Sept. 3, 1968 W. F. KELLY 3,399,434

ANCHORS FOR STRESSED CABLES

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FIG. 1A.

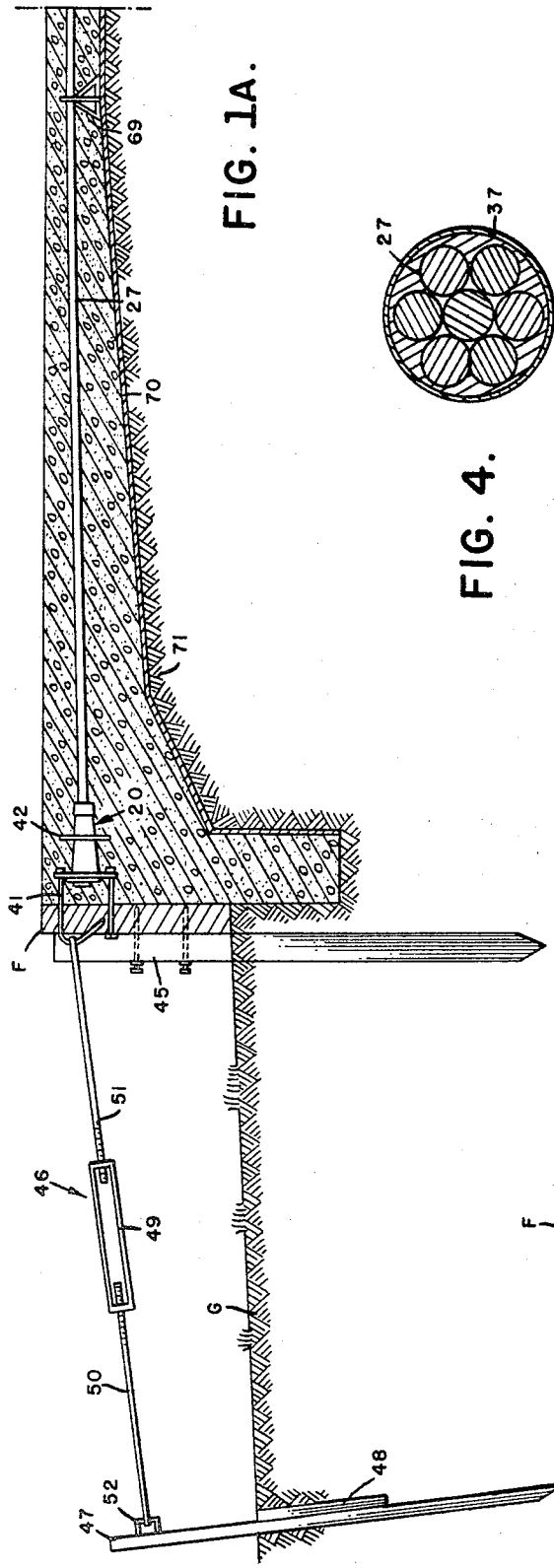
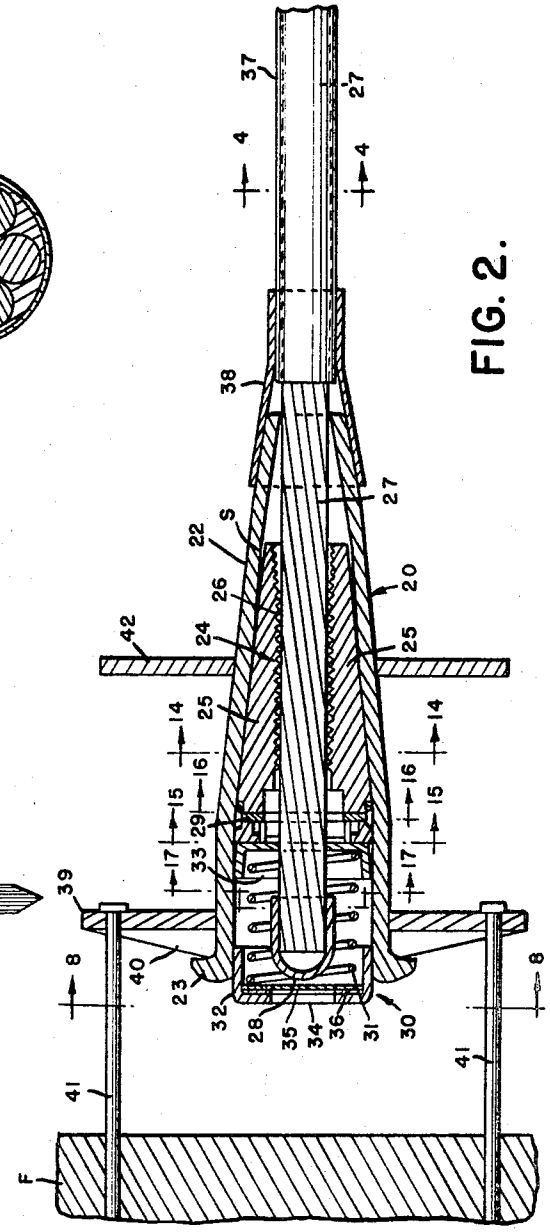


FIG. 4.

FIG. 2.



INVENTOR
WILLIAM F. KELLY

BY Garvey & Garvey
ATTORNEYS

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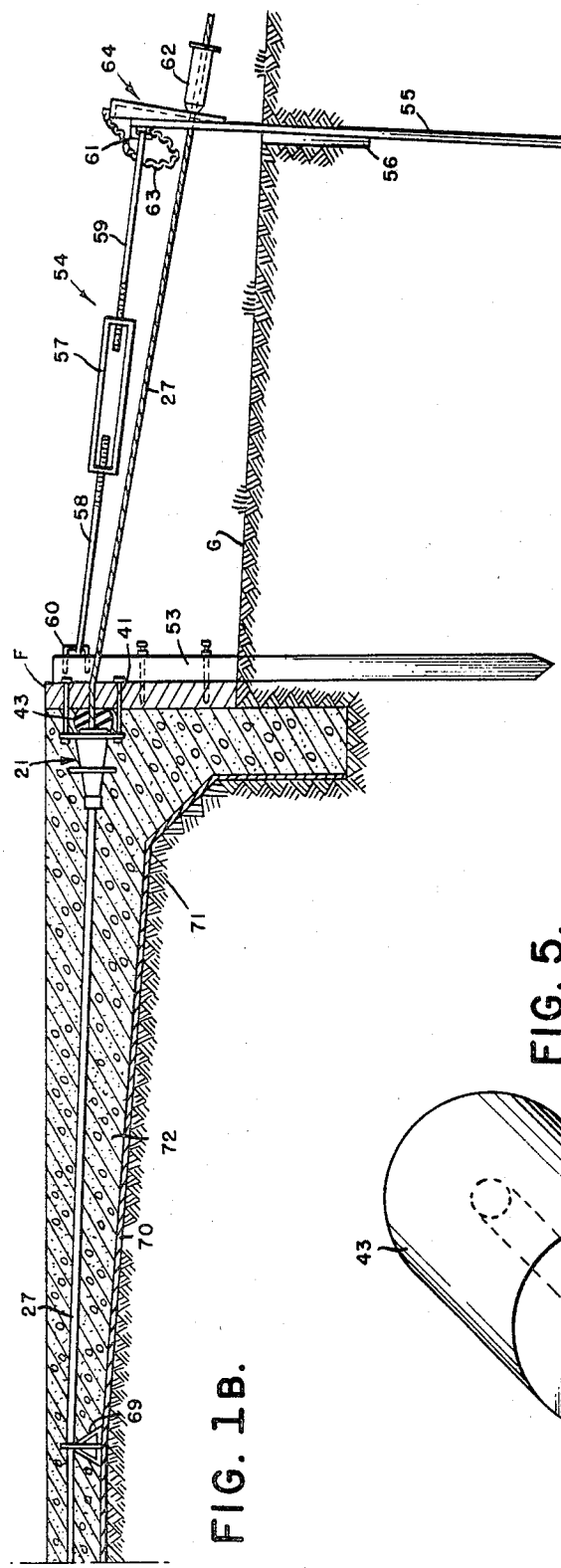


FIG. 1B.

FIG. 5.

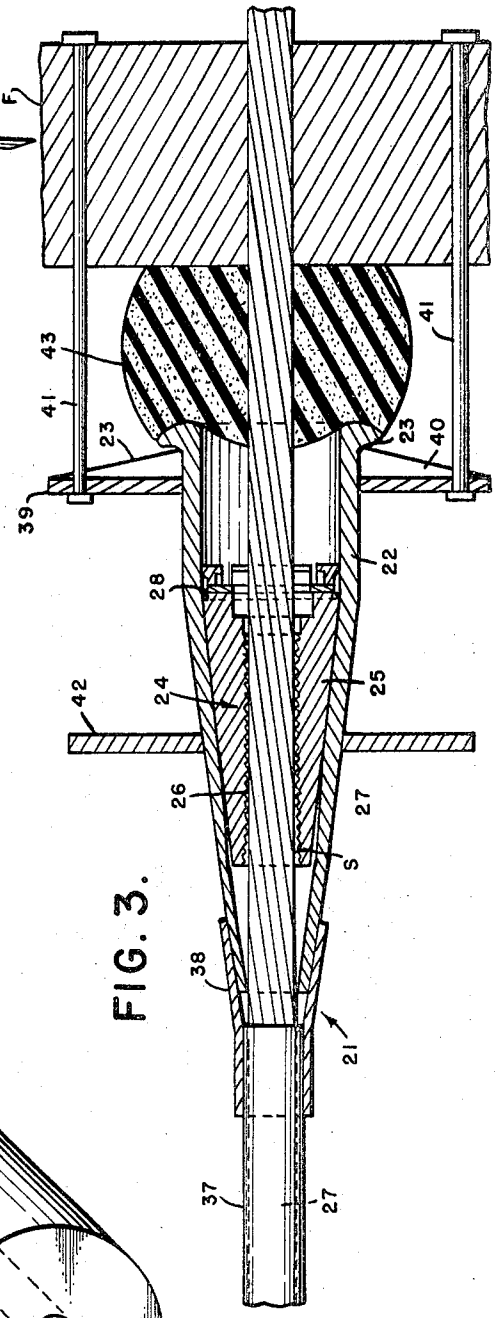


FIG. 3.

INVENTOR
WILLIAM F. KELLY

BY Garvey & Garvey
ATTORNEYS

Sept. 3, 1968 W. F. KELLY 3,399,434

ANCHORS FOR STRESSED CABLES

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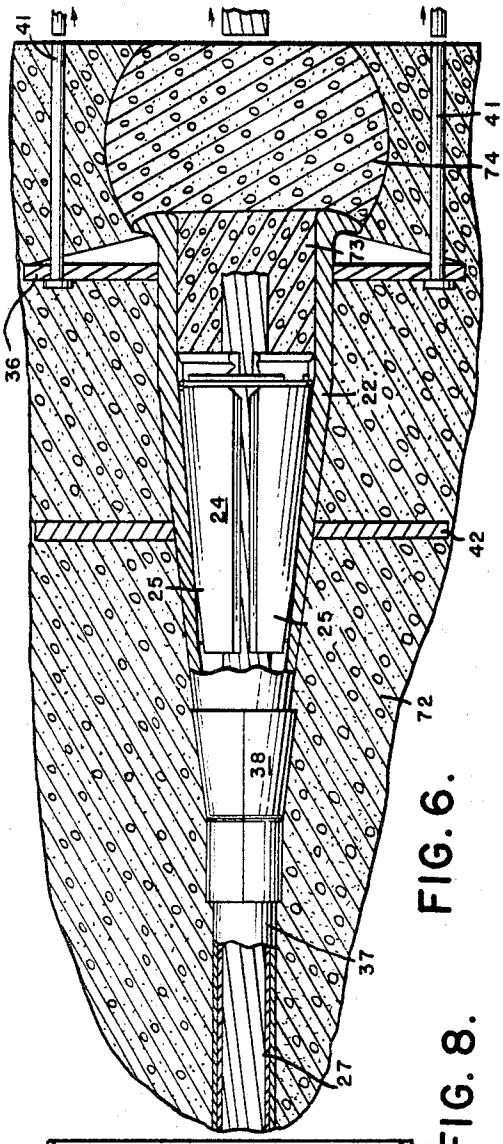


FIG. 6.

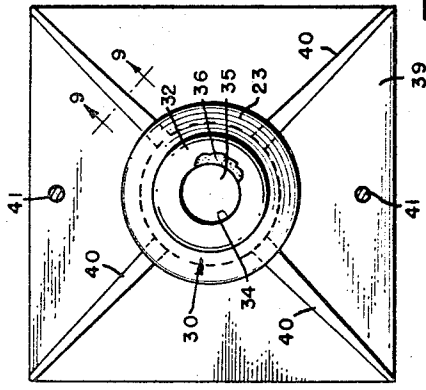


FIG. 8.



FIG. 9.

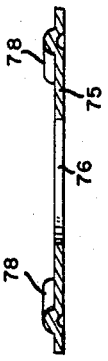


FIG. 11.

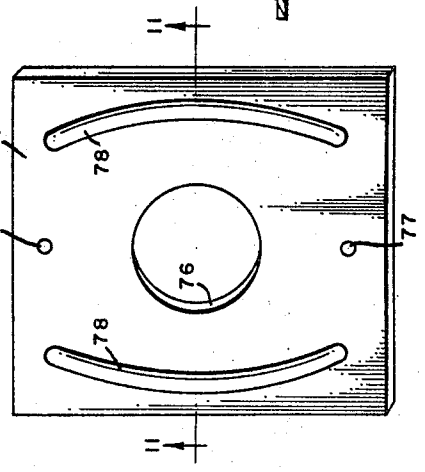


FIG. 10.

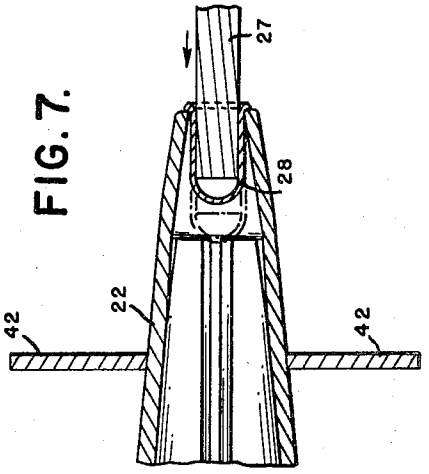


FIG. 7.

INVENTOR
WILLIAM F. KELLY

BY Garvey & Garvey
ATTORNEYS

Sept. 3, 1968 W. F. KELLY 3,399,434

ANCHORS FOR STRESSED CABLES

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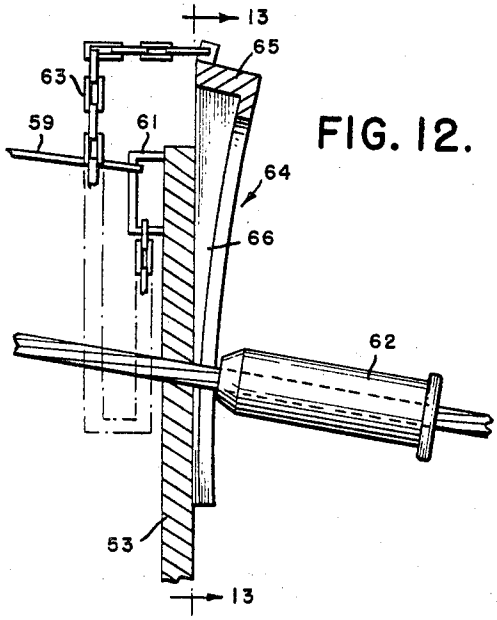


FIG. 12.

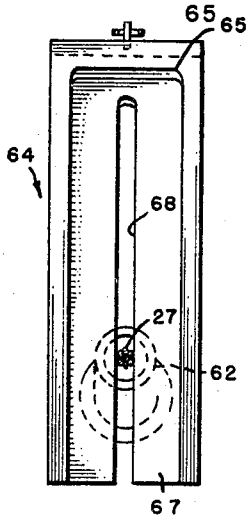


FIG. 13.

FIG. 14.

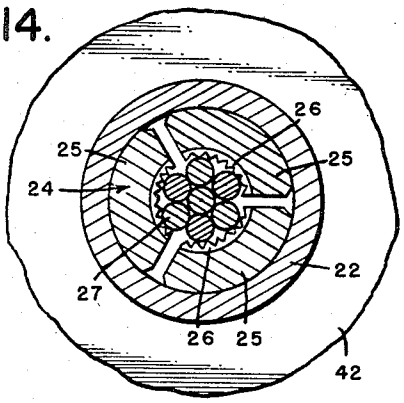
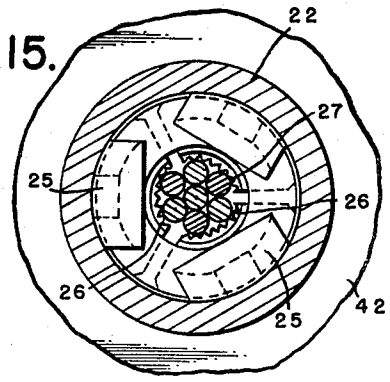


FIG. 15.



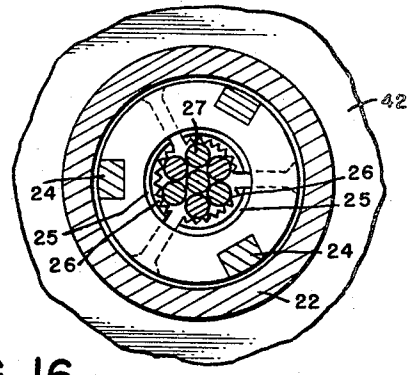


FIG. 16.

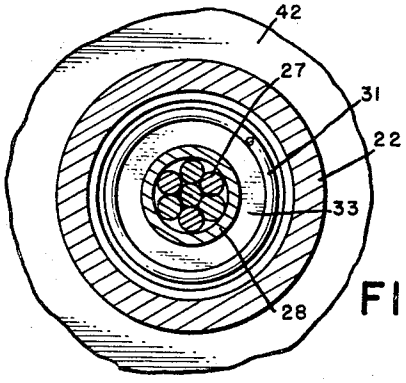


FIG. 17.

INVENTOR
WILLIAM F. KELLY

BY Garvey & Garvey
ATTORNEYS

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3,399,434

ANCHORS FOR STRESSED CABLES

William F. Kelly, 100 Bellaire Drive,
New Orleans, La. 70124

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11 Claims. (Cl. 24—126)

ABSTRACT OF THE DISCLOSURE

A process and apparatus for post-tensioning prestressed concrete including placing opposed forms in the area to be concreted, securing a dead end anchor to one form and a live end anchor to the opposite form, securing a terminal of a tensioning member in the dead end anchor, passing the other end of the member through the live end anchor and through the form, exerting a pulling pressure on the member to lightly pretension the latter for holding the same in proper position when concrete is poured, and pouring concrete into the area between the forms to embed the anchors and members therein, the anchors including a tapered case, a complemental gripping jaw assembly slidably mounted in the case, the inner wall of the jaw assembly being toothed for surface engagement with a tensioning member passing therebetween, and spaced reaction plates secured to the outer periphery of the tapered case, the dead end anchor further including a closure cap frictionally engaged in the tapered case and having a window therein for viewing the position of the tensioning member inserted into the case, and a helical spring positioned between the jaw assembly and closure cap, the live end anchor additionally including a compressible seal engaged with the outer end of the tapered case to prevent concrete from coming in contact with the jaw segments, the seal being readily removed to permit the tensioning member to be jacked through the cavity thus formed by the seal.

This invention is a process and apparatus for post-tensioning of prestressed concrete, which is especially adapted for use in the construction of poured-on-grade concrete slabs used in building structures, but susceptible of a variety of other uses.

An object of this invention is to provide a series of spaced tensioning assemblies, each assembly including a dead end anchor unit, secured to one end of a concrete form, and a live end anchor unit secured to an opposed form, the anchors being equipped with appurtenances for supporting and holding the terminals of a high-strength tensioning member, such as a cable or rod, which is stressed to a predetermined tautness before pouring the concrete, for post-tensioning the prestressed concrete, the appurtenances also including means positioned near each anchor and adjustably connected to the opposite ends of the member, the means including, inter alia, reaction plates embedded in the earth and supported by reaction stakes to complete the force couple through the earth.

Other objects are to provide a versatile anchor adaptable for use either as a dead end or live end anchor, the anchor having movable components which are positively retained within an exterior casing when transported to the place of use, the anchor in this form being employed as a dead end anchor; to provide an anchor of the character described, wherein the anchor is adapted for use as a live end anchor by the facile removal in situ, of a few inexpensive parts; and to provide a live end anchor wherein a sponge rubber seal is positioned between the outer end of the anchor and the form to prevent the flow of concrete interiorly of the anchor, thereby insuring free passage of the tensioning member through the live anchor, its seal, and the wood form, the sponge seal being readily removed after the concrete has set to permit caulking

compound to be inserted into the outer end of the anchor casing and a concrete plug placed in the cavity from which the seal has been removed.

Additional objects are to provide a process of the character described for prestressing tensioning members to a predetermined tautness before placement of concrete within the forms, the members being readily adaptable for the application of conventional jacking equipment to effect post-tensioning of the concrete, and to provide a system of the character described, wherein the anchors are disposed between the forms, thereby wholly embedding the anchors in the poured concrete and obviating removal of any portion of the anchors after the concrete has set and the forms removed.

Other objects of the invention will be manifest from the following description of the present preferred forms of the invention, taken in connection with the accompanying drawings, wherein:

FIG. 1A is a side elevational view of a dead end anchor engaged with one end of a stressing cable mounted in a concrete slab on grade between wooden forms and illustrating the adjustable assembly connected to an auxiliary anchor just outside the form;

FIG. 1B is a similar view of an anchor constructed in accordance with this invention and comprising the live anchor through which the tension cable is jacked and secured to the adjustable assembly that coacts with the adjustable assembly of the dead end anchor;

FIG. 2 is a longitudinal sectional view taken through the dead end anchor showing to advantage the manner of mounting one end of a prestressing cable therein;

FIG. 3 is a similar view taken through the live end anchor and illustrating the manner of mounting the other end of the prestressing cable therein;

FIG. 4 is a vertical sectional view taken along the lines **4—4** of FIG. 2, looking in the direction of the arrows;

FIG. 5 is a perspective view of the sponge rubber seal used between the outer end of the live anchor and the concrete form;

FIG. 6 is a longitudinal sectional view taken through the live end anchor after the concrete has set;

FIG. 7 is a detail fragmentary sectional view of the dead end anchor illustrating the manner of initiating movement of one terminal of the tensioning member thereinto;

FIG. 8 is a vertical sectional view taken along the lines **8—8** of FIG. 2, looking in the direction of the arrows and showing one end of the dead end anchor in elevation;

FIG. 9 is a cross sectional view taken along the lines **9—9** of FIG. 8, looking in the direction of the arrows, showing a reinforcing flute of the reaction plate;

FIG. 10 is an elevational view of a modified form of an anchor reaction plate;

FIG. 11 is a cross sectional view taken along the lines **11—11** of FIG. 10, looking in the direction of the arrows;

FIG. 12 is a fragmentary vertical sectional view of the adjustable tensioning means engaged with the live anchor;

FIG. 13 is a vertical sectional view taken along the lines **13—13** of FIG. 12;

FIG. 14 is a vertical sectional view taken along the lines **14—14** of FIG. 2, looking in the direction of the arrows;

FIG. 15 is a similar view taken along the lines **15—15** of FIG. 2;

FIG. 16 is also a vertical sectional view taken along the lines **16—16** of FIG. 2, looking in the direction of the arrows; and

FIG. 17 is a similar view taken along the lines **17—17** of FIG. 2, looking in the direction of the arrows.

The process and apparatus of this invention is here shown reduced to practice for post-tensioning a prestressed, poured-on-grade concrete slab, but is susceptible

of use for any purpose to which an anchor for post-tensioning prestressed concrete can be applied. In FIGS. 1A and 1B, a pair of anchors are illustrated. The dead end anchor assembly, generally designated **20**, is shown in FIGS. 1A and 2, and the live anchor assembly, generally designated **21**, is shown in FIGS. 1B and 3. In accordance with the present invention, the dead end and live end anchors are of the same basic manufacture, including a tapering case **22** of generally frustro-conical shape, preferably of coldpress extruded steel, having a flange **23** on the larger end. A jaw assembly **24** complements and is slidably mounted in each case **22** and is preferably composed of three arcuate elongated tapering segments **25**. The inner wall of each jaw segment is toothed, as shown at **26**. The extreme inner ends of the walls of each segment terminates in a smooth flared mouth for facile introduction of a cable or other suitable tensioning member **27** thereinto after the latter has passed through the inner, reduced end of the case **22**. A movable thimble-like finder **28** at the smaller terminal of tapered case **22** is adapted to receive an end of cable **27** and is movable therewith, to insure passage thereof completely through jaw assembly **24**. Jaw segments **25** are retained together by a resilient band **29**.

Dead end anchor **20**, in addition to including case **22** and jaw assembly **24**, also comprises a closure and jaw-retention assembly **30**, shown to advantage in FIG. 2. This assembly is secured in the outer end of case **22**, and embodies a helical spring **31** mounted between a closure cap **32** and a cup **33**, the latter being contiguous with the outer ends of the jaw segments to exert continuous pressure thereon. Cap **32** is preferably of cup-shape, the flanged edges of which are adapted for frictional engagement with the inner peripheral wall of case **22**. Cap **32** is further provided with a central opening **34** which is covered by a translucent window **35** of clear plastic or like material inside the cap, an annular seal **36** being interposed between the cap and window. This arrangement permits visual inspection to determine that tensioning member **27** has been properly inserted into the anchor, as shown in FIG. 2. Cap **32** additionally prevents the passage of concrete interiorly of the anchor.

The apparatus of the present invention is further provided with means for permitting free movement of the tensioning member within the concrete after it has hardened. For this purpose, the surface of the member may be greased and encased in a vinyl jacket **37**, the extremity of the jacket being covered by a sleeve **38** of masking tape or the like, which also overlaps the inner end of tapering case **22**, as advantageously shown in FIGS. 2 and 3. This prevents passage of concrete into the case.

For carrying out the objects of the present invention, a reaction plate **39**, which may be of square configuration, is centrally press fitted or secured in any other suitable fashion to the outer periphery of case **22** adjacent flange **23**. A plurality of radial flutes on the plate are indicated at **40**. Case **22** is held in spaced connection with concrete form F through the medium of nails **41** which extend through openings in plate **39**. Case **22** is also provided with a hoop stress restraining washer **42**, which is fixed to the outer periphery of the case at a point intermediate its length. This washer obviates the need for using a larger and heavier steel case on jobs requiring a tensioning member of larger diameter, and also serves as an additional reaction plate.

It is a salient feature of the present invention to construct the anchor in such a manner that none of teeth **26** will engage tensioning member **27** with sufficient pressure to cut the same or, in the case of cable, to sever a strand or strands. For carrying out this purpose, case **22** and jaw assembly **24** are so constructed that a space S is provided between the lower outer periphery of jaw segments **25** and the adjacent inner periphery of case **22**. Therefore, when a tensioning force is exerted on member **27**, the forward portions of segments **25** are flexed outwardly in space S so that forward teeth **26** either do not engage, or engage lightly, the tensioning member. (See FIG. 2.) This results in a more uniform application of pressure by the remainder of teeth **26** on member **27** without damage to the latter and makes the theoretical triangular stress take-up distribution an actuality rather than purely theoretical. The angle through which the forward portion of the jaw assembly moves will vary from one application to another.

The manufactured anchors above-described may be transported to a building site or other locale where the anchors are to be used, and a plurality thereof secured in spaced relation to concrete form F to serve as dead end anchors, as shown in FIG. 2.

To adapt the anchor for use as a live end anchor, cap **32**, spring **31** and cup **33** are removed, removal being readily effected by forcing tensioning member **27** through jaw assembly **24** against cap **32**. The live end anchor, shown to advantage in FIG. 3, therefore, omits structure in the outer end of case **22** beyond the jaw assembly, leaving member **27** free to pass through and beyond said assembly, case **22** and form F. To prevent concrete from flowing through the open end of the case to the jaw assembly, a seal **43**, preferably of sponge rubber, is compressed between flange **23** at the outer end of case **22** and form F. It will be noted upon reference to FIG. 3, that a portion of seal **43** extends into the open outer end of case **22** and has a cable-access opening **44** extending axially therethrough.

As shown in FIGS. 1A and 1B, forms F are held in place by anchoring stakes **45** which are driven into the ground. It will also be noted from these figures that member **27** spans the distance between opposed forms F, said member being secured in dead end anchor **20**. Anchor **20** is also adjustably connected to reaction means **46** comprising a steel reaction stake **47** and a steel reaction plate **48**, the latter being completely embedded in the ground G and secured to stake **47** which is driven into the ground at an angle, as shown in FIG. 1A. Adjustment of tension on dead end anchor **20** is effected by a turnbuckle **49** threadedly connected to rods **50** and **51**. The free terminal of rod **50** is secured to a hook **52** fixed to stake **47** and the free terminal of rod **51** is engaged with a bent portion of a nail **41** connected to dead end anchor **20**.

The form holding the live end anchor is in turn supported by a stake **53** driven into the ground G, to which reaction means **54** are connected. Reaction means **54** includes a steel stake **55** engaged with a reaction plate **56** which is completely embedded in the ground. Adjustment of tension is effected by a turnbuckle **57** threadedly connected to rods **58** and **59**. The free terminal of rod **58** is secured to a hook **60** fixed to stake **53** and the free terminal of rod **59** is engaged with a hook **61** carried by stake **55**.

In connection with stake **55**, there is provided means for pretensioning tensioning member **27** in accordance with one of the objects of the present invention. This means includes a pretension anchor **62** of conventional type which is initially engaged with tensioning member **27** at the locus of stake **49**, after the cable has been drawn tight, manually. A pretensioning wedge **64** is permanently connected to stake hook **61** by a chain **63**. As shown in FIGS. 12 and 13, pretensioning wedge **64** is preferably of longitudinally dished formation and includes a top wall **65**, tapering side walls **66** and a sloping end wall **67**. End wall **67** is provided with a center longitudinal recess **68** extending from the lower terminal thereof to a point proximate the upper limit of the wedge, which recess is adapted for the reception of member **27** in the manner shown in FIGS. 12 and 13. By inserting wedge **64** between stationary stake **55** and pretension anchor **62**, thereby forcing member **27** into longitudinal recess **68**, movement of the member occurs in a direction to effect tightening of the latter until the desired tautness or prestressing is obtained. Stake **47** and its reaction plate **48**

is the final terminal point of the pretensioning forces which is put on the tensioning member prior to its encasement in the concrete slab. The dead end anchor and its appurtenances, which have been generally designated **20**, fixes the static or non-jacking end of the post tensioning cable and transmits the post tensioning stress to the concrete, after final tensioning, converting the structure to a post tensioned, prestressed concrete structure. The greased tensioning member and vinyl covering permits the member to, in effect, float free in the concrete, after it has hardened, to successfully post-tension the prestressed concrete slab. The excess cable or rod projecting beyond the live anchor is relieved of its vinyl jacket and grease, as their functions have been accomplished.

In use, one end of member **27** is inserted into dead end anchor **20** and pushed therethrough until finder **28** engages cap **32**. Upon exerting pull on tensioning member **27**, teeth **26** of each segment of jaw assembly **24** engages member **27** and uniform pressure is applied to a substantial portion of the outer periphery of member **27**. Dead end anchor **20** is then secured to form F by nail members **41**. Reaction means **46** is then connected to one of nail members **41**, as illustrated in FIG. 1A. Intermediate portions of the cable are then engaged with conventional chairs **69** positioned subjacent the cable on a Visqueen membrane or the like **70**, spread over compacted fill **71**. This controls the loop effect of member **27** between the forms F.

The free terminal of tensioning member **27** is then trained through live anchor **21**, sponge rubber seal **43** and form F, the anchor being secured in spaced relation to form F by nails **41**. After the member is manually drawn tight, it is released and held in place by virtue of the engagement of teeth **26** of jaw segments **25** with the outer periphery of the cable in the same manner as at the dead anchor end. Member **27**, beyond form F is drawn through stake **53** which is, in turn, connected to form F as shown in FIG. 1B. Pretension anchor **62** is next applied to member **27**, at the point where it passes through stake **55**. Initial pretensioning of cable **27** between the forms is then effected by driving wedge **64** between anchor **62** and stake **55**, thereby taking up any slack in cable **27** between the forms and assuring proper positioning and tightening of the member. It has been found that by driving wedge **64** between anchor **62** and stake **55**, that a pull on tensioning member **27** of approximately 500 to 750 pounds is developed, which is sufficient for the purposes of the present invention.

After the cable has been initially pretensioned, concrete **72** is poured and permitted to harden. Before post-tensioning, forms F and sponge rubber seal **43** are removed and after post-tensioning of the member with jacking equipment, terminals of nails **41** and end portion of member **27** beyond live end anchor **21** are removed. A caulking compound **73** is then inserted into case **22** between jaw assembly **24** and the terminal of the casing. Concrete **74** is next placed in the cavity from which seal **43** has been removed to form a concrete plug extending to the limit of concrete **72**. It will be noted from FIG. 6, that by virtue of the conformation of the cavity and of plug **74**, accidental displacement of the plug is obviated.

In FIGS. 10 and 11, there is shown a modified form of reaction plate shown in FIG. 8, which modified form is designated **75** and includes a central opening **76** for mounting on case **22** and nail openings **77**. In this form of reaction plate there are provided opposed arcuate reinforcing ribs **78** extending through a substantial portion of the reaction plate, the ribs being preferably pressed from the body portion of the plate as shown to advantage in FIG. 11.

There has been herein shown and described a single cable adapted for connection to the anchor of the present invention and it is to be understood that where multiple steel cables are employed in close relationship, these cables may extend through clusters of anchors made in accordance with the present invention.

While preferred embodiments of the present invention have been shown and described, it is nevertheless to be understood that various changes may be made therein, without departing from the spirit and scope of the claims hereto appended.

What is claimed is:

1. In a forming and reinforcing apparatus, an anchor for fastening a stressed cable to a body of set concrete, said anchor comprising an elongated, tubular metallic case impervious to the passage of moisture through the walls thereof, said case tapering in diameter from a large end to a small end, the small end being adapted to receive said cable, a sealer member encircling the smaller end of said case and having a portion extending beyond the end thereof, said sealer member being in sealing relationship with said smaller end and the extending portion being adapted to sealingly engage a sleeve on said cable, a complemental gripping jaw assembly slidably mounted in said case, said assembly comprising at least a pair of jaw segments having a bore extending therethrough, said bore being co-axially aligned with the axis of said case, flexible means maintaining the jaw segments in assembled relationship, said jaw assembly being spaced inwardly of both ends of said case, an anchoring and fastening flange frictionally engaging the outer periphery of said case, said anchoring and fastening flange including a series of apertures therethrough, sealing means engaging the large end of said case, said means being in sealing engagement with the large end and spaced from said jaw assembly thereby preventing the ingress of moisture and unset concrete into said space within said case through said large end.

2. The anchor of claim **1**, wherein the sealing means engaging the large end of said case comprises a cylindrical member of a flexible, compressible material having an axial bore through which the cable passes, said cylindrical member being compressed against the large end of the tapered case to effect sealing engagement with the large end of said case and with the cable extending through the axial bore of said case.

3. The anchor of claim **1**, wherein the sealing means comprises a closure cap engaged with the large end of said tapered case.

4. The anchor of claim **3**, wherein said closure cap is provided with a central opening forming a window and a translucent material covering the central opening of said closure cap, for viewing the position of a tensioning member inserted into the case and preventing the ingress of moisture and unset concrete into the case.

5. In a forming and reinforcing apparatus, an anchor for fastening a stressed cable to a body of set concrete, said anchor comprising a tapered case impervious to the passage of moisture through the walls thereof, said case tapering in diameter from a large end to a small end, the small end being adapted to receive the cable, a complemental gripping jaw assembly slidably mounted in said case, said jaw assembly including jaw segments, the inner walls of said jaw segments having means for grippingly engaging the cable passed therebetween, a closure cap engaged with the large end of the tapered case to prevent the ingress of moisture and concrete, the closure cap having a central opening forming a window, for viewing the position of a cable within the tapered case, a translucent material covering the opening for preventing passage of moisture and concrete through the opening, and a spring interposed between said jaw assembly and closure cap.

6. The anchor of claim **5**, wherein said closure cap is of substantially cup shape and includes a central portion which issues into flanged edges, said flanged edges being frictionally engaged with the inner peripheral wall of said case, said central portion being provided with an opening, and translucent moisture-impervious material covering the opening to prevent ingress of moisture or concrete into the tapered case.

7. The anchor of claim 5, with the addition of a movable thimble-like finder in the smaller end of said tapered case, said finder being adapted to receive the terminal of the cable inserted into the case.

8. The anchor of claim 5, with the addition of a sealer member encircling the smaller end of said tapered case and having a portion extending beyond the end thereof, said sealer member being in sealing relationship with said smaller end and the extending portion being adapted to sealingly engage a sleeve on said cable.

9. The anchor of claim 5, with the addition of a reaction plate secured to the outer periphery of said tapered case intermediate its length, and reinforcing means extending through a substantial portion of said reaction plate.

10. The anchor of claim 9, wherein said reinforcing means comprise flutes radiating outwardly from the outer periphery of said tapered case.

11. The anchor of claim 9, wherein said reinforcing means comprise opposed arcuate reinforcing ribs.

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HENRY C. SUTHERLAND, *Primary Examiner.*