

[54] **SYSTEM FOR POST-TENSIONING AND ANCHORING PRESTRESSING TENDONS**

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[51] Int. Cl. **E04c 3/20, B23p 19/00**

[58] Field of Search **29/252, 452, 244; 52/223 L, 52/225, 230; 254/29 A**

[56] **References Cited**

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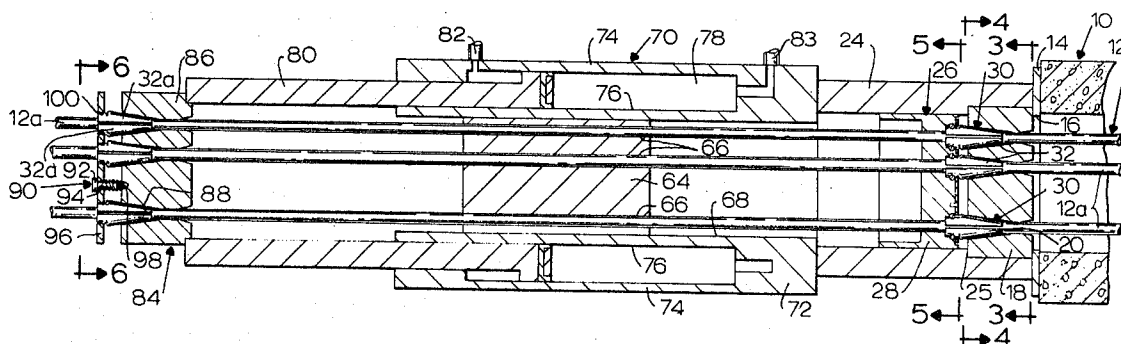
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[57]

ABSTRACT

A system for applying tension to and anchoring the end of a prestressing tendon extending from a concrete structure. The system includes a jack for applying tension to the tendon at a first location along the length thereof, anchoring means comprising an anchoring plate and collar means disposed about the tendon and adapted for movement into cooperation with the anchoring plate to grip the tendon located at a point on the tendon between the first location and the concrete structure, and actuator means mounted for movement relative to the jack and the anchoring plate to position the collar means into engagement with the plate and into gripping engagement with the tendon. The actuator means and the collar means incorporate cooperable structure for retaining the collar means against movement relative to the actuator means until the collar means moves into said gripping engagement.

12 Claims, 8 Drawing Figures



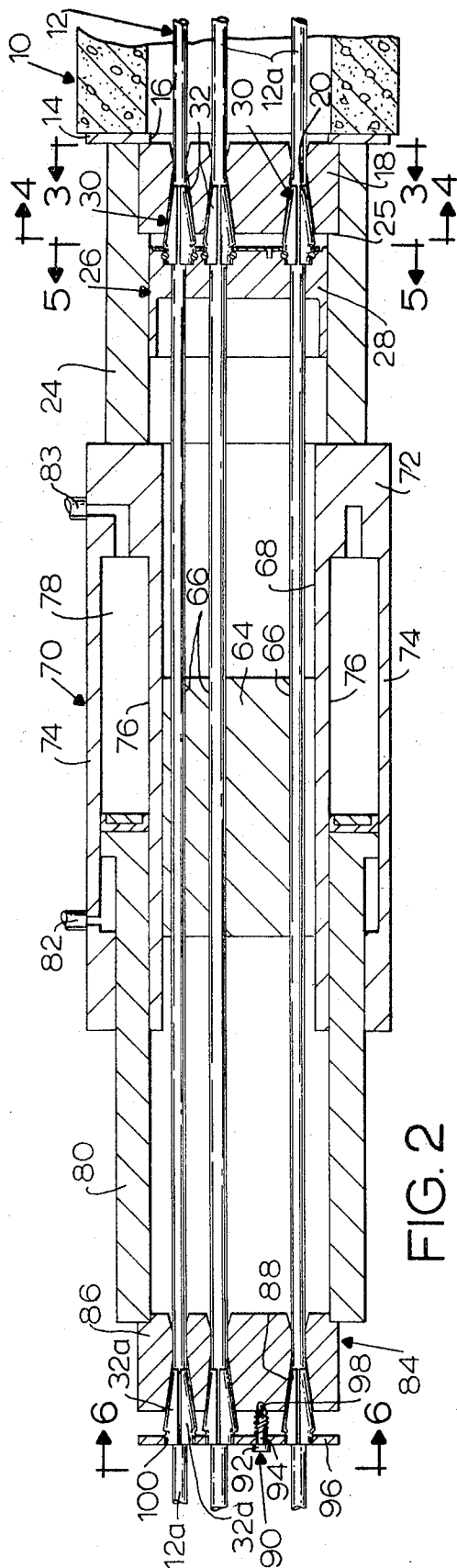


FIG. 2

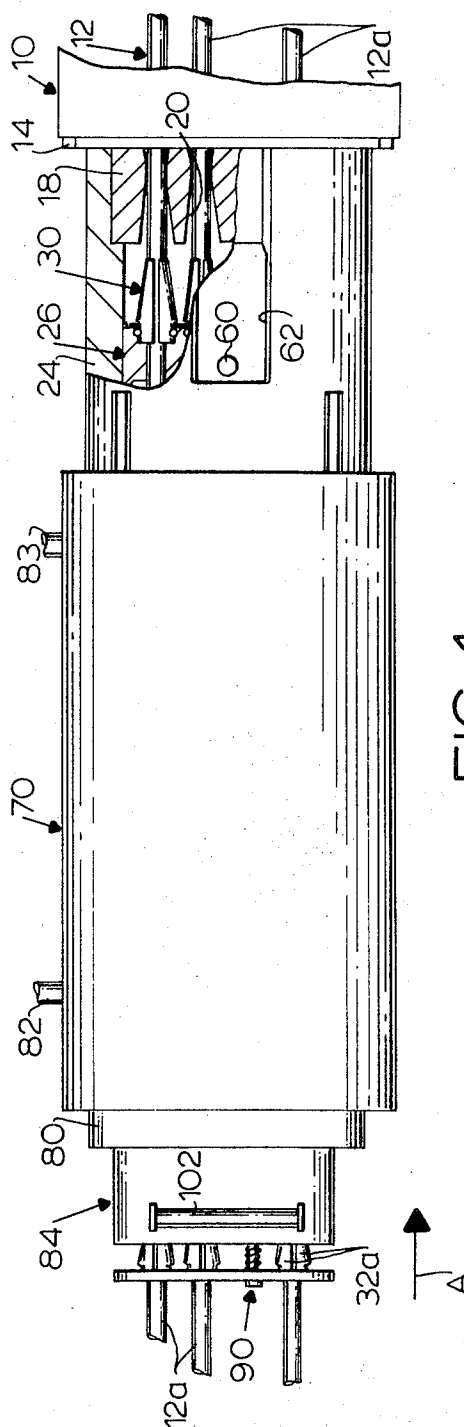


FIG. 1

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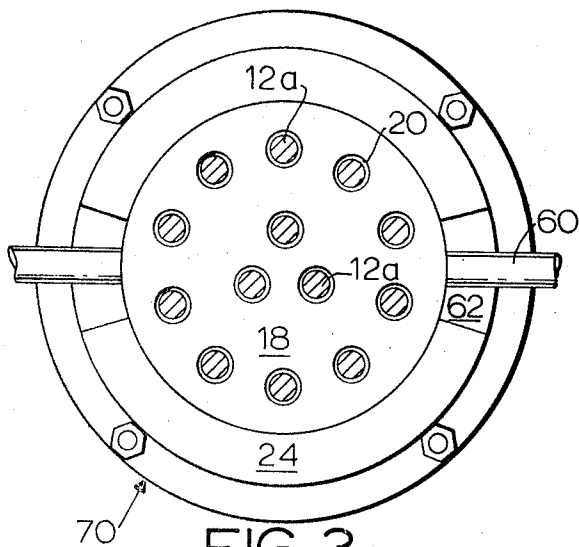


FIG. 3

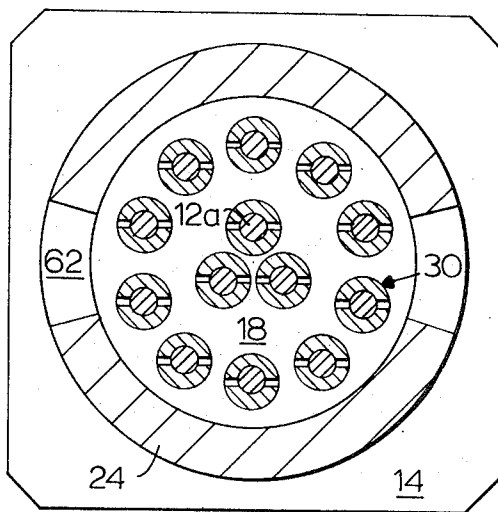


FIG. 4

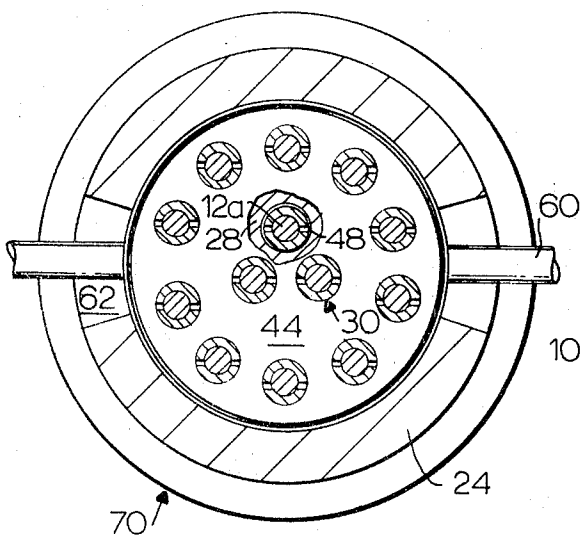


FIG. 5

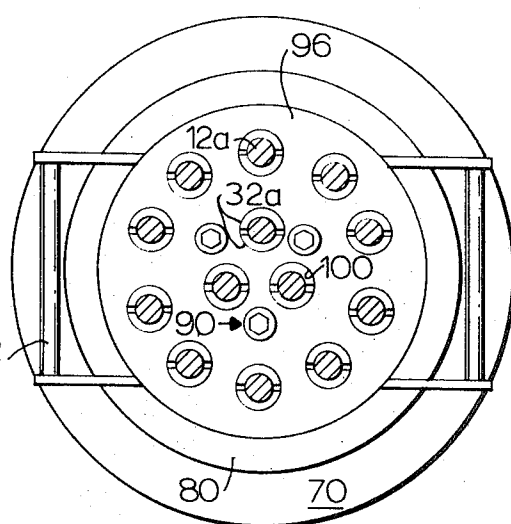


FIG. 6

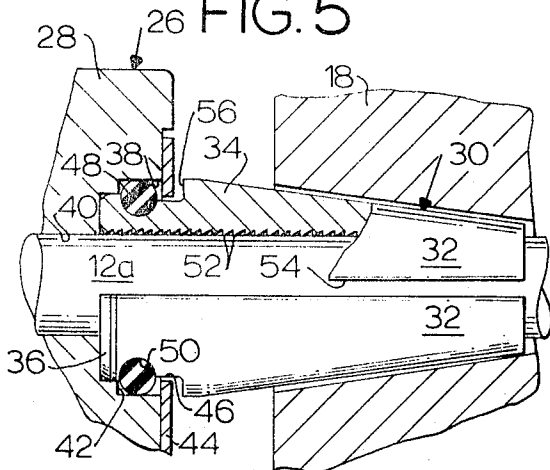


FIG. 7

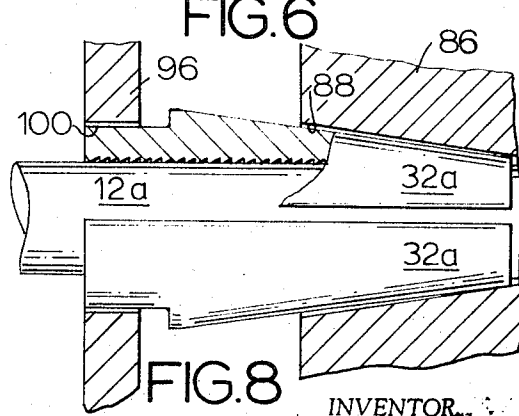


FIG. 8
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SYSTEM FOR POST-TENSIONING AND ANCHORING PRESTRESSING TENDONS

BACKGROUND OF THE INVENTION

In my co-pending U.S. Pat. application Ser. No. 780,111, filed Nov. 29, 1968, now U.S. Pat. No. 3,597,830, I have disclosed a method and apparatus for post-tensioning a prestressing tendon disposed in a concrete structure through the employment of a first jack to impart a uniform predetermined tension to the tendon, and a second jack used in conjunction with an engageable anchor to selectively engage the anchor to the prestressing tendon and place the anchor in abutment with the concrete structure. The jacks are separate and separable from each other to facilitate pre-assembly of the second jack and anchor on a tendon prior to the application of the first jack.

While the invention set forth in my co-pending application provides a number of significant advantages over prior art constructions and approaches, there continues to be a need for even simpler and less expensive arrangements for post-tensioning prestressing tendons disposed in a concrete structure. This is especially true where such tendons are comprised of a plurality of strands, each of which is to be anchored by separate collars, each gripping a strand of the tendon.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention an improved assemblage for applying tension to and anchoring the end of a prestressing tendon extending from a concrete structure is provided. The assemblage incorporates separable units which facilitates assembly and use thereof. In addition, the present invention provides for use of but a single hydraulically actuated jack member to apply tension to the tendon prior to anchoring thereof. Anchoring means is disposed about the tendon between the point of application of the tension force and the structure. The anchoring means comprises an anchoring plate having truncated conical holes through which the tendon strands are directed and collar means disposed about the tendon strands and adapted for movement relative thereto from a first position wherein the collar means are out of engagement with the anchoring plate to a second position wherein the collar means are wedged into the anchoring plate holes and grippingly engage the tendon strands. Actuator means is mounted for movement relative to the base member for moving the collar means from the first position to the second position, said actuator means and said collar means incorporating cooperating structure for retaining said collar means against movement relative to the actuator means until the collar means reaches the second position whereupon the actuator means releases the collar means. The actuator means may also be used to hold the collar means out of engagement with the tendon strands when a reduction of the force applied to the tendon is desired prior to anchoring.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of the post-tensioning apparatus assembled and ready for operation, with the pulling jack thereof being illustrated in its retracted position;

FIG. 2 is a cross-sectional side view of the post-tensioning apparatus assembled and ready for operation, with the pulling jack thereof in its extended position;

FIGS. 3, 4, 5 and 6 are enlarged cross-sectional views taken along the lines 3—3, 4—4, 5—5, and 6—6, respectively;

FIG. 7 is an enlarged detailed sectional view illustrating cooperating structure of the apparatus anchor plate and collar means; and

FIG. 8 is an enlarged detailed sectional view of portions of the apparatus jack plate and a cooperating locking collar.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring now in detail to the drawings, a concrete structure in the form of a beam or column is designated therein by the

reference numeral 10. The structure is typical of the type used for post-tensioning processes and includes a multistrand prestressing tendon 12 extending longitudinally therethrough. One end of the tendon, as can be clearly seen in the drawings, protrudes from the structure. While not illustrated, it should be understood that the other end of the tendon is suitably anchored to the structure and, possibly, protrudes therefrom.

Prior to the process of post-tensioning the prestressing tendon 12, the elements making up the apparatus constructed in accordance with the teachings of the present invention are assembled around the end of the tendon extending from the structure. In the following discussion, these elements will be described in the sequence in which they are assembled into place.

The first of the elements comprises a bearing plate 14 having an opening 16 extending through the central portion thereof. The plate 14 is seated against the end of the structure 10 with the strands of the tendon 12 extending through the opening 16. For convenient reference the individual tendon strands are designated by means of reference numeral 12a.

The next of the elements comprises an anchoring plate 18 threaded over the strands of the tendon 12 in abutting engagement with the plate 14. The anchoring plate is of a type conventionally employed for anchoring prestressing tendons in place and has a plurality of truncated conical holes 20 extending therethrough through which individual tendon strands 12a project. The anchoring plate 18 is assembled into place so that the holes or apertures 20 converge toward the plate 14.

Next, an assembly generally designated by means of reference number 26 is placed in position. As may best be seen with reference to FIGS. 1, 2, 5 and 7, the assembly 26 comprises an actuator plate 28 having a plurality of locking collars 30 projecting outwardly therefrom. Each of the collars 30 comprises two internally toothed wedge segments 32, each of said segments comprising a main body portion 34 and a reduced end portion 36. The main body portions 34 define converging-curved outer surfaces adapted to enter into truncated conical holes 20 of the anchoring plate and cooperate with said plate in grippingly engaging the tendon strands. This operation will be described in greater detail below.

The wedge segments 32 when the assembly 26 is in its fully assembled illustrated condition, are disposed in pairs about the respective tendon strands 12a. The means by which this is accomplished will now be described in detail. Actuator plate 28 has formed in the inwardly extending face thereof a plurality of recesses 38 corresponding in number to the number of tendon strands 12a. The recesses 38 have a circular cross-sectional configuration and the interiors thereof are in communication with throughbores 40 formed in the plate substantially co-axially with the recesses. The outermost extent of each recess 38 has a cross-sectional dimension somewhat greater than the inwardly disposed portion thereof so that each recess forms an outwardly disposed annular ledge 42. Secured over actuator plate 28 by means of any suitable expedient such as metal screws or the like is a retention plate 44 defining a plurality of apertures 46 corresponding in number to that number of recesses 38, and hence the number of tendon strands 12a. Apertures 46 of the retention plate have a somewhat smaller cross-sectional dimension than do the enlarged portions of recesses 38. The retention plate 44 is affixed to actuator plate 28 so that apertures 46 are disposed co-axially with the recesses 38 and consequently a portion of the retention plate 44 projects annularly over the recess 38 and in general spaced registry with annular ledge 42. Each annular ledge 42, its associated overlapping annular portion of the retention plate 44 and the side wall of the enlarged portion of the recess 38 thus define an annular channel. Housed in this channel is an O-ring 48 constructed of a suitable resilient material. The O-ring 48 is adapted for positioning within aligned grooves 50 formed on the reduced end portions 36 of wedge segments 32. It will be appreciated that when assembly 26 is in the illustrated fully assembled condition, the relative dimensions of the recesses 38, the O-rings 48 and their cooperating wedge segments reduced

end portions 36 result in the compression of the O-ring and the continual biasing thereby of the reduced end portions 36 into loose engagement with each tendon strand 12a to retain the segments 32 in place while permitting the free passage of the strand therethrough.

Referring now specifically to FIG. 7, it should be noted that the teeth when not gripping the tendon strand are positioned on the outer surface thereof under the biasing influence of O-ring 48 with the two wedge segments 32 being spaced from one another in the manner illustrated to provide a gap 54 therebetween. The main body portion 34 and the reduced end portion 36 of each wedge segment define an outwardly extending shoulder 56 which when the wedge segments are disposed with respective reduced end portions 36 in the recesses 38 are in abutting engagement with retention plate 44. Since tendon strands 12a must be disposed between the wedge segments to keep them in the illustrated position, the strands are threaded through actuator plate 28 prior to the positioning of assembly 26 within a housing 24, which comprises a portion of the apparatus pulling jack which will be described in detail below.

Affixed to and projecting outwardly from the actuator plate as shown are handles 60. The handles protect outwardly through elongated slots 62 formed in the housing 24. It will be appreciated that actuator plate 28 may be manually moved relative to housing 24 by means of the handles. The purpose of this feature of construction will be brought out in greater detail below.

The next stage of the assembly of the apparatus of the present invention is as follows. Referring now to FIG. 2, a spacer sleeve 64 of unitary construction is illustrated, said sleeve having a plurality of throughbores 66 formed therein corresponding in number and relative configuration to throughbores 40 within actuator plate 28. The tendon strands 12a are individually threaded through each of the throughbores 66 so that they are maintained in a generally parallel condition. The spacer sleeve 64 and the ends of the tendon strands passing therethrough are then positioned within a cylindrical interior 68 of a jack 70. The relative dimensions of cylindrical interior 68 and spacer sleeve 64 are such that the sleeve is maintained in engagement with the jack wall which defines the cylindrical interior. The jack includes a double walled housing 72 and the aforementioned open-ended housing 24. The latter housing may be referred to as a "chair."

After the sleeve is positioned within the jack 70, assembly 26 is introduced through the open end of housing 24 thereof and the housing is placed in end-wise abutting engagement with bearing plate 14 about anchoring plate 18. The internal dimensions of housing 24 are such that it defines a ledge 25 which restrains from movement the anchoring plate 18.

The double annularly spaced walls 74 and 76 of the housing 72 define an annular chamber 78 which accommodates therein one end of a hollow jack ram 80. It will be appreciated that by introducing hydraulic fluid or the like through one or the other of lines 82 and 84 communicating with the annular chamber 78, the hollow jack ram 80 may be caused to move between the retracted position of FIG. 1 relative to housing 72 or the extended position of FIG. 2.

The jack 70 further comprises a jack lock assembly generally designated by means of reference numeral 84 disposed at one end of hollow jack ram 80. With the hollow jack ram 80 in the retracted position of FIG. 1, the outermost ends of tendon strands 12a are threaded through the assembly and secured thereto in a manner which will now be described. Jack lock assembly 84 includes a jack plate 86 having a plurality of truncated conical throughbores 88 formed therein, the throughbores 88 corresponding in number and relative placement to conical holes 20 of anchoring plate 18. Affixed to jack plate 86 as by means of screw threads or the like are three bolt elements 90, each of which has an enlarged head 92 and a smooth cylindrical body portion 94. Mounted for free sliding engagement with cylindrical body portions 94 is an auxiliary plate 96. Compression springs 98 are disposed about

the cylindrical body portions 94 and are in compressive engagement between jack plate 86 and auxiliary plate 96 to continuously urge the auxiliary plate against the bolt element heads 92. In addition to the apertures formed in the auxiliary plate which accommodate bolt elements 90, the plate (as may best be seen with reference to FIG. 8) has additionally formed therein enlarged apertures 100. Accommodated within each of the apertures 100 is a tendon strand 12a and two wedge segments 32a which may be similar in construction to previously described wedge segments 32. As illustrated, however, the wedge segments 32a have straight, rather than grooved, end portions. Each tendon strand 12a and its associated wedge segments 32a are relatively loosely disposed within the auxiliary plate apertures 100, with the wedge segments 32a being loosely held in position by the cooperative relationship between jack plate 86 and auxiliary plate 96. It is to be understood of course that the bolt elements 90 prevent separation of the two plates to such an extent that the wedge segments would fall therefrom. Jack plate 86 preferably has handles 102 extending outwardly therefrom to assist in the manual manipulation of the jack as it is placed in position.

The operation of the assembled device will now be described. As previously stated, during the initial stage of operation the jack ram 80 and jack lock assembly 84 are in the positions illustrated in FIG. 1. When it is desired to tension the tendon 12 the operator pushes auxiliary plate 96 in the direction of arrow A to firmly seat wedge segments 32a into engagement with both the tendon strands 12a and the jack plate 86. Pressurized hydraulic fluid is then introduced through fluid line 83 to force jack ram 80 to the extended position illustrated in FIG. 2. This movement of course applies tensile forces to the tendon strands 12a. Such movement continues until the tendon is stressed to a predetermined force. If stressing to compensate for tendon friction is necessary, that degree of force is applied. The ram is then retracted slowly to the position desired to reduce the force in the tendon as may be required.

At this point the operator through manipulation of handles 60 moves assembly 26 from the position illustrated in FIG. 1 to that shown in FIG. 2 thereby causing locking collars 30 to grippingly engage tendon strands 12a through their cooperation with anchoring plate 18. Pressurized fluid is then bled through conduit 83 and introduced into conduit 82 whereby the jack ram 80 will again move to a retracted position. This movement transfers the tensile load of the tendon strands 12a from jack lock assembly 84 to locking collars 30 and anchoring plate 18. Gripping engagement between the tendon strands and the jack lock assembly 84 may now be terminated simply by imparting a shock thereto as by means of a hammer. The entire assemblage with the exception of bearing plate 14, anchoring plate 18 and collars 30 may now be readily removed from the work site. Ready disengagement between collars 30 and actuator plate 28 is insured by virtue of the fact that the gripping engagement of the wedge segments 32 into the tendon strands 12a has allowed the segments of each pair to move inwardly to such an extent that they may be readily disengaged from O-rings 48. The tendon strands 12a may now be cut off at a point close to the locking collars 30.

From the above disclosure it may be seen that the present invention has a number of significant advantages over prior art approaches. Once the tendon strands 12a and wedge segments 32 have been positioned with actuator plate 28 as previously described, the wedges are maintained therein without the necessity for any contact between the wedges and anchoring plate 18. This aids in the preassembly operation since the actuator plate 28, the wedge segments 32 and the tendon strands may be handled as an integral unit. In addition, the tendon strands are maintained within the assembly 26 so that they are prepositioned for ready insertion into jack 70 without undue delay. This is important since jack 70, which constitutes the most expensive element of the invention, may be kept in virtually a constant state of use.

While a preferred embodiment of the invention has been illustrated and described, it should be understood that variations may be made without departing from the spirit of the invention. For example, flexible spring clips might be used in place of the flexible O-ring arrangement to retain the segments 32 in place. The scope of the invention is defined by the accompanying claims.

I claim as my invention:

1. An assemblage for applying tension to and anchoring the end of a prestressing tendon extending from a concrete structure, said assemblage comprising:

A. a jack having a base member disposed in compression imparting relationship to said structure and a ram selectively expandable relative to said base member disposed in gripping engagement with said tendon at a first location along the length of said tendon;

B. anchoring means disposed about said tendon at a second location along the length thereof between said structure and said first location, said anchoring means comprising:

- a. an anchoring plate having a truncated conical hole through which the tendon is directed; and
- b. collar means disposed about said tendon and adapted for movement relative to said tendon from a first position wherein said collar means is out of engagement with said anchoring plate to a second position wherein said collar means is wedged into said anchor plate hole and grippingly engages said tendon; and

C. actuator means mounted for movement relative to said base member for moving said collar means from said first position to said second position, said actuator means and said collar means incorporating cooperable structure for retaining said collar means against movement relative to said actuator means until the collar means reaches said second position whereupon said actuator means releases said collar means.

2. The assemblage of claim 1 wherein said collar means comprises a plurality of internally toothed wedge segments, said cooperable structure including biasing means cooperable with the wedge segments to continuously urge said wedge segments into engagement with said tendon.

3. The assemblage of claim 2 wherein said tendon comprises a plurality of strands, said anchoring plate having at least one truncated conical hole for each strand of said tendon, and a plurality of wedge segments are provided for each of said strands, said actuator means cooperable with said wedge segments to substantially simultaneously move all of the wedge segments provided for all of the strands from said first position to said second position.

4. The assemblage of claim 1 wherein said jack includes a housing within which said actuator means is slidably disposed and defining at least one longitudinal slot providing communication between the interior of said housing and the exterior thereof, said actuator means incorporating handle means projecting outwardly through said slot and adapted to be engaged by the operator to move said actuator means relative to the housing.

5. The assemblage of claim 1 wherein said collar means comprises a plurality of internally toothed wedge segments, said cooperable structure comprising:

- a recess formed in said actuator means;
- a reduced end portion formed on each of said wedge seg-

ments for reception in said recess; and

a flexible element compressably disposed in said recess between said actuation means and said reduced end portions.

6. The assemblage of claim 5 wherein each of said reduced end portions has a groove formed in the outer surface thereof, said grooves being disposed in circumferential alignment about said tendon, said flexible element comprising an O-ring of resilient material disposed in said aligned grooves of said reduced end portions.

7. The assemblage of claim 6 wherein said actuator means includes means for securing said O-ring within said recess.

8. The assemblage of claim 7 wherein said securing means comprises a retention plate affixed to said actuator means and defining an aperture, said aperture overlying said actuator means recess and having a cross-sectional dimension less than the corresponding cross-sectional dimension of said recess whereby a portion of said retention plate is disposed over said recess and said O-ring is prevented thereby from moving out of said recess.

9. The assemblage of claim 8 wherein said actuator means has a throughbore formed therein in communication with said recess, said throughbore slidably receiving said tendon therein.

10. The assemblage of claim 8 wherein said wedge segments have shoulders formed thereon, said shoulders being in abutting engagement with said retention plate when said collar means is retained against movement relative to said actuation means.

11. The assemblage of claim 1 wherein said jack ram has affixed thereto a jack plate having a conical throughbore formed therein for receiving said tendon;

an apertured auxiliary plate mounted on said jack plate for reciprocal movement relative thereto;

means biasing said apertured plate into spaced relation relative to said jack plate with said aperture and said throughbore in substantial alignment; and

a locking collar disposed about said tendon releasably retained within the aperture of said auxiliary plate, said collar upon movement of said auxiliary plate against the force exerted by said biasing means moving into said throughbore and into gripping engagement with said tendon.

12. Apparatus for establishing gripping engagement with a prestressing tendon extending from a concrete structure for the purpose of post-tensioning said structure, said apparatus comprising:

a plate having a truncated conical hole formed therein for receiving said tendon;

a collar slidably disposed about said tendon and including internally disposed teeth, a generally conical-shaped outer surface, said collar movable from a first position out of engagement with said plate to a second position wherein said collar is wedged into the plate hole with said conical-shaped outer surface in engagement with said plate and said collar grippingly engaging said tendon; and means releasably connected to said collar and mounted for slidable movement relative to said plate to move said collar from said first position to said second position, said means releasing said collar when said collar reaches said second position.

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