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[21] Appl. No. **780,111**
[22] Filed **Nov. 29, 1968**
[45] Patented **Aug. 10, 1971**

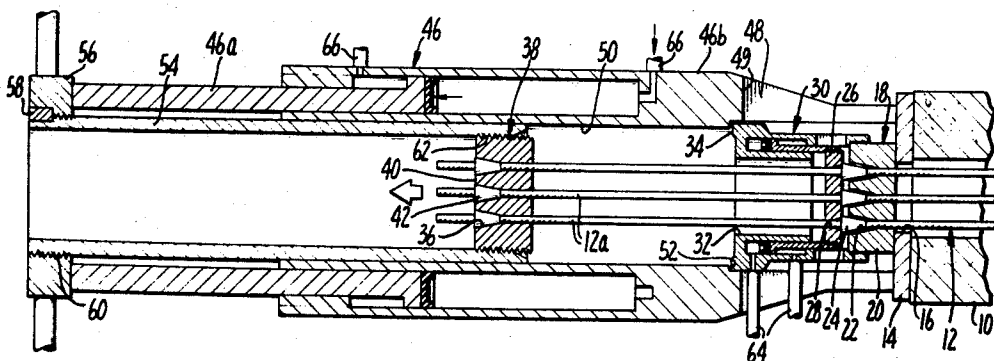
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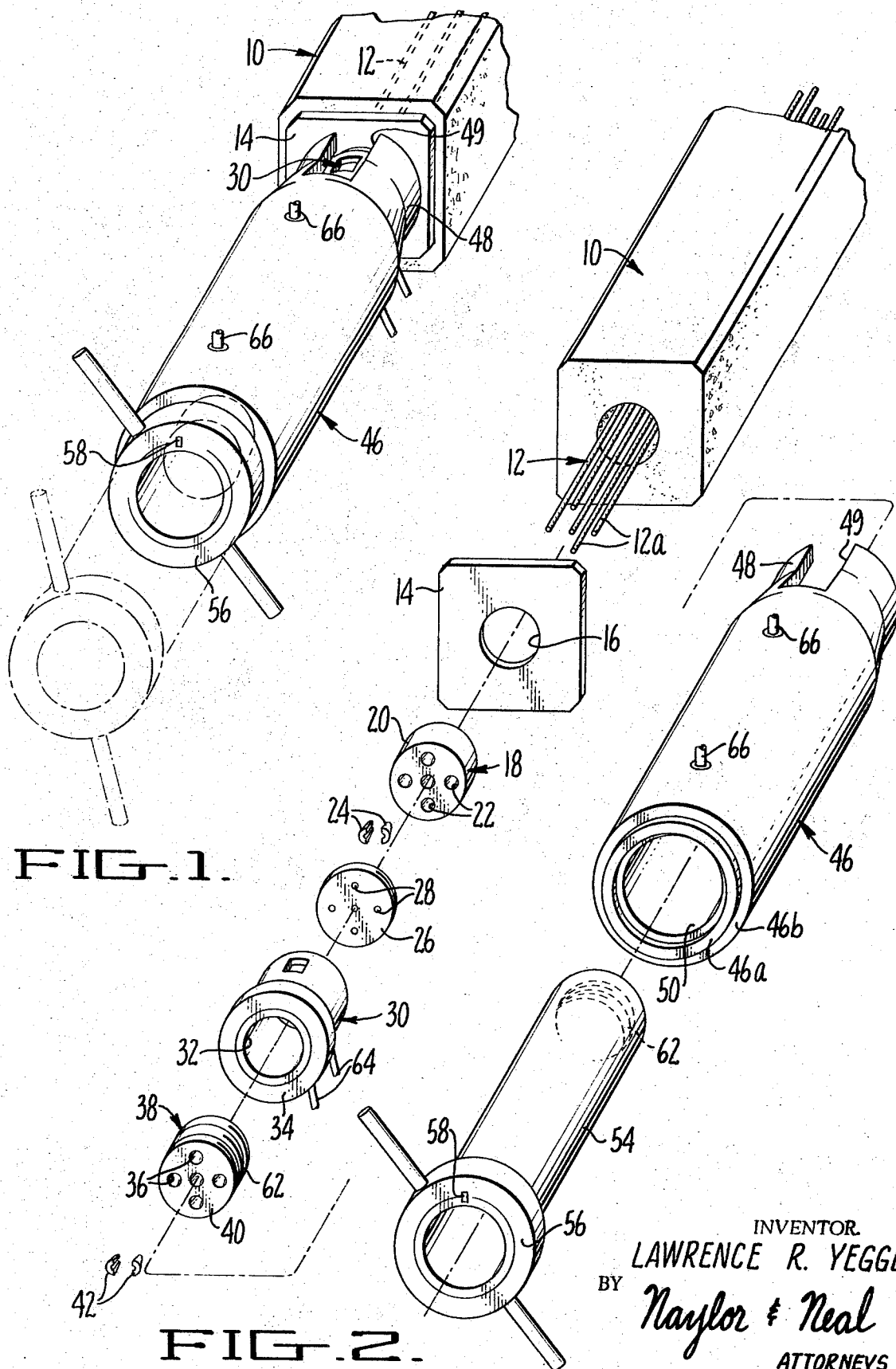
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[54] **METHOD AND APPARATUS FOR POST TENSIONING AND ANCHORING PRESTRESSING TENDONS**
10 Claims, 4 Drawing Figs.

[52] U.S. Cl. **29/452, 254/29 A**
[51] Int. Cl. **B21d 39/00, E21b 19/00**
[50] Field of Search **254/29 A; 29/452; 52/223, 225, 230**

ABSTRACT: 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 preassembly of the second jack and anchor on a tendon prior to the application of the first jack.





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METHOD AND APPARATUS FOR POST TENSIONING AND ANCHORING PRESTRESSING TENDONS

BACKGROUND OF THE INVENTION

The present invention relates to posttensioning a concrete structure, and specifically to a method and apparatus for applying a uniform tension to and anchoring a prestressing steel tendon. The invention is also concerned with uniformly tensioning and anchoring each strand of a multiple-strand prestressing tendon to the concrete structure within which it has been incorporated.

Posttensioning is a method of prestressing concrete with which the present invention is concerned. This is the method of stressing the steel tendon members after the concrete has been formed and cured, and causing that stress to be borne uniformly throughout the length of the composite concrete and steel structure. To accomplish a uniform stress distribution, it has been found necessary to apply an initial tension to the tendon in excess of the working stress desired in order to overcome the effects of friction between the tendon and the concrete. The tension is then reduced to a predetermined value to obtain a uniform distribution of stress along the tendon.

In posttensioning methods, the tendon is held under this uniform tension while it is anchored to the concrete in order that the prestress be retained in the composite structure when the externally applied tension is released. One means of accomplishing this anchorage, which is conveniently effected at the site of construction, is through the use of collar-shaped wedges in conjunction with a conical receiving hole, as shown in the prior art and illustrated in U.S. Pat. No. 3,090,598. The wedge and receiving hole make up an engageable collet-type anchorage. This is the preferred type of anchorage with which the present invention is to be used. However, any type of anchorage which is engageable responsive to the application of lateral force thereto could be used.

The use of such a collet device has certain inherent problems. If the collet is designed to be self-actuating, that is to engage itself to the tendon as the externally applied tension is released and it begins to shrink back to its normal length, there will be a tension loss associated with the amount of tendon shrinkage necessary to effectively engage the collet to the tendon and to seat the collet against the abutting portion of the structure. The amount of tension loss associated with a given amount of shrinkage will vary depending upon the length, cross section and modulus of elasticity of the particular tendon involved. Also, the process of initially overtensioning the tendon to overcome frictional effects is made more difficult because the collet must be restrained from self-engagement during the tension reduction stage.

If the collet is forcibly engaged by manual means such as hammering, the process becomes prohibitively slow. This is especially undesirable with the use of a multiple stranded tendon which requires engagement of each strand separately. The use of a hydraulically actuated piston used to engage and seat or "lock" the collet as disclosed in U.S. Pat. No. 3,090,598 remedies this problem by providing a "locking piston" for the positive engagement of the engageable collet. But this has its own shortcomings inasmuch as the time involved in setting up the anchorage elements and the locking piston decreases the efficiency with which the expensive multifunction hydraulic jack suggested therein is utilized.

SUMMARY OF THE INVENTION

The present invention seeks to remedy these and other shortcomings in the prior art by providing for the use of two coaxially located, but separable, jacks. When positioned over one end of a tendon, they cooperate to stress and anchor that tendon to the structure. Their separable character is intended to facilitate more efficient implementation of the most expensive piece of equipment, the pulling jack, by allowing a staged assembly. With the use of this invention, a plurality of setup

crews working on a plurality of tendons with a plurality of engaging jacks and anchorages can service a single pulling jack, thereby increasing the efficiency of its use by decreasing the amount of preparation time involved in applying the pulling jack to each tendon.

The foregoing abstract summarizes the method and apparatus of the invention. A more precise definition is found in the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the posttensioning apparatus assembled and ready for operation, with the extended position of the pulling jack shown in phantom.

FIG. 2 is an exploded view of the apparatus.

FIG. 3 is a longitudinal sectional view of the anchoring collet, the engaging jack and a pulling vise assembled upon strands of a prestressing tendon, with the pulling jack shown in phantom.

FIG. 4 is a sectional view of the collet anchor the engaging jack and the pulling jack attached to the pulling vise, with the pulling jack in its extended condition as it imparts tension to the strands of a prestressing tendon.

FIG. 5 is a detailed sectional view of the engaging jack as it engages the engageable collet anchor.

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 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 seen in the drawings, protrudes from the structure. While not illustrated, it should be understood that the other end of the tendon would be suitably anchored to the structure and, possibly, protrude therefrom.

STRUCTURE AND ASSEMBLY

Prior to the process of posttensioning the prestressing tendon 12, the elements making up the apparatus 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 strands are designated 12a.

The next of the elements comprises an engageable collet anchor 18 threaded over the strands of the tendon 12 in abutting engagement with the plate 14. The anchor 18 is of the type conventionally employed for anchoring prestressing tendons in place and comprises a plate 20 having a plurality of conical apertures 22 extending therethrough, and a pair of collar-shaped wedges 24 loosely received in each of the apertures. The anchor 18 is assembled into place so that the apertures 22 converge towards the plate 14. Each strand 12a making up the tendon 12 extends through one of the apertures 22 and is surrounded by a pair of the wedges 24. The strands 12a, plate 20 and wedges 24 are so interrelated that, upon forcing of the wedges into the apertures 22, the wedges simultaneously seat in the apertures 22 and assume gripping engagement with the strands. It is through this operation that the strands are, ultimately, anchored.

Adjacent the collet anchor 18, a seating plate 26 is threaded over the strands of the tendon 12 and disposed for movement toward and simultaneous abutting engagement with the wedges 24 of the collet anchor 18. The seating plate 26 is peripherally threaded and has a plurality of apertures 28 extending therethrough, each of which is of a size sufficient to closely, but slidably, receive one of the tendon strands 12a. They are arranged in a pattern corresponding to those in the

anchor 18. Thus, when the plate 26 is assembled into place with each strand 12a making up the tendon 12 extending through an aperture 28, movement of the plate 26 toward the anchor 18 will bring the plate 26 into abutment with the wedges 24 protruding from the anchor plate 20 of the anchor 18.

An engaging jack 30 is received over the tendon 12 to one side of the plate 26. It is of relatively conventional center hole type construction and comprises a hollow inner member 30a and a hollow outer member 30b selectively expansible relative to each other. The inner expansible member 30a is disposed toward the structure and is internally threaded to receive the seating plate 26 therein. The tendon 12 extends through the hollow center 32. A face 34 on the outer member 30b is formed to cooperatively abut with structure within a pulling jack 36, which will be described in detail later, to restrain the motion of the engaging jack 30 away from the structure 10. Thus disposed and restrained, expansion of engaging jack 30 will move the seating plate 26 into abutment with the wedges 24 of the anchor 18. The lateral force so applied to the anchor 18 will bring the anchor plate 20 into bearing interrelationship with the structure and effect gripping engagement of the tendon 12 by forcing the wedges 24 into the conical apertures 22.

A pulling vise 38, identical in structure and operation to the collet anchor 18 is assembled over the tendon to one side of the plate 26. It comprises a vise plate 40 having a conical apertures 36 converging toward the structure 10 and collar-shaped wedges 42 received in the apertures. As assembled, it is received over the tendon 12 adjacent the engaging jack 30 and grippingly engaged to the tendon strands 12a.

A center hole hydraulic pulling jack 46 having a hollow inner member 46a and a hollow outer member 46b selectively expansible relative to each other is positioned over the above-described assemblage with the outer member 46b disposed toward the structure 10. At the end of the pulling jack 46 nearest the structure 10, the walls of the outer member 46b form a housing 48 adapted to pass over and receive the engaging jack 30, the seating plate 26 and the engageable collet anchor 18 when the distal end of the outer member 46b abuts the bearing plate 14. Slots 49 extend laterally through the housing 48 to provide for access to the jack 30 and accommodate the connection of hydraulic lines thereto. The housing 48 is of increased diameter relative to the cylindrically hollow center, designated 50, of the member 46b. The transition between the two diameters is square-cut to form an abutting surface 52 which cooperates with the face 34 of the outer member of the engaging jack 30b to restrain the motion of that outer member 30b away from the structure 10 when the outer member 46b of the pulling jack 46 is similarly restrained.

The hollow center 50 of the inner member 46a is formed to receive a pulling tube 54. The end of the tube most remote from the structure 10 threadably receives a ring nut 56 which is keyed thereto, as seen at 58. The keyed interrelationship is provided to prevent relative rotation between the nut 56 and the pulling tube 54, once the nut and tube are threadably engaged by means of threaded portions, designated 60. The opposite end of the pulling tube 54 is provided with an internally threaded portion 62 to engage the pulling vise 38. When the pulling jack 46 is positioned around the tendon 12 with the above-described assemblage in place, the pulling tube 54 is slid through the center of the pulling jack 50 and is rotated by means of the ring nut 56 until the pulling vise 38 has been engaged and the ring nut 56 abuts the outward end of the inner member of the pulling jack 46a.

Hydraulic lines 64 and 66 are attached to the jacks 30 and 46, respectively, to effect the operation thereof during the posttensioning operation.

OPERATION

By selectively connecting the hydraulic lines 64 and 66 to a source of hydraulic pressure, not shown, the expansible members of the jacks 46 and 30 may be expanded or collapsed as

required by the posttensioning procedure. This procedure comprises tensioning the tendon 12 by expanding the pulling jack 46, and then partially relaxing that tension to achieve a uniform stress distribution along the tendon 12. While the relaxing step may be omitted, it is generally preferred for optimum results. With the pulling jack 46 now in tensioned engagement with the tendon, and the outer member 46b thus restrained from movement away from the structure 10, the engaging jack 30, which rests in abutment upon the abutting surface 52, is expanded to cause the seating plate 26 to abut the collar-shaped wedges 24, seat the anchor plate 20 firmly against the bearing plate 14 and wedge the collar-shaped wedges 24 between the tendon strands 12a and the sloping sides of the conical apertures 22 in the anchor plate 20. With the tendon 12 so anchored to the structure 10, both jacks 30 and 46 are then collapsed. Once thus conditioned, the pulling jack 46 may be counterrotating the ring nut 56, thus disengaging the pulling tube 54 from the pulling vise 38. The pulling tube 54 is then removed from the pulling jack 46, allowing the pulling jack 46 to be removed from around the inner assemblage and to be taken to another location for similar use. Finally, the pulling vise 38, engaging jack 30 and seating plate 26 may be removed to be used in another location.

METHOD

From the foregoing description, the method of the invention is believed apparent. First the elements are sequentially assembled into place. Once assembled, the elements are operated to selectively tension the tendon and anchor it in place. In the latter operation, the tendon 12 may be partially relaxed prior to anchorage to equalize the tension therein. Once the anchor 18 is set, the engaging jack 30 is relaxed and then the pulling jack 46 is relaxed. The method is completed by removing the jacks 46 and 30 and seating plate 26 to leave the tendon 12 anchored in place by the engageable anchor structure 18.

CONCLUSION

While but a single tensioning operation has been described, it should be understood that the apparatus and method of the invention are ideally suited to multiple tensioning operations wherein it is necessary to tension tendons located at a plurality of locations. In such an environment, a single pulling jack may be used with a plurality of engaging jacks and anchorage assemblies. In this way, engaging jack and anchorage assemblies may be set up at one location while the pulling jack is being used at another location and, thus, the pulling jack may be maintained in substantially continuous use. The fact that the pulling jack may be assembled over an engaging jack after it has been preassembled into place and removed while the engaging jack is still in place optimizes this operation.

The use of the term strand as herein employed is intended to apply equally to a strand comprised of a single wirelike element, as well as a strand comprised of a plurality of tightly grouped small-wire like elements.

I claim:

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

- a. anchoring means disposed around said tendon for seating engagement with said structure and selective gripping engagement of said tendon upon the application of compressive force to said means;
- b. a first jack having a base member disposed in compression imparting relationship to said structure and a ram selectively expansible relative to said base member disposed in gripping engagement with said tendon; and
- c. a separable second jack releasably connected to said first jack, said second jack having a base member restrained against movement away from said structure by said first jack base member and a ram selectively expansible relative to said second jack base member and disposed for

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movement towards and into abutting engagement with said anchoring means to impart compressive force thereto to effect gripping said tendon and seating said anchoring means against said structure.

2. The assemblage as described in claim 1 wherein the anchoring means comprises:

- a. an anchoring plate in abutting engagement with said second jack base member and having a truncated conical hole through which the tendon is directed; and,
- b. internally toothed collar-shaped wedges received around the tendon, said wedges being adapted, under the application of compressive force thereto by said second jack ram upon expansion thereof relative to said second jack base member, to wedge into the anchor plate hole and grippingly engage said tendon,

3. The assemblage as described in claim 2 wherein:

- a. the second jack base member defines a cavity;
- b. the tendon is comprised of a plurality of strands;
- c. the anchoring plate is at least partially disposed within said cavity and in abutting engagement with the wall of said second jack base member defining said cavity, said anchoring plate having at least one such truncated conical hole for each strand of said tendon, said holes disposed in a uniform pattern across said plate; and,
- d. toothed collar-shaped wedges are provided for each strand to grippingly engage each strand responsive to a common compressive force applied thereto.

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

- a. anchoring means disposed around said tendon for seating engagement with said structure and selective gripping engagement of said tendon upon the application of compressive force to said means;
 - b. a first jack having a base member disposed in compression-imparting relationship to said structure and a ram selectively expansible relative to said base member disposed in gripping engagement with said tendon; and
 - c. a second jack interposed between said first jack and said anchoring means, said second jack having a base member restrained against movement away from said structure and a ram selectively expansible relative to said base member and disposed for movement towards and into abutting engagement with said anchoring means to impart compressive force thereto to effect gripping said tendon and seating said anchoring means against said structure;
- said first jack being of the center hole type and formed with a cavity within the base member thereof to receive said anchoring means and said second jack and said second jack being restrained from movement away from the structure by an abutting engagement between the base member of said second jack and a wall of the cavity in the base member of said first jack.

5. A center hole pulling jack for use in imparting tension to a tendon extending from a concrete structure, said jack comprising:

- a. a base member adapted to be seated against the structure, said base member having:
 - 1. a cavity in and opening through the distal end thereof of a size sufficient to freely pass over and receive an independent expansible center hole jack;
 - 2. a surface within said cavity and spaced from the open end thereof against which an independent jack received therein may bear whereby, upon expansion, movement of said independent jack away from a structure against which said base member is seated is restrained;
 - 3. an open area within said cavity and communicating with the open end thereof through which an independent jack received therein may expand; and,
 - 4. an elongated throughbore formed in said base member

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and communicating with said cavity, said surface surrounding said throughbore; and

- b. a ram expansible relative to said base member.

6. The jack as described in claim 5 wherein, an opening extends laterally through said base member and into communication with the cavity therein to permit access to an independent jack received in said cavity.

7. A method of posttensioning and anchoring the end of a prestressing tendon extending from a concrete structure by means of an engageable collet which grips said tendon responsive to application of a compressive force thereto and anchors the tendon to the structure, comprising:

- a. positioning the engageable collet adjacent said structure and around the emerging end of the prestressing tendon;
- b. positioning an engaging jack having two portions selectively expansible relative to each other to restrain one of said portions against movement away from said structure and dispose the other for selective movement toward and into abutment with said engageable collet to effect the gripping engagement of said collet with said tendon and force said collet into bearing interrelationship with said structure;
- c. positioning around the tendon, the engaging jack and engageable collet, a center hole pulling jack having two hollow portions selectively expansible relative to each other, with one portion disposed in compression imparting relationship to said structure, and the other portion disposed in gripping engagement to the end of said tendon;
- d. expanding said pulling jack to impart a predetermined tension to said tendon;
- e. expanding said engaging jack to force the collet into gripping engagement with the tendon and bearing interrelationship with the structure;
- f. collapsing the engaging jack;
- g. collapsing the pulling jack;
- h. removing the pulling jack; and
- i. removing the engaging jack.

8. The method as described in claim 7, wherein:

- a. prior to engaging the engageable collet, the pulling jack is expanded to impart a tension in excess of the predetermined amount ultimately desired to overcome frictional effects along the length of the tendon;
- b. the pulling jack is partially collapsed to impart a uniform predetermined tension to the tendon; and,
- c. the engaging jack is then expanded to engage the engageable collet.

9. The method as described in claim 7, wherein:

- a. the tendon is composed of a plurality of strands;
- b. the engageable collet is of the type adapted to individually accommodate a plurality of strands and is positioned so that each strand of the tendon is individually surrounded thereby;
- c. a single pulling jack is employed to simultaneously engage and tension all of the strands; and,
- d. a single engaging jack is employed to simultaneously engage the collet to all of the strands;
- e. the one portion of said engaging jack is restrained against movement away from the structure by abutment with said pulling jack.

10. The method as described in claim 9, wherein:

- a. prior to engaging the engageable collet, the pulling jack is expanded to impart a tension in excess of the predetermined amount ultimately desired to overcome frictional effects along the length of the tendon;
 - b. the pulling jack is partially collapsed to impart a uniform predetermined tension to the tendon; and,
 - c. the engaging jack is then expanded to engage the engageable collet.
- c. the engaging jack is then expanded to engage the engageable collet.