United States Patent

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[54] **EXPLOSIVE TENDON-TENSIONING MEANS**
10 Claims, 6 Drawing Figs.

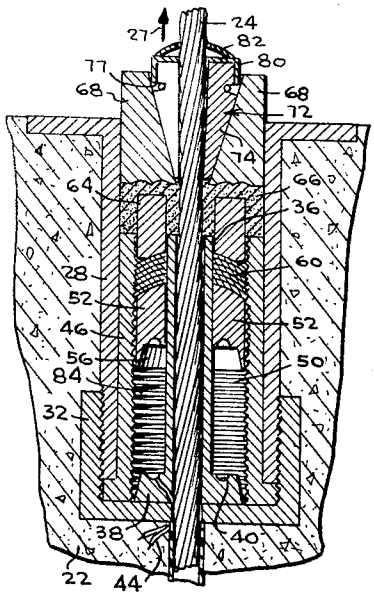
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[51] **Int. Cl.** **E04g 21/12**
[50] **Field of Search** ..... 25/118 (H), 118 (T), (Dig. 30), (Inquired); 29/421 (E), (Inquired); 254/29 (A), (Inquired); 52/223 (L), 230

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ABSTRACT: A concrete embedded barrel member in which a reinforcing tendon extends with explosive means inside the barrel for exerting a substantial tensioning force on the tendon through a cushioning member of soft metal and a plurality of apertured discs engaging the interior of the barrel so that the discs serve to retain the tendon in permanent tensioned condition.



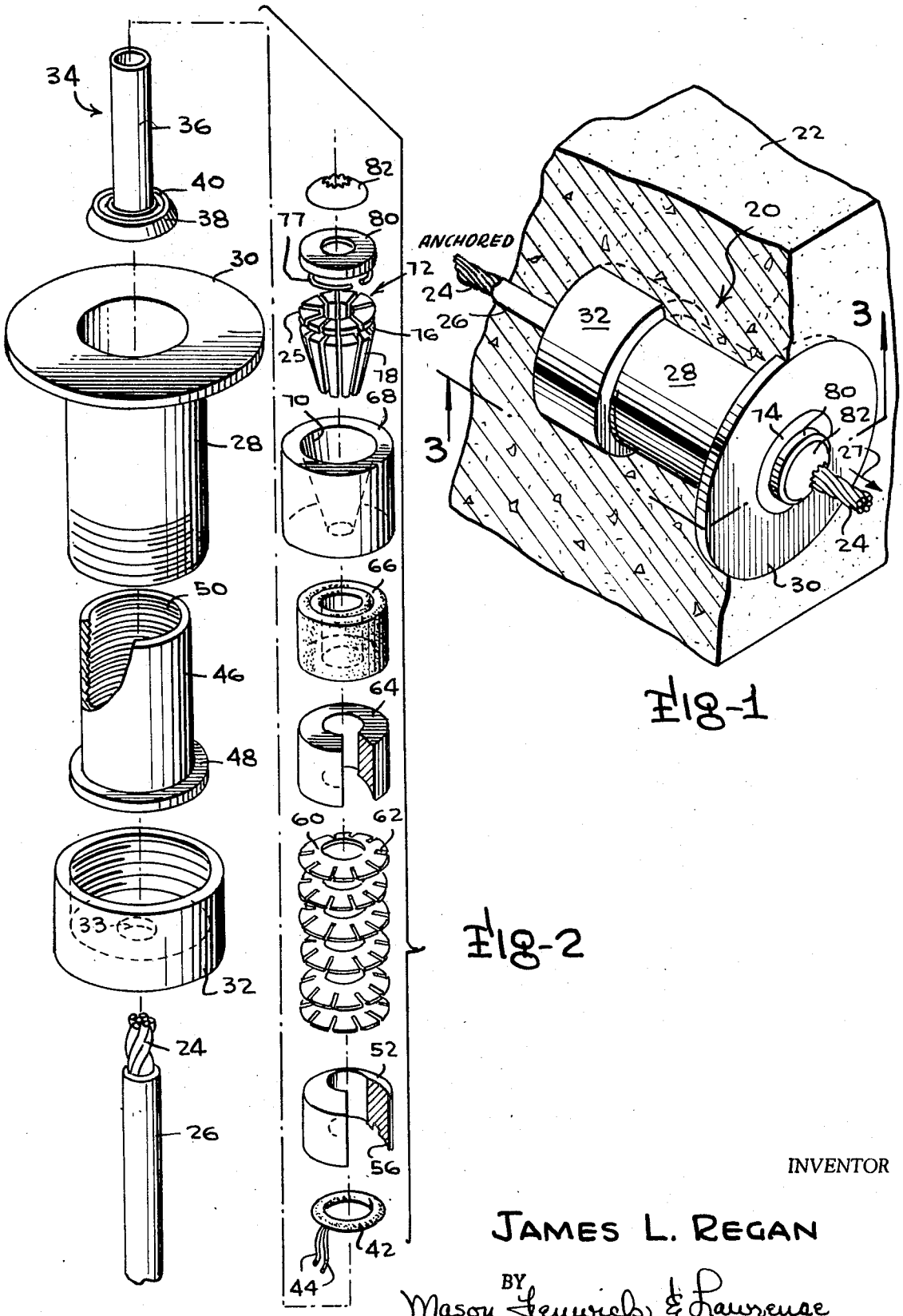


Fig-1

Fig-2

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Fig-3

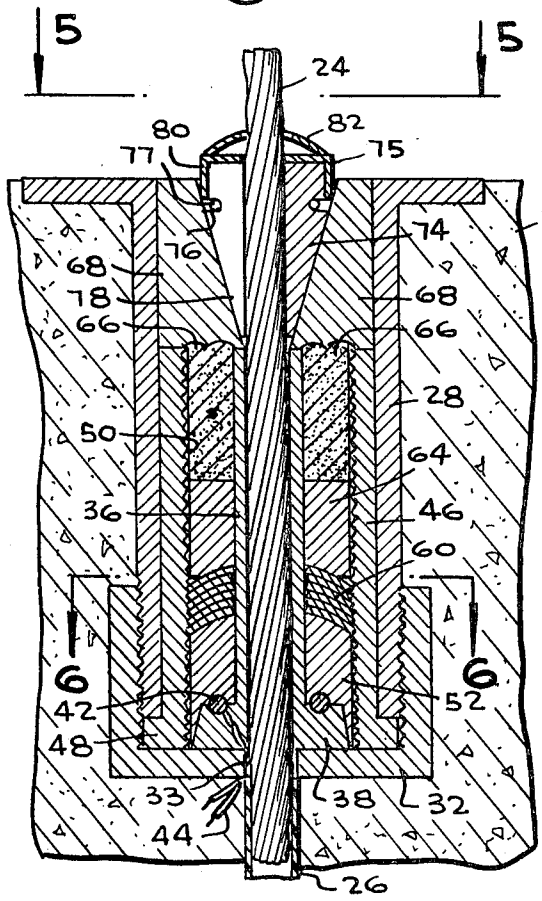


Fig-4

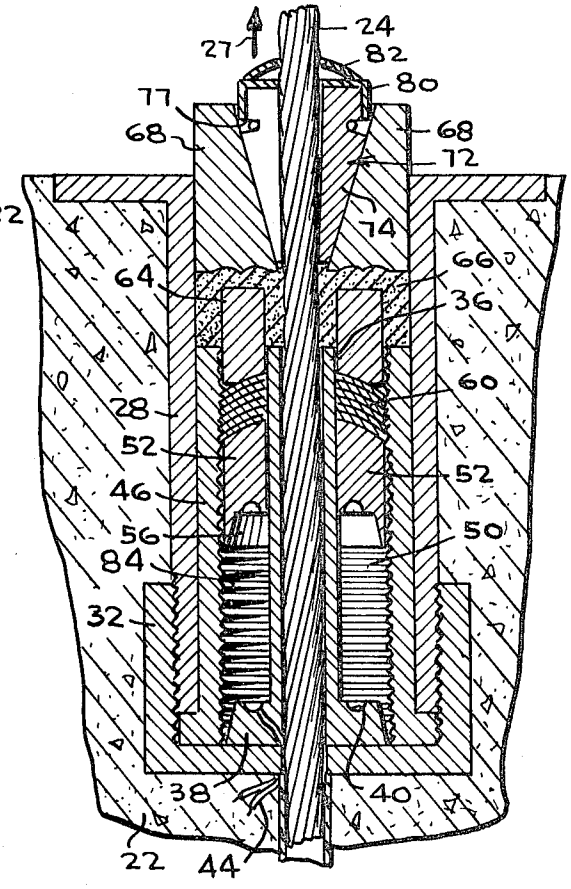


Fig-5

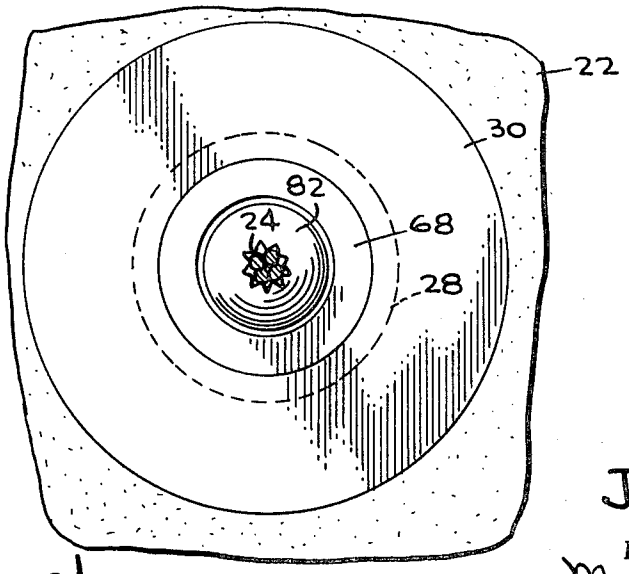
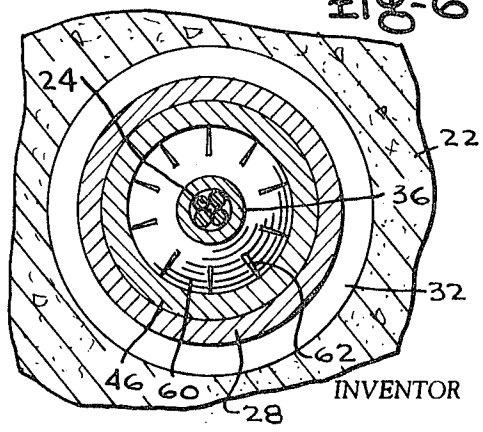


Fig-6



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EXPLOSIVE TENDON-TENSIONING MEANS

BACKGROUND OF THE INVENTION

This invention is in the building construction field and is specifically directed to a new and improved device for tensioning concrete reinforcing cables or tendons. Even more specifically, the subject invention is directed to reinforcing tendon tensioning means operable by means of an explosive charge for tensioning concrete reinforcing cables or tendons.

Numerous prior-art devices have been employed for the purpose of tensioning concrete-reinforcing tendons in order to place a body of concrete in compressive stress. While the prior known devices have proved to be fairly satisfactory in some respects, they have suffered from a number of deficiencies for which this invention provides a unique solution. For example, many of the prior known tensioning devices have employed mechanical means operable either manually or by means of hydraulic or electrical power for tensioning the reinforcing tendons. These devices employing either electrical or hydraulic power require extensive auxiliary accouterments such as heavy-duty wiring, hydraulic lines, pumps and the like. Moreover, the complex nature of the prior-art devices has not only increased the initial cost of such, but has also increased the likelihood of mechanical failure or breakdown.

Additional problems have been occasioned by virtue of the fact that most of the prior-art devices have been substantially cumbersome and have had to be placed exteriorly of the slab being stressed prior to usage. The cumbersome nature of such devices has limited their flexibility and they have been precluded from being used internally in slabs or in cramped or otherwise limited quarters.

This invention overcomes the foregoing deficiencies of the prior art in that it provides a self-contained explosively operated tensioning device that can be embedded at any location along the length of a reinforcing tendon with the only external connections necessary being wiring for detonating the explosive means. A minimum of auxiliary equipment is needed for using the tensioning means of this invention and the entire construction is economical to manufacture and operate. Moreover, the device can be placed in any desired location or locations in a slab so as to enable placing the slab in compression in the optimum manner to provide the greatest strength possible.

SUMMARY OF THE INVENTION

It is the primary object of this invention to provide a new and improved tendon-tensioning means.

Obtainment of the primary object of this invention is enabled through the provision of a tensioning member in the form of a cylindrical outer barrel member which is embedded in the slab to be reinforced with the tendon extending axially through the outer barrel member. The interior of the barrel is provided with a tendon-gripping means which is attached to the tendon. The tendon is anchored a distance from the tensioning means and an explosive charge within the tensioning means acts through a shock-absorbing body of soft metal to urge the tendon-gripping means outwardly to place the tendon in a tensioned condition. A plurality of conical discs on the interior of the barrel are provided for engaging serrations on the barrel interior to prevent the tendon from returning to its original position following tensioning thereof.

Unique versatility is attained by the instant invention in that it can be placed anywhere in the slab to be reinforced and is operable solely by means of small detonating wires connected to the explosive means. Moreover, a plurality of the individual devices of this invention can be placed along the length of a single tendon to tension the tendon in its entirety by simultaneous actuation of all of the individual tensioning means. Additional versatility is obtained by virtue of the fact that two or more of the tensioning members forming the subject matter of this invention can be placed alongside each other in connection to a tendon for providing a large amount of tensioning force in circumstances in which one tensioning member would not provide adequate tensioning force.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the preferred embodiment as embedded in a concrete slab with a portion of the slab removed for clarity;

FIG. 2 is an exploded perspective view of the component parts of the preferred embodiment;

FIG. 3 is a sectional view taken along lines 3–3 of FIG. 1 illustrating the condition of the parts of the preferred embodiment prior to a tensioning operation;

FIG. 4 is a sectional view taken along the same lines as FIG. 3 but illustrating the condition of the parts following tensioning of the tendon member;

FIG. 5 is a sectional view taken along lines 5–5 of FIG. 3; and

FIG. 6 is a sectional view taken along lines 6–6 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is initially invited to FIG. 1 of the drawings which illustrates the preferred embodiment of this invention which is generally designated 20 and which is embedded in a body of concrete 22. A tensioning tendon or cable 24 contained within a sheathing member 26 extends through the body of concrete 22 and is anchored on one end in a conventional manner (not shown) and on its other end extends through the preferred embodiment. The purpose of the preferred embodiment is to exert a tensioning force outwardly from the concrete body in the direction of the arrow 27 as shown in the lower right corner of FIG. 1. The "outward" direction as used in the specification and claims is the direction out of the concrete as illustrated by arrow 27 whereas the "inward" direction is the opposite direction and is indicative of positioning inward into the body 22. Forces in direction of the arrow 27 in FIG. 1 will serve to tension the cable 24 by virtue of the fact that the opposite (inward) end of the cable is anchored and will consequently serve to place the concrete body 22 in a state of compression to provide resultant strength for the concrete body in a well-known manner.

Turning now to FIGS. 2 and 3, it will be seen that the preferred embodiment comprises an outer casing in the form of a hollow outer barrel member 28 of cylindrical configuration having a radially extending peripheral exterior flange 30 on its outward or exterior end and extending inwardly into the concrete body 22 with an end cap 32 being threadably received on its innermost end as shown in FIG. 3. End cap 32 is provided with an axial aperture 33 communicating with sheathing 26 as is shown in FIG. 3.

Tendon 24 extends through aperture 33 in end cap 32 into the interior of the outer barrel 28 and extends completely through the outer barrel along the axis thereof. A hollow guide member 34 (FIG. 2) consisting of a tendon guide tube 36 and a radially extending base flange 38 is mounted on the interior of the outer barrel 28 with the base flange having an inward or bottom face engaging the interior surface of the end cap 32. A circular groove 40 (FIG. 2) is provided on the other face of flange 38 for the purpose of receiving a donut-shaped explosive charge 42. A pair of detonating wires 44 are connected to the explosive charge and extend outwardly from the tensioning means to a conventional detonating device.

An inner barrel 46 is matingly received within the outer barrel 38 and is provided with a radially extending end flange 48 which is clamped against the end of the outer barrel by means of end cap 32 in an obvious manner so as to retain the inner barrel 46 in a fixed position therein. The interior surface of the inner barrel 46 is serrated with horizontal grooves 50 along its entire extent as best shown in FIGS. 2 and 4.

A steel thrust block 52 having a central axial aperture encircling the tendon guide tube 36 and a circular groove 54 on its inward end for receiving the upper half of the donut-shaped explosive charge 42 is supported on the upper or outward surface of flange 38 to receive the full force of the explosive charge upon detonation of the charge. It should be noted that the steel thrust block 52 is provided with a peripheral skirt 56 which will be distended radially outward by detonation of the

explosive charge **42** to engage the grooves **50** for a purpose to be discussed hereafter. A plurality of conical discs **60** are mounted immediately above the upper surface of the thrust block **52** and are provided with a plurality of radial slots **62** as best shown in FIG. **2**. Radial slots **62** divide the periphery of each of the discs **60** into a plurality of radial fingers as shown in FIG. **2**. The ends of the radial fingers are in an engagement with the serrated surface formed by grooves **50** on the interior of the inner barrel **46**.

A cylindrical steel plunger ring **64** has a central aperture fitted over the exterior of the guide tube **36** and has its innermost end engaging the outermost one of discs **60**. Cushioning means in the form of a block of soft metal **66** is provided immediately adjacent the outer side of the steel plunger ring **64** and is also of cylindrical configuration with a central aperture surrounding the guide tube **36**. Cushioning block **66** is preferably formed of lead or zinc which is easily deformable when subjected to high pressure. The outer end of cushioning block **66** is immediately adjacent the inside surface of a drive block **68** which is concentrically fitted within the interior of the outer end of the outer barrel **28** as shown in FIG. **3**. The interior of drive block **68** is provided with an axially concentric conical surface **70** (FIG. **2**) into which is received a composite wedge clamp member **72** the purpose of which is to clamp tendon **24** for cushioning. Wedge clamp **72** comprises a plurality of individual wedge members **74** which are fitted together to form a tapered bottom portion matingly received in conical surface **70** and disclike base **75** separated from the conical bottom portion by a peripheral circular groove **76** in which a spring clip **77** is received for maintaining the wedge members **74** in fixed relation to each other. The inner edges of wedge members **74** directly grasp the exterior of tendon **24** and outward movement of the drive block **68** will tend to press the individual radial wedge members **74** inwardly to provide a high gripping force on tendon **24**. Additionally, a metal cover cap **80** is provided to fit over base **75** formed of the plural wedge clamps **74** and is retained in place by a metal clip **82** the main purpose of which is to maintain the parts and the association illustrated in FIG. **3** prior to the detonation of explosive means **42**. It should be kept in mind that the preferred embodiment can be employed in any vertical orientation, and it would be quite possible that the entire device might be inverted so that the members **80** and **82** would be beneath the rest of the structure.

The manner in which the preferred embodiment operates will now be discussed with initial reference being made to FIG. **3** which illustrates the condition of the device prior to detonation of explosive means **42**. Upon detonation of the explosive **42**, the resultant gases serve to drive the steel thrust block **52** upwardly from the position illustrated in FIG. **3** to the position illustrated in FIG. **4**. The force of the explosion also tends to drive skirt **56** radially outward into engagement with the grooves **50** for retaining block **52** in the position shown in FIG. **4**. Additionally, the upward movement of the thrust block **52** causes the discs **60** and plunger ring **64** to be rapidly moved outwardly so that the plunger **64** acts on the soft metal of cushioning block **66** to exert force upwardly and outwardly above the uppermost end of the inner barrel **46**. The pressure of the soft metal of cushioning block **66** causes drive block **68** to be urged upwardly which, in turn, creates great force on the wedges **74** to forcefully clamp tendon **24** and consequently move the tendon outwardly in the direction of the arrows **27** in FIGS. **1** and **4**. However, it is necessary that the tendon be retained in the position shown in FIG. **4** following its positioning therein and prevented from being returned to the FIG. **3** position by virtue of its internal tension. Means for retaining the tendon in the position illustrated in FIG. **4** constitute the discs **60** and the peripheral skirt **56** on thrust block **52**. It should be noted that the explosion of explosive means **42** tends to distort the peripheral skirt **56** outwardly into engagement with grooves **50** and that the geometric shape of discs **60** similarly cause their outer periphery in the form of the radial fingers to enter the grooves **50**. The configuration of discs **60** and skirt **56** is such that they can be moved outwardly without undue effort; however, they resist inward movement. Consequently, it is impossible for the tendon to return from its FIG. **4** position to the original FIG. **3** position. While the guide tube **36** is shown as being relatively thick, it should also be understood that this tube could be made with a thinner wall so that the inner surface of the axial apertures of discs **60** could force the wall of **36** inwardly to provide additional gripping force on tendon **24**.

It should be noted that any number of the tendon-tensioning devices could be employed and detonated simultaneously or in any desired sequence. Moreover, it should also be noted that a hollow end cap could be provided over the movable external end elements **82**, **80**, etc. in order that the entire construction could be completely embedded within a concrete body. Several of the tensioning devices might well be employed along the length of a single tendon of substantial length in order that complete tensioning could be obtained. The devices might be closely adjacent each other or they might be spaced equidistantly along such a tendon. Numerous other variations of employment of the preferred embodiment will be obvious to those skilled in the art and it should be understood that the manner of using the preferred embodiment should not be limited to the aforementioned possibilities.

While the discs **60** and peripheral skirt **56** normally provide adequate means for retaining the device in the position shown in FIG. **4**, it might be desirable in some instances to provide a tube or conduit communicating with the innermost end of the inner barrel in order that liquid concrete can be supplied to the void space **84** (FIG. **4**) created by the displacement of steel thrust block **52** by the explosive charge **42**. Upon hardening of such concrete, it would be absolutely impossible for the tendon to return to its original FIG. **3** position.

While the preferred embodiment of this invention is directed to a tendon-tensioning means for use with concrete reinforcing tendons, it should be understood that the invention can also be employed for tightening tendons employed in other environmental locations. For example, the subject invention could be employed for connecting sections of very large flanged pipe together.

I claim:

1. An explosive tendon-tensioning means for tensioning a concrete reinforcing tendon anchored on one end to a body of concrete and having a free end extending through the body of concrete, said tensioning means comprising hollow outer barrel means having an inward end and an outward end and being embedded in said concrete, with said free end of said tendon extending into said inward end of said hollow outer barrel means, tendon-gripping means within said hollow outer barrel, explosive means within said hollow barrel for exerting a substantial force on said tendon-gripping means for driving said tendon-gripping means outwardly into a tensioned condition and retaining means for retaining said tendon means in tensioned condition following the tensioning thereof by said explosive means.

2. The invention of claim **1** additionally including shock-absorbing means between said explosive means and said tendon-gripping means for cushioning the force imparted to said tendon-gripping means and said tendon by said explosive means.

3. The invention of claim **2** wherein said shock-absorbing means comprises a body of soft deformable metal.

4. The invention of claim **3** wherein said outer barrel means comprises a main cylinder member concentrically oriented with respect to said tendon and having an end cap connected to and covering the inward end of said main cylinder which faces inwardly into said body of concrete with said end cap having an aperture through which said tendon member extends from said body of concrete.

5. The invention of claim **4** wherein said retaining means includes a plurality of radially apertured discs each of which is in peripheral engagement with a serrated surface on the interior of a cylindrical inner barrel fixedly connected in concentric manner to said main cylinder and has an axial aperture

received over the outer surface of an axially positioned tendon guide member of hollow cylindrical configuration having an axial aperture concentrically oriented with respect to said main cylinder through which said tendon extends with said apertured discs being of generally conical configuration so that said discs are easily moved in a first direction by said explosive means as said tendon means is being tensioned but being prevented from movement in an opposite direction by the engagement of its periphery with said serrated surface.

6. The invention of claim **5** wherein said tendon-gripping means includes a conical segmented wedge clamp member matingly received within a conical opening in a drive block having an inward side and an outward side which is concentrically fitted within the hollow outer barrel with said conical segmented wedge clamp member being defined by a plurality of radially oriented wedge members which are urged toward said tendon by outward movement of said drive block to grip said tendon which extends through an axial passageway in said segmented wedge clamp member.

7. The invention of claim **6** wherein said tendon guide member includes a radial base flange having an inward face and an outward face with the inward face abutting against the inward side of said end cap and an axially aligned guide tube extending a substantial distance outwardly from said base flange coaxially with respect to said outer barrel means and having an axial passageway through which said tendon extends and wherein said explosive means is located adjacent the outward face of said base flange and additionally including a thrust block with an inward face and an outer face encircling said guide tube with its inward face adjacent said explosive means and having a periphery matchingly received within said inner barrel with the innermost one of said apertured discs being mounted adjacent the outer face of said thrust block, a plunger ring encircling said tubular guide adjacent the outermost one of said discs and having an inward face and an outward face with its outward face engaging said body of soft deformable metal with said body of soft deformable metal encircling said guide tube adjacent the outward side of said plunger ring and engages said drive block on its inward side.

8. The invention of claim **1** wherein said tendon-gripping means includes a conical segmented wedge clamp member matingly received within a conical opening in a drive block having an inward side and an outward side which is concentrically fitted within the hollow outer barrel with said conical segmented wedge clamp member being defined by a plurality of radially oriented wedge members which are urged toward said tendon by outward movement of said drive block to grip said tendon which extends through an axial passageway in said segmented wedge clamp member.

9. The invention of claim **8** wherein said outer barrel means comprises a main cylinder member concentrically oriented with respect to said tendon and having an end cap connected to and covering the inward end of said main cylinder member which faces inwardly into said body of concrete with said end cap having an aperture through which said tendon member extends from said body of concrete.

10. The invention of claim **9** wherein said retaining means includes a plurality of radially apertured discs each of which is in peripheral engagement with a serrated surface on the interior of a cylindrical inner barrel fixedly connected in concentric manner to said main cylinder and has an axial aperture received over the outer surface of an axially positioned tendon guide member of hollow cylindrical configuration having an axial aperture concentrically oriented with respect to said main cylinder through which said tendon extends with said apertured discs being of generally conical configuration so that said discs are easily moved in a first direction by said explosive means as said tendon means is being tensioned but being prevented from movement in an opposite direction by the engagement of its periphery with said serrated surface.