and extending on opposite sides of said plate, each tube being threaded in its associated bore, elastomeric hole defining means positioned over each tube adjacent said hubs, the projecting ends of said tubes on the other side of said plates being formed and adapted to receive plastic protective sheaths thereover, the other projecting ends of said tubes having means for rotating the tubes thereon, and bearing means between said hole defining means and each said rotating means and being adjustably positionable along the length of said tubes.

12. The structure of claim 11 wherein each tube has exterior threads between said rotating means and said hole defining means and bearing means are rotatably positioned on said threads to adjustably accommodate varying thicknesses of form boards between said hole defining means and said bearing means.

13. A post-tensioning assembly for concrete slabs and beams, including an elongated cable and means for holding one end portion of the cable within a concrete mass, an anchorage assembly positioned on the cable and near the other end of said cable, said anchorage being defined by an elongated tube received over the other end portion of said cable, an anchorage plate received over said tube, said plate being in threaded engagement with an intermediate portion of said tube, said tube having opposite ends extending from opposite sides of said plate with one end within said concrete mass and the other end projecting outwardly from said mass, said other end of said tube having means for rotating said tube thereon and bearing means adjustably positioned along the length of the tube between said rotating means and said plate, said one end of said tube having an end portion of a protective sheath surrounding said cable received thereover.

14. The structure of claim 13 wherein said first named means is defined by a second anchorage of the type described.

15. The structure of claim 13 wherein two cables with anchorage assemblies of the type described are positioned side by side, said anchorage plate having plural bores therein for receiving said tubes.

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