Feb. 18, 1969 G. W. WILLIAMS 3,427,772

APPARATUS FOR POST-TENSIONING AND INTERCONNECTING RE-ENFORCING WIRES USING KEY HOLE ANCHOR PLATES IN A CONCRETE STRUCTURE

Filed Sept. 6, 1966 Sheet 1 of 2

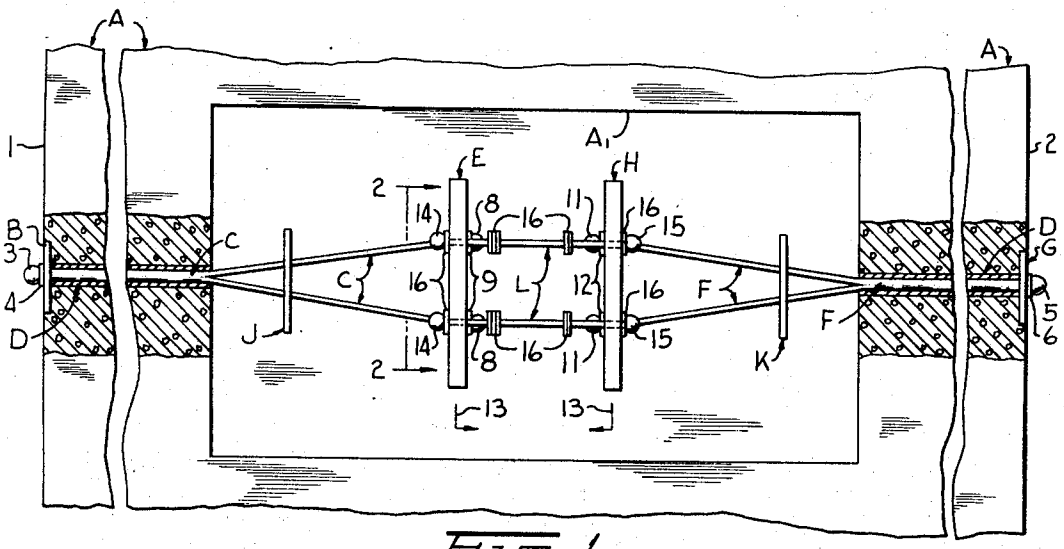

FIG. 1

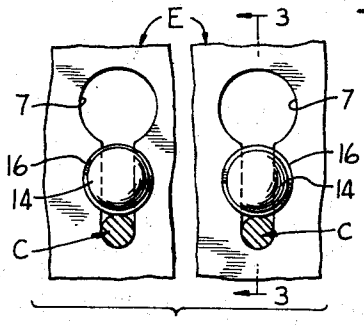

FIG. 2

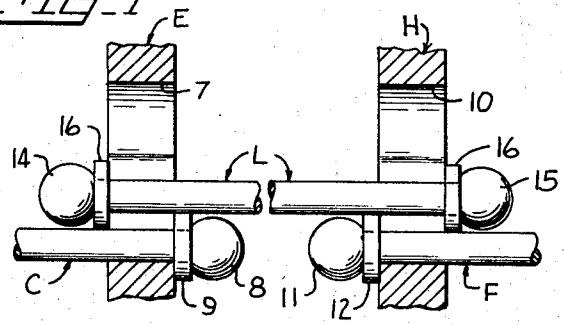

FIG. 3

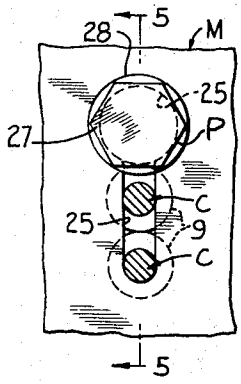

FIG. 4

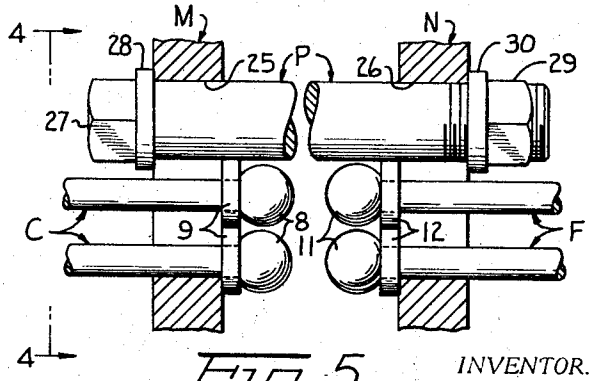

FIG. 5

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Sheet 2 of 8

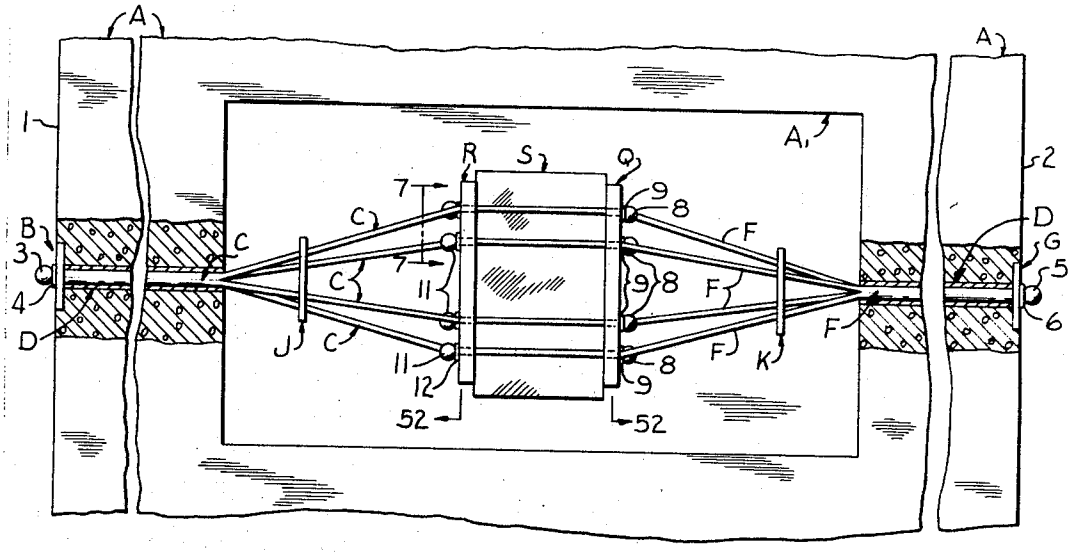

FIG. 6

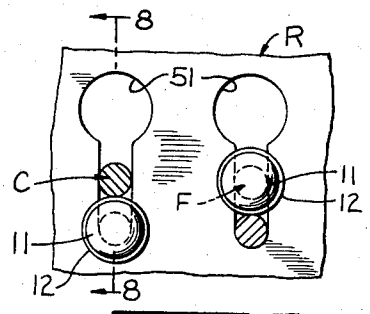

FIG. 7

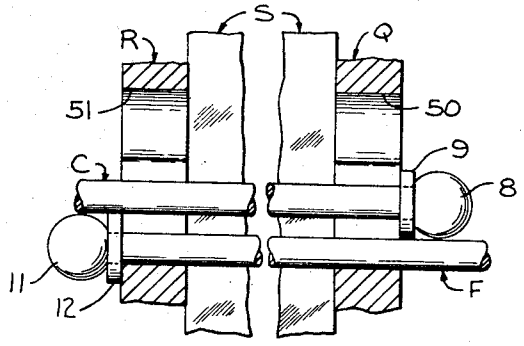

FIG. 8

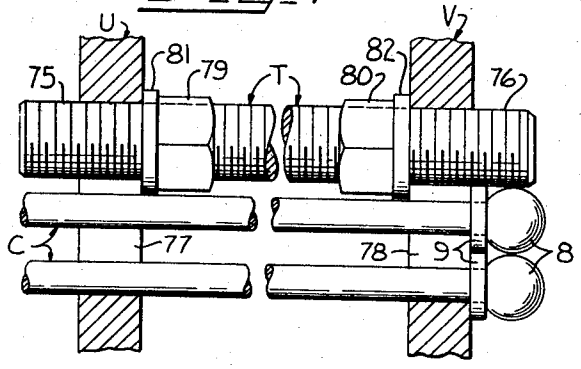

FIG. 9

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APPARATUS FOR POST-TENSIONING AND INTERCONNECTING RE-ENFORCING WIRES USING KEY HOLE ANCHOR PLATES IN A CONCRETE STRUCTURE

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Int. Cl. E04c 3/10, 3/26, 5/12

ABSTRACT OF THE DISCLOSURE

An apparatus and method for post-tensioning a concrete structure where the post-tensioning wires extend in opposite directions and in substantial alignment with each other from a central recess in the structure and have their outer ends anchored to the opposite sides of the structure. The inner wire ends have heads that can be inserted into keyhole slots provided in spaced apart inner anchor plates and then the wires can be moved transversely into the narrow portions of the slots for causing the heads to bear against the inner plates. One or more washers may be used on the wires to space the heads from adjacent plates to alter the effective lengths of the wires. Tie wires have heads at each end that are receivable in the same slots that receive the wires and then the tie wires can be moved laterally into the narrow slot portions after the post-tensioning wires have been tensioned and the tire wires with the inner anchor plates will constitute a connection between the aligned post-tensioning wires that is substantially in alignment with these wires for post-tensioning the concrete structure.

An object of my invention is to provide an improvement over my two copending applications, one on an apparatus and method for post-tensioning a concrete slab or the like, Ser. No. 554,081, filed May 31, 1966; and the other on an apparatus and method for post-tensioning and interconnecting reenforcing wires in a concrete structure, Ser. No. 559,996, filed June 23, 1966. In the earlier filed case the inner sides of the cable wires were secured to two anchor plates that had bayonet slots in their edges for receiving the wires. The wire ends had integral heads or beads and washers were placed next to the heads and pressed against the inner surfaces of the plates. The two anchor plate were forced toward each other for tensioning the wires that extended from the plates to opposite sides of the concrete structure. When the desired tension was reached on the wires, tie wires or bolts were placed in other slots provided in the peripheries of the anchor plates and these tie wires or bolts had washers bearing against the outer surfaces of the plates for holding the plates and maintaining the tensions on the wires. The use of slots in inner anchor plates permitted the wires to be connected to the plates at the construction site. Shorter length wires and cables could be used and this made their transportation to the building site easier. Also shorter cables and wires can be handled and tensioned more readily than longer ones that extend between opposite sides of the concrete slab or structure. The interconnecting of the inner ends of the wires by the anchor plates and tie wires or bolts in effect spliced the shorter length cables or wires together to make longer ones that extended between opposite sides of the concrete slab and a uniform tension on both shorter cables was maintained by the tie wires or bolts.

In my other copending application, the inner ends of the shorter wires and cables were connected to anchor plates that were moved away from each other for tensioning the cables rather than toward each other. Both anchor plates had slots in their peripheries for receiving the wire ends. The inner wire ends of one short cable overlapped the inner wire ends of the other short cable and the length of the lapped wire end portions was the distance between the two spaced apart anchor plates. When the desired tension was reached on the wires and cables, shims were placed between the two anchor plates for holding them apart and maintaining the same tension. Adjustable shims in the form of threaded rods with nuts and washers are also disclosed in the copending case.

An object of my present invention is to provide anchor plates that have one or more key holes therein, the larger diameter portion of each key hole being adapted to receive the head and one or more washers of one or more cable wires so that these heads and washers can be passed through the key hole, after which the wire is moved into the narrow portion of the key hole for connecting the wire to the anchor plate. The tie wire can have its head and one or more washers passed through the key hole after which the tie wire is moved into the narrow key hole portion for connecting the tie wire to the same anchor plate.

Where the anchor plates are moved toward each other for tensioning the wires and cables, the tie wires will extend between the two plates for maintaining the same tension on the cable wires. Anchor plates with key holes in them for receiving cable and tie wires are stronger than the same size and thickness of anchor plates with wire-receiving slots in their peripheries because the key holes are entirely surrounded by metal while the periphery slots are open ended and thereby weakened. It is just as easy to connect cable wires and tie wires to anchor plates having key holes for receiving them as it is to connect the cable and tie wires to anchor plates having slots in their edges.

The tension force is more directly in line between two cable wires that are connected to two anchor plates by the use of key holes and where the two plates are also interconnected by a tie wire whose ends are received in the same key holes because the tie wire can lie adjacent to the two cable wires and be received in the same narrow portions of the key holes that receive the cable wires. This permits thinner anchor plates to be used without the plates becoming bent under tension than is possible to use where the tie wires are received in separate slots from those receiving the cable wires in the anchor plates disclosed in my copending applications. Tie bolts can adjustably interconnect the two anchor plates and can be received in the enlarged portions of the key holes rather than in the narrow portions.

I disclose a modified form of my invention wherein key holes are used in anchor plates that are moved away from each other for tensioning the cable wires rather than be moved toward each other.

Other objects and advantages will appear as the specification continues and the novel features of the invention will be set forth in the appended claims.

Drawings

For a better understanding of my invention, reference should be made to the accompanying drawings, forming a part of this application, in which:

FIGURE 1 is a plan view of a concrete structure and shows my tensioning and re-enforcing apparatus in place.

FIGURE 2 is an enlarged transverse section taken along the line 2—2 of FIGURE 1.

FIGURE 3 is a longitudinal section taken along the line 3—3 of FIGURE 2.

FIGURE 4 is a view similar to FIGURE 2, but shows the use of a tie bolt and two cable wires arranged side by side and is taken along the line 4—4 of FIGURE 5.

FIGURE 5 is a longitudinal section taken along the line 5—5 of the modified form shown in FIGURE 4.

FIGURE 6 is a plan view of a concrete structure and shows another modified form of my tensioning and re-enforcing apparatus in place.

FIGURE 7 is an enlarged transverse section taken along the line 7—7 of the modified form shown in FIGURE 6.

FIGURE 8 is a longitudinal section taken along the line 8—8 of FIGURE 7.

FIGURE 9 is a longitudinal section through a third modified form of my invention.

While I have shown only the preferred forms of my invention, it should be understood that various changes, or modifications, may be made within the scope of the annexed claims without departing from the spirit thereof.

Detailed description

In carrying out my invention, I show in FIGURE 1 a concrete structure indicated generally at A and having a central recess A1 and opposite outer parallel sides 1 and 2. It is possible to have more than one recess A1 between the opposed sides 1 and 2 if desired. An outer anchor plate B is placed against the side 1 of the concrete structure or slab A, and it may be partially embedded in the concrete if desired. A re-enforcing and post-tensioning cable C is attached to the outer anchor plate B, and it extends through the concrete from the side 1 to the recess A1 in the concrete slab A. I have indicated the cable C as being composed of two wires C in FIGURE 1, although in actual practice the cable would be composed of any number of wires which could be combined to form a single cable with a single covering or could be individual wires with individual coverings and an outer anchor plate for each or a combination thereof, and I do not wish to be confined to any exact number.

The portion of the cable C that is embedded in the concrete of the slab A may be sheathed in a plastic tube indicated generally at D and the latter may be cut longitudinally and have overlapping edges defining the cut so that the cable may be readily inserted into the tube without the necessity of threading the cable therethrough. The cable wires can also be independent of one another with each wire having its own covering. The scale of the drawing is small in FIGURE 1 and so I have indicated the cable C as extending through an opening in the outer anchor plate B and as being provided with only one beaded outer end 3 that bears against a single washer 4 and the latter bears against the anchor plate. Each wire in the cable C will have its outer end provided with a bead 3 and a washer 4 and the anchor plate will have an opening for each cable wire. The cable comprising more than one wire or one or more wires in combination or separately could have a non-friction film applied to the portion that is to be embedded in the concrete so that this portion could be tensioned with the rest of the cable during the tensioning operation and would be free to move with respect to the concrete. If this were done, the plastic tube or tubes D would not be needed.

Before describing how the inner ends of the wires from the cable C are connected to an inner anchor plate E, it is best to state first that another cable F has its outer end secured to a second outer anchor plate G that in turn bears against the opposite side 2 of the concrete slab A, see FIGURE 1. The outer ends of the cable wires F extend through openings in the outer anchor plate G and are provided with beads or heads 5 and washers 6, the latter bearing against the anchor plate. Only one head 5 and one washer 6 are shown in FIGURE 1 because of the smallness of the scale. The inner ends of the wires from the cable F are connected to a second inner anchor plate H. The wires from the inner end of the cable C may be passed through a ring J or be independent of each other and the wires from the inner end of the cable F may be passed through another ring K or be independent of each other. It is possible to wrap tape or the like around the wires of each cable rather than use a ring if it is so desired.

The purpose of the rings J and K or the wrapped tape is to prevent the cable wires from spreading apart too far. If each wire is independent of the others it would take its own position in the concrete slab and then no ring or other device would be required. The cable F may be sheathed in a plastic tube D.

In FIGURES 2 and 3, I show on an enlarged scale how the wires from the cables C and F are connected to their respective anchor plates E and H. The anchor plate E is provided with one or more key holes 7. The larger diameter portion of the key hole will permit the beaded inner end 8 of one of the wires of the cable C and its associate washer 9 to be passed therethrough and then the cable wire can be moved into the narrow portion of the key hole. The washer 9 will bear against the inner surface of the anchor plate. In like manner the inner anchor plate H is provided with one or more key holes 10 and the larger diameter portion of the key hole will permit the headed inner end 11 of one of the wires of the cable F and its associate washer 12 to be passed therethrough after which the cable wire can be moved into the narrow portion of the key hole. The washer 12 will bear against the inner surface of the inner anchor plate H.

The key holes 7 and 10 are entirely enclosed by metal of the inner anchor plates and the plates are stronger because of this and may be made thinner than the inner anchor plates shown in my copending cases where the cable wire receiving slots are in the edges of the plates and therefore are open ended. Anchor plates provided with key holes can accommodate more cable wires than the anchor plates having wire receiving slots only in the edges of the plates. The key hole slots can be so placed in the inner anchor plates as to provide space for the fingers of a hydraulic jack, not shown, to be applied to the plates for moving them toward each other for tensioning the cables C and F. I have indicated by arrows 13—13 the direction of force applied to the two inner anchor plates E and H when tensioning the cables C and F. Hydraulic or mechanical jacks may be used for this purpose.

It will be noted from FIGURE 1, that shorter cable lengths can be used when post-tensioning a concrete structure A, where the cables do not need to extend from the side 1 to the side 2. The tensioning of the cables can also be done at the center of the concrete slab A rather than from either or both sides of the slab. Furthermore, the shorter length cables C and F need not be connected to the inner anchor plates E and H until at the construction site and the anchor plates need not be interconnected by tie wires until after the shorter cables are tensioned.

In FIGURES 1, 2 and 3, I show tie wires L of predetermined lengths and being provided with an integral head at each end, indicated at 14 and 15. A plurality of washers 16 are mounted on the tie wires L and one or more may bear against the heads 14 or 15 to vary the effective length of the tie wire. The key hole 7 in the inner anchor plate E has its enlarged portion capable of receiving the head 14 and one or more washers 16 while the key hole 10 in the inner anchor plate H has its enlarged portion capable of receiving the head 15 and one or more washers 16. One or more tie wires L are moved into place in the key holes 7 and 10 when the inner anchor plates E and H have been moved toward each other to tension the shorter cables C and F to the desired extent. The tie wire is moved into the narrow portions of the key holes 7 and 10 and the washers 16 will contact with the outer surfaces of the inner anchor plates E and H to hold them in the position into which they have been moved by the hydraulic jacks, not shown, or the like.

The key holes 7 and 10 make it easy to assemble the cable wires C and F and the tie wires L to the inner anchor plates E and H. Each key hole can accommodate one tie wire and one or more cable wires. The tie wires L are dropped onto the cable wires as shown in FIGURE

3. Thus, when the cable wires have been stretched to the required amount, the tie wires can be dropped in place, and when the tension is released on the anchor plates holding the cable wires, the load will be taken up by the tie wires which are immediately adjacent to the cable wires. Therefore the force from the cable wires will be applied almost directly to the tie wire at practically the same point that the cable wire penetrates the anchor plate. The counteracting force of the tie wire is closer to the point where the initial force from the cable wires C and F is being applied. If additional tie wires are needed to balance the force against the inner anchor plates, additional key hole slots can be provided in the plates for this purpose. The narrow portions of the key slots **7** and **10** are long enough so that no part of the peripheries of the washers overlies the larger diameter portions of the key holes. FIGURE 3 clearly illustrates how the opposing washers **9** and **16** of the cable wire C and the tie wire L, overlap and therefore a portion of the force of the wire C against the anchor plate E is directly cancelled out to the extent that the washers **9** and **16** directly offset one another. The same is true of the opposing washers **12** and **16** for the cable wire F and the tie wire L. This reduces the tendency of the anchor plates to bend and thinner anchor plates may be used.

In FIGURES 4 and 5, I show a slightly modified form of my invention. The inner anchor plates M and N have key holes **25** and **26** with longer narrow portions that can receive two cable wires C and two cable wires F, rather than one as illustrated in FIGURE 3. The washers **9** on the cable wires C will abut one another and the washers **12** on the cable wires F will abut one another. Instead of the tie wire L, I provide a bolt P whose diameter is slightly less than the larger diameter portions of the key holes **25** and **26** and therefore these portions will receive the bolt shank. The bolt head **27** and a washer **28** on the bolt bear against the outer surface of the inner anchor plate M while a nut **29** and a washer **30**, both mounted on the bolt, bear against the outer surface of the inner anchor plate N. If additional tie wires are needed to balance the forces against the inner anchor plates, additional key hole slots can be provided in the plates for this purpose.

One or more bolts P may be used and they are under tension when the nuts **29** are tightened to hold the inner anchor plates M and N in the position into which they have been moved by the post-tensioning means, not shown, for the shorter cables C and F. The diameter of the tie bolt P is large enough to offset two cable wires C and F in FIGURE 5. Although the tie bolt is shown as being received in the enlarged portion of the key hole, it could be received in the narrow portion of the slot or in separate key hole slots positioned in the anchor plates to balance the forces against these plates.

FIGURES 6, 7 and 8, illustrate a further modified form of my invention. In this form the inner anchor plates Q and R are moved away from each other when tensioning the cable wires C and F. The cable wire C has its inner head **8** and washer **9** passed through the larger diameter portions of key holes **50** and **51** in the inner anchor plates Q and R, respectively. The wire is then moved into the narrow portions of the key holes as shown in FIGURES 7 and 8 and the washer **9** will bear against the outer surface of the anchor plate Q. The cable wire F has its inner head **11** and washer **12** passed through the larger diameter portions of the key holes **51** and **50** in the anchor plates R and Q, respectively and then the wire is moved into the narrow portions of the key holes, note the wire F in FIGURE 7. The washer **12** will bear against the outer surface of the anchor plate R.

The inner anchor plates Q and R are forced apart by any means, not shown, and this force is indicated by the arrows **52** in FIGURE 6, and will post-tension the cables C and F to the desired extent. Shims S are placed between the anchor plates and will hold them in the position into which they have been moved so as to maintain the tension on the cables. The inner ends of the cable wires will overlap each other. It is possible to make the narrow portions of the key holes **50** and **51**, deeper so as to receive two cable wires in each narrow portion. This would permit aligned slots in the two anchor plates R and Q in FIGURE 8, to each receive one cable wire C and one cable wire F. The cable wire C would extend through both aligned key holes **50** and **51**, as shown in FIGURE 8, and the other cable wire F, shown in FIGURE 8, would also extend through the same two key holes **51** and **50** and be received in their narrow portions with the head **11** and washer **12** bearing against the outer surface of the anchor plate R. The concrete structure A, shown in FIGURE 6 is the same as that shown in FIGURE 1 and similar parts will be given like reference letters and numerals and further description of this need not be given.

The modified form of the device shown in FIGURE 9 is like FIGURE 5, except that the tie rod T has threaded ends **75** and **76** and these are received in the enlarged portions of key holes **77** and **78** provided in inner anchor plates U and V. The narrow portions of the key holes are long enough to receive two cable wires C that are superimposed one upon the other. The inner ends of the cable wires have integral heads **8** and washers **9** bear against the outer surface of the anchor plate V. If desired it is possible to have aligned key holes **77** and **78** receive one cable wire C and one cable wire F that extends in an opposite direction from the wire C.

When the anchor plates are moved away from each other for tensioning the cable wires C and F, the nuts **79** and **80** may be rotated on the threaded ends **75** and **76**, respectively of the tie rod T so as to force the washers **81** and **82**, against the inner surfaces of the anchor plates U and V, respectively and hold them apart so as to maintain the tension on the shorter cables C and F. Further description of this form of the device need not be given.

I have found that on small cables involving from one to four wires, it is more economical to cover the individual wires and allow each wire to take its position in the concrete slab rather than to combine the various wires into a single cable. On account of the tremendous forces developed during the tensioning of the cable wires, there is the possibility of the unequal forces bending the single inner anchor plates unless the same can be equalized by changing the locations of the tie wires or tie bolts. One or more extra tie bolts or tie wires might need separate key hole slots and these can be provided in the inner anchor plates and the operator can insert them in the desired slots to equalize the pressures on the cable wires and plates.

The drawings do illustrate in FIGURES 1 and 6 a balancing of tensioning pressures on the cable wires and inner anchor plates with the wires forming cables C and F. It is possible to have individual tensioning wires extend from the inner anchor plates and be arranged parallel to each other as they extend to the outer anchor plates. In this event the wires would not form parts of cables to be tensioned. This is not illustrated in the drawings but comes within the spirit of my invention.

I claim:

1. A post-tensioning apparatus for a concrete structure comprising:

(a) a first cable having one end secured to a first outer anchor plate;

(b) a first inner anchor plate having key holes therein for receiving the inner headed portions of the cable wires, the headed portions being passable through the enlarged diameter portions of the key holes and the wire portions being receivable in the narrow portions of the key holes so that the headed portions can bear against said plate;

(c) a second cable having one end secured to a second outer anchor plate;

(d) a second inner anchor plate spaced from said first plate and having key holes therein for receiving the inner headed portions of the second cable wires, the headed portions of these wires being passable through the enlarged diameter portions of the key holes in said second anchor plate and the wire portions adjacent to said headed portions being receivable in the narrow portions of the key holes in said second plate so that the headed portions of said second cable wires will bear against said second plate; said second cable being substantially in line with and extending in the opposite direction from said first cable; and

(e) tie wires equal in number to the cable wires and having headed ends passable through the larger portions of the same key holes in said anchor plates that receive the cable wires and having portions adjacent to the headed ends receivable in the narrow portions of the key holes in both anchor plates for interconnecting said plates so that each tie wire will be disposed adjacent to and substantially in alignment with the two opposing cable wires received in the same key holes that receive the tie wire.

2. The combination as set forth in claim **1**: and in which

(a) the inner headed ends of each wire of the opposed cables has a plurality of washers thereon of a diameter that permits them to pass through the larger diameter portions of the key holes in both of the inner anchor plates; and

(b) each tie wire having a plurality of washers disposed adjacent to each head and of a diameter that permits passage through the larger diameter portion of the key holes in both of the inner anchor plates;

(c) whereby at least one washer on said inner wire ends may be disposed between the inner head of the wire and the adjacent inner anchor plate for altering the effective lengths of the wires, and at least one washer on said tie wires may be disposed between the heads at each tie wire end and the adjacent inner anchor plate for altering the effective lengths of said tie wires.

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U.S. Cl. X.R.

24—123.1; 52—230