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2,637,895

METHOD OF TENSIONING AND ANCHORING WIRE BUNDLES FOR
PRESTRESSED CONCRETE STRUCTURAL ELEMENTS

Filed Jan. 23, 1947

4 Sheets-Sheet 1

Fig. 1.

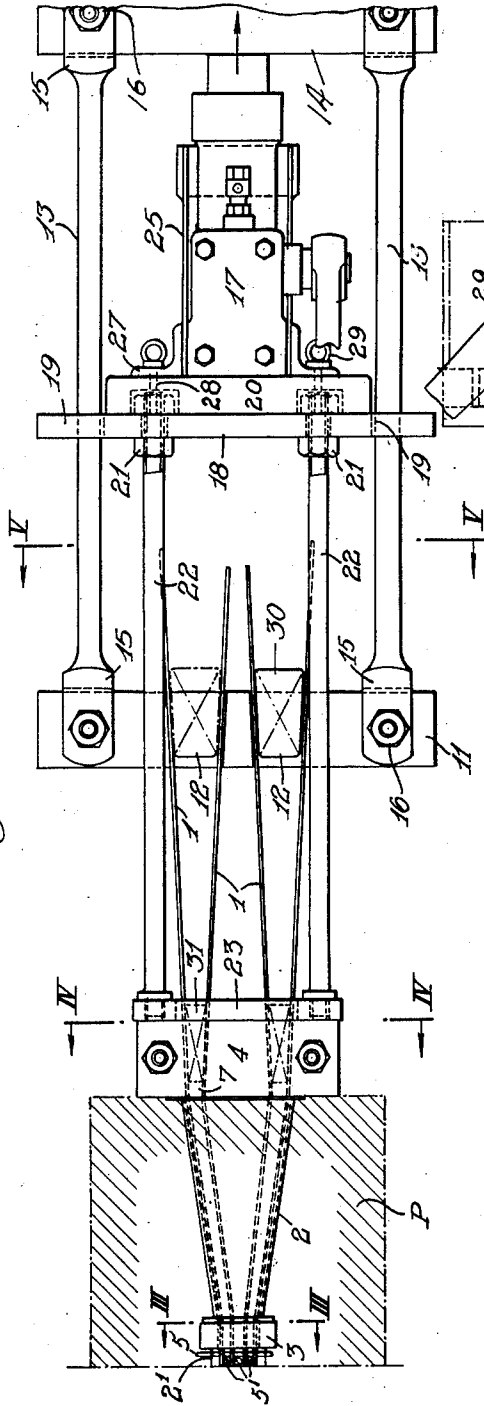
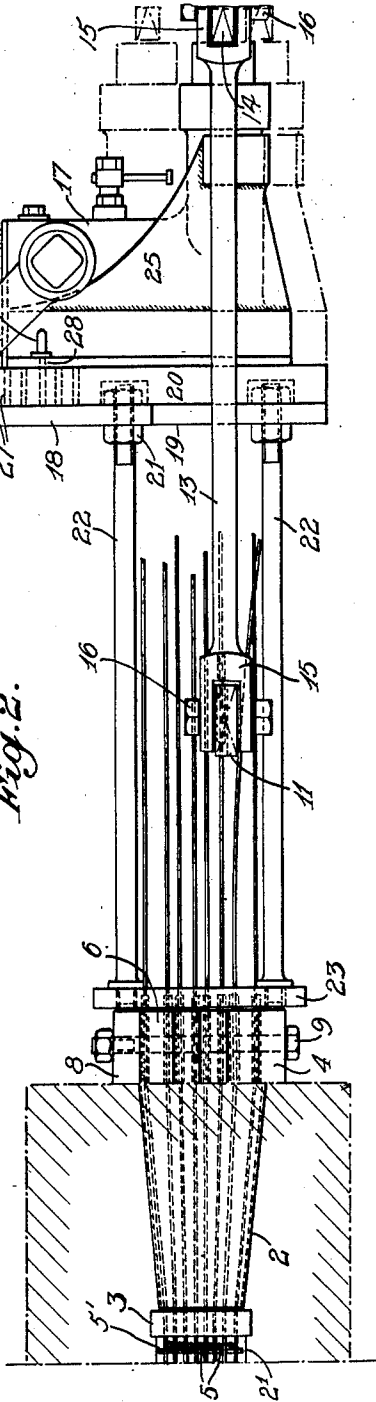


Fig. 2.



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4 Sheets-Sheet 2

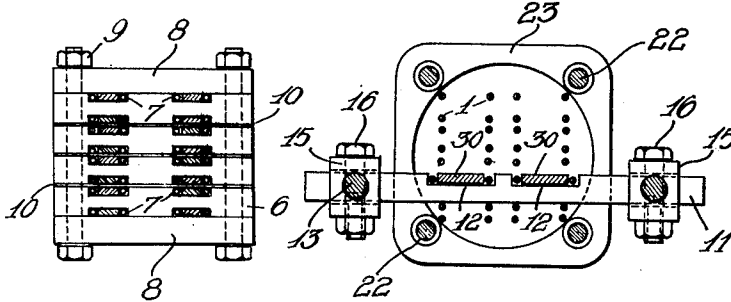


Fig. 4.

Fig. 5.

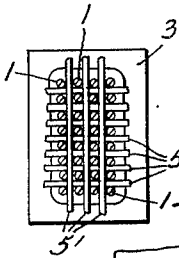


Fig. 3.

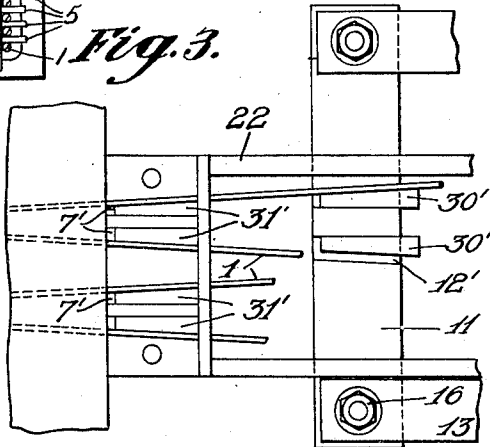


Fig. 6.

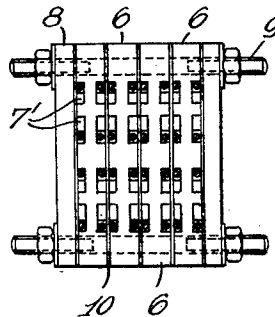


Fig. 7.

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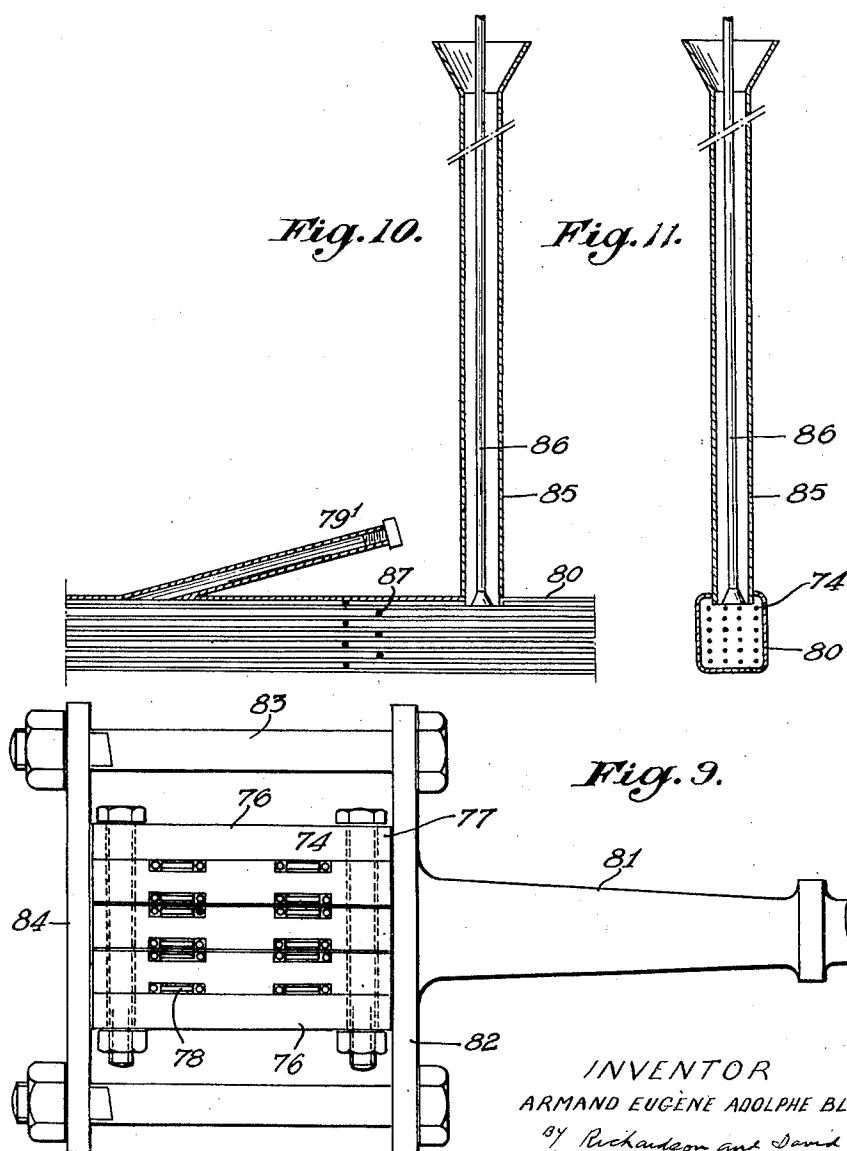
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Fig. 8.

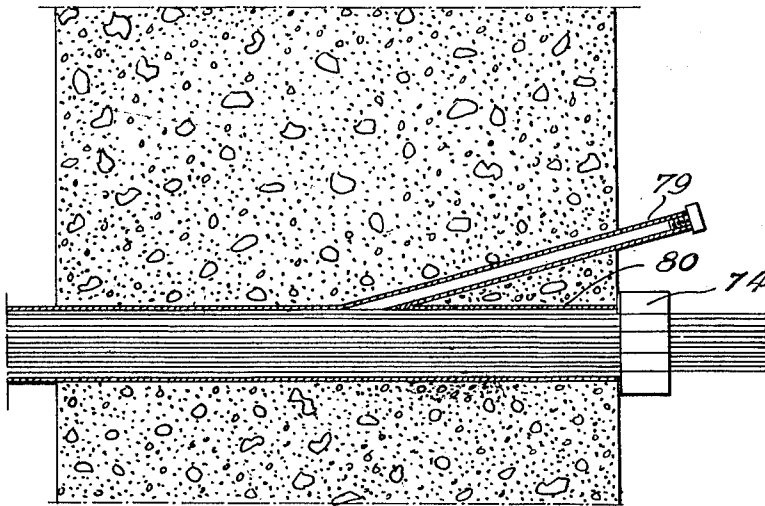


Fig. 12.

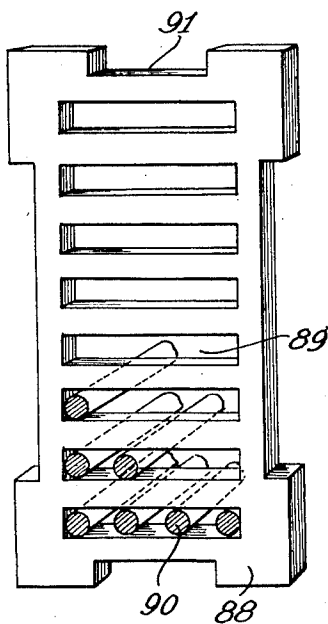
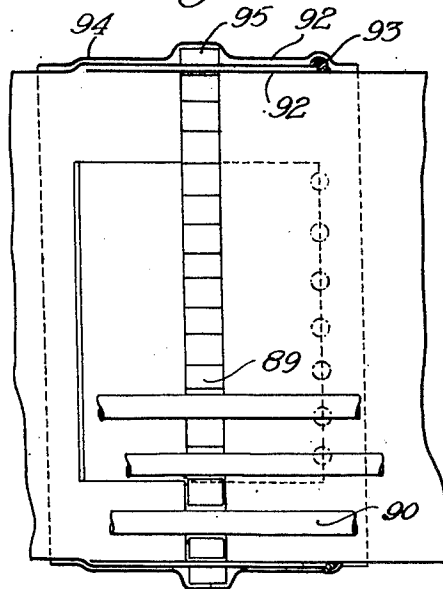


Fig. 13.



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2,637,895

METHOD OF TENSIONING AND ANCHORING
WIRE BUNDLES FOR PRESTRESSED CON-
CRETE STRUCTURAL ELEMENTS

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Pierre, Brussels, Belgium, assignor of one-half
to Emile Jules Lucien Blaton, Brussels, Belgium
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Patent expires March 21, 1962

6 Claims. (Cl. 29-148)

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The present invention relates to a method of producing a predetermined tensile stress between two fixed points of a concrete structure by means of a tensioned wire bundle consisting of a plurality of high tensile strength metal wires extending adjacent to one another between said fixed points.

The principal object of the invention is to obviate the difficulties which heretofore have been encountered in the uniform tensioning of wire bundles, and particularly in the uniform tensioning of wire bundles of a length exceeding several feet and containing a considerable number of individual wires.

Another object of the invention is to provide a method whereby even in a multi-wire bundle of great length and containing a large number, such as 20 or more wires, an exactly uniform tensioning of all the individual wires can be accomplished.

A still further object of the invention is to provide a method for the tensioning of multi-wire bundles which can be carried into effect easily and with smaller and less expensive tensioning machinery than had to be used heretofore.

Still another object of the invention is to provide a method which can be used without increased difficulties regardless of the number of wires in the bundle so that wire bundles containing a great number of wires can be employed and uniformly tensioned just as easily as wire bundles containing a small number of wires.

Generally according to the present invention, these objects are accomplished by a method comprising the following steps:

First, the untensioned wires forming the bundle are arranged throughout the main longitudinal portion of the wire bundle, which extends between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers each including a plurality of closely spaced substantially parallel wires in such a manner that at any cross section of said main portion of the wire bundle the wires are substantially uniformly distributed over the entire area of the cross section. Then, the wires are anchored at one end of the bundle against longitudinal movement in the direction towards the other end of the bundle in relative positions of the several wires with respect to one another the same as in said main portion of the bundle. Then, a predetermined, uniform, longitudinal tensioning stress is exerted at the other end of the bundle on a fraction of the total number of wires in the bundle so as to tension one,

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two or a small number of wires, such as four wires, at one time, while maintaining all the wires throughout said main portion of the bundle in their mutually spaced parallel positions.

Each tensioned wire is anchored at the opposite end of the bundle against longitudinal movement relative to the fixed points of the structure in a relative position with respect to the other wires the same as in said main portion of the bundle, and the tensioning and anchoring steps are repeated with respect to a small number of the order from one to four at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

The invention is particularly applicable to the manufacture of articles, such as concrete beams, to which a certain pre-tension is to be imparted.

An element for distributing the wires in preferably horizontal or superposed layers may, according to the present invention, be constituted by superposed plates, which are connected together, for example, by a bolt, and each of which is provided with trapezoidal recesses in which the wires after having been stretched can be locked and anchored for example by means of wedges known per se.

Numerous variations in the design of these elements can naturally be conceived according to the application envisaged without departing from the principles which form the basis of the invention.

The accompanying drawings show the manner in which the invention can be carried into effect:

Figure 1 is a plan view, and

Figure 2 an elevation of the whole installation serving to stretch the metal wires.

Figures 3, 4 and 5 are sections on the lines III—III, IV—IV and V—V, respectively of Figure 1.

Figures 6 and 7 relate to a modification in which the wires are tensioned individually.

Figures 8 to 13 relate to certain modifications of the method according to the invention and to certain details of the structural elements which may be used in its execution.

In Figures 1 to 5, 1 designates round wires, for example of steel, forming a wire bundle on which a tensile force to be exerted, as is shown particularly in Figure 3, according to the invention, the wires 1 are disposed in the bundle in closely adjacent horizontal parallel layers each including a plurality of closely spaced substantially parallel wires.

The various layers are maintained at a dis-

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tance from one another by the interposition of horizontal pins 5 which are inserted at intervals during the preparation of the cable so as to effect a preliminary grouping. Vertical pins 5¹ are also provided in order to separate the wires. 2 is a thin metal envelope in the form of a truncated pyramid, which is provided at its extremity directed towards the main portion of the wire bundle with a metal ring 3, through which pass the wires 1 (Figure 3). The envelope 2 directs the wires towards a wire anchoring element 4, which may vary in design according to the purpose of the arrangement. Preferably, the wires 1 are enclosed in a sheath 2¹ of sheet iron connected to the ring 3. It will be understood that the wires in the main portion of the wire bundle which extends to the left from the ring 3, as shown in Figures 1 and 2, for instance, to a similar ring near the other end of the bundle (not shown), are arranged and maintained throughout in the positions indicated by the cross section shown in Fig. 3, so that at any cross section of said main portion of the wire bundle the wires are substantially uniformly distributed over the entire area of the cross section. It will also be understood that the wires 1 are anchored at the other end of the bundle, for instance, in an anchoring element (not shown) corresponding substantially to the wire-anchoring element 4.

The wires 1 may be, for instance, steel wires with a high elastic limit. Wire bundles consisting of such steel wires are particularly suitable for the reinforcement of concrete structures. Part of a concrete block reinforced by a wire bundle tensioned according to the present invention is indicated by the reference numeral P in Fig. 1. However, the invention is not limited to this application.

In the examples shown in Figures 1 to 5, the wire anchoring element 4 comprises a series of superposed metal plates 6 provided with recesses 7 having a trapezoidal form in plan view and two locking plates 8 rigidly connecting all the plates 6 with the aid of bolts 9 (Figure 4). Between the plates 6 provided with notches are interposed thin metal sheets 10 serving to avoid friction of the wires against one another when they are placed under tension.

The traction device, which is shown by way of example in the right hand part of Figures 1 and 2, comprises a metal cross-piece 11 having on one of its faces two recesses 12 of trapezoidal form and forming with two rods 13 and a cross-piece 14 a coupling system permitting of exerting a tractive force on the wires. The rods 13 form at their extremities forks 15 bearing against the cross pieces 11 and 14, and bolts 16 connect the rods 13 to the cross-pieces 11 and 14.

The cross-piece 14 bears against a traction device 17 which may be a hydraulic jack or any other lifting apparatus.

A metal plate 18 having slots 19 for the passage of the rods 13 serves as a seat for a base 20 supporting the traction device 17. This plate 18 is in addition provided with securing members 21 for stays 22 connected to an annular plate 23 adapted to bear against the anchoring element 4.

The suspension of the jack 17 may be effected with the aid of metal plates 25 reinforced by angle irons 26. These angle irons have apertures 27 which may be brought into register with apertures 28 in the base 20. Pins 29 may be inserted into these apertures to secure the jack

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17 at different heights. During vertical adjustment of the jack 17 the rods 13 move vertically in the slots 19 of the plate 18.

As will be seen from Figure 4, owing to the design of the anchoring element 4 which is formed by superposed plates having recesses therein, the wires, on leaving the envelope 2, are distributed in parallel, horizontal layers which, in the case illustrated, each comprise four wires 1 penetrating in pairs into the recesses 7. Each layer could comprise a larger number of pairs of wires or only two wires. The number of layers will depend upon the tensile force to be exerted.

In order to exert a tensile stress on the wires and to maintain this pull for as long as desired, the following procedure is adapted in the case where it is desired to tension two wires at a time.

Two of the wires 1 passing through a recess 7 in the element 4 are brought into a recess 12 in the cross member 11 and are secured therein by means of a key or wedge 30. The jack 17 is then set in operation, and this jack, by exerting a thrust in the direction of the arrow on the cross piece 14 moves the entire coupling system and exerts on the pair of wires secured in the cross piece 11 the pull to be produced. When the elongation of these two wires is such that it corresponds to the force which it is desired to produce, the two wires 1 are keyed in the element 4 in known manner by means of a wedge 31, whereupon the jack 17 is slackened and the wedge which has served to secure the two wires 1 to the coupling system 11, 13, 14 is removed. The operation is repeated as many times as there are pairs of wires in the bundle and it is thus possible by multiplying the number of wires to obtain a total tensile force of any desired strength as shown in Fig. 1, up to 4 wires may be tensioned simultaneously.

When all the wires of the bundle have been placed under tension, the coupling system 11—13—14 is removed, as also the members 18—22—23, and the tensile force will be maintained in the wires as long as the wedges 31 are left in position.

If it is desired to remove the tensile force in the wires 1, the coupling system is replaced in position and a further pull is exerted on each pair of wires until the keys or wedges 31 can readily be removed. The device employed for applying the tensile force is slackened, the wedges 30 are removed and the various pairs of wires are released.

Instead of measuring the tensile force to be produced in wires by calculating their elongation, it is possible to insert between the coupling system and the device for tensioning the wires, a dynamometer indicating at each instant, the intensity of the tensile force produced. A manometer indicating the pressure obtained in the jack may also be employed. The successive tensioning of the two wires permits of producing a uniform tension throughout all the wires constituting the bundle.

It will be understood that the anchoring elements 4 permit of so disposing the wires in the bundle that they are in parallel layers not touching one another and they also permit that when the tensile force is exerted on some of the wires this arrangement be maintained and that none of the wires which are tensioned become wedged between wires which are not tensioned.

In the embodiment shown in Figures 1 to 5, it has been assumed that the tensile force has been applied to two wires or to four wires at a time.

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It is, however, possible to tension only one wire at a time. In this case, it is sufficient to modify the form of the recesses 1 and 2 in the respective plates 6 and in the cross member 41, and that of the wedges 30 and 31.

As is shown in Figures 6 and 7, these recesses 1 and 2 then have a horizontal face and an inclined face and each wire 1 is locked between the wall of the recess and a wedge (30 or 31) which also has a horizontal face and an oblique face.

As will be understood, the method described permits of producing the same tension in all the wires of a wire bundle.

The construction of the wire bundle also permits of injecting through one of its extremities a substance for protecting the wires against corrosion in such a manner as to ensure that each individual wire will be protected over its entire length.

According to the invention, it is also possible to carry out in addition to this injection, a vibrating operation which is intended to ensure good distribution of the injected substance over the entire length of the cable.

The coating liquid may be injected, as shown, for example, in Fig. 8, through a tube 79 which is disposed close to the extremity of the cable and extends to the sheath 87, for example of sheet metal, surrounding the cable. The liquid is preferably injected under pressure.

The vibration may be effected, as shown, for example, in Fig. 9, by securing a vibrating apparatus of known type to the wire-anchoring member. As shown in this figure, the wire-anchoring member may comprise, for example, superposed plates 76 connected together by bolts 77 and each having trapezoidal recesses in which the wires 74 may be anchored by means of wedges 78 after having been stretched. In order to obtain the desired vibration, the rod 81 of a vibrator (not shown) is provided with a plate 82 which is applied against one of the plane faces constituted by the superposition of the plates 76, and a further plate 84 is secured to this plate 82, for example by bolts 83; the said further plate bearing against the face of the anchoring device which lies opposite the face with which the plate 82 comes into contact.

The vibrations produced by the vibrating device are thus imparted successively to the wire-anchoring device, to the wires themselves and to the injected liquid, which ensures with certitude the advance of the liquid along each element of the cable. In fact, if an obstacle, for example a particularly large particle, hinders the displacement of the liquid, this obstacle is immediately eliminated by the vibration, and the liquid can continue its movement without interruption.

When the cable is of great length, supplementary points of injection and of vibration may be provided at certain intervals, each comprising, for example, a tube 85 for the introduction of the liquid, into which the rod 86 of a vibrator can be introduced, as listed by way of example in Figs. 10 and 11. Injection and vibration is effected at each of these points. Injection may alternatively be effected at intermediate points through a tube 79 similar to the tube 79 at the extremity of the wire bundle.

When the work is completed, the tubes 85 are removed.

The constructional details described and illustrated have obviously only been given by way of example and numerous modifications may be introduced without departing from the invention.

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Thus, in particular, the vibration could be imparted to the wires and to the substance by means other than those described, and at other points. The vibrator, instead of being secured to the device for securing and distributing the wires, could also be located outside this device.

Also in accordance with the invention, the grouping of the wires in the bundle before the tensioning force is exerted, instead of being effected by means of pins 87, may be carried out with the aid of a plate 88 of prismatic form, generally of metal (Figures 12 and 13), which is located in a position perpendicular to the wire bundle and in which parallel slots 89 are formed, each slot being intended to receive the wires 90 forming part of a layer of wires. Vertical pins are also provided between the plates 88 in order to separate the wires.

These plates 88 which are disposed at suitable intervals along the wire bundle, have on each of their four faces in the example illustrated a recess 91 receiving extensions 92 which are formed by elements of the juxtaposed sheath. The extensions forming part of two successive sheath elements are superposed as is shown in the drawing, and a weld 93 may be provided to join the elements together. The joints are preferably covered with insulating fabric, as indicated at 94.

When the pull is exerted on the wires, the plates 88 remain in position since, owing to the projections 95, these plates are anchored in the concrete, situated around the sheath and bear against this concrete, and owing to this fact they cannot deviate from their position under the effect of the tensile force.

A practical means is thus provided for rapidly regrouping the wires and eliminating certain difficulties in manipulation which are inherent in the use of the pins.

These plates 88 will be of great use and even indispensable at the point at which the cable deviates from the rectilinear direction and thus permit of guiding all the wires in this curve and maintaining them in their grouped position.

What I claim is:

1. In the manufacture of load-carrying structural concrete elements pre-stressed to a high tension by means of at least one bundle of high tensile strength metal wires which cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of untensioned high tensile strength wires to extend throughout the main longitudinal portion of the wire bundle formed by said wires between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers each including a plurality of closely spaced substantially parallel wires in such a manner that, at any cross-section of said main portion of the wire bundle, the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the bundle against longitudinal movement in the direction toward the other end of the bundle in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the bundle so as to tension a small number of wires of the order from

1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire at said opposite end of the bundle against longitudinal movement in the direction toward said first end of the bundle in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

2. In the manufacture of load-carrying structural concrete elements pre-stressed to a high tension by means of at least one bundle of high tensile strength metal wires which extend closely adjacent to one another in a longitudinal cavity of the structural element and cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of untensioned high tensile strength wires to extend, throughout the main longitudinal portion of the wire bundle formed by said wires between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers, each including a plurality of closely spaced substantially parallel wires in such a manner that, at any cross-section of said main portion of the wire bundle, the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the bundle against longitudinal movement in the direction toward the other end of the bundle in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the bundle so as to tension a small number of wires of the order from 1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire at said opposite end of the bundle against longitudinal movement in the direction toward said first end of the bundle in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

3. In the manufacture of load-carrying structural concrete elements pre-stressed to a high tension by at least one bundle of high tensile strength metal wires which extend closely adjacent to one another in a longitudinal cavity of the structural element and cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of high tensile strength metal wires in a longitudinal cavity left in a pre-cast concrete element to extend, throughout the main longitudinal portion of the wire bundle formed by said wires between two transverse planes located near the

respective ends of the bundle, in several closely spaced substantially parallel layers each including a plurality of closely spaced substantially parallel wires in such a manner that at any cross-section of said main portion of the wire bundle the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the hardened structural concrete element against longitudinal movement in the direction toward the other end of the structural element in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the bundle so as to tension a small number of wires of the order from 1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire at the opposite end of the structural concrete element against longitudinal movement relative to the structural element in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

4. In the manufacture of load-carrying structural concrete elements pre-stressed to a high tension by means of at least one bundle of high tensile strength metal wires which cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of untensioned high tensile strength wires to extend throughout the main longitudinal portion of the wire bundle formed by such wires between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers each including a plurality of closely spaced substantially parallel wires in such a manner that, at any cross-section of said main portion of the wire bundle, the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the bundle against longitudinal movement in the direction toward the other end of the bundle in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, guiding the wires from the end of the main portion of the bundle near the opposite end of the latter through a transverse anchoring plane located between said end of said main portion and said opposite end of the bundle along diverging lines to define an imaginary truncated pyramid having its smaller base at the end of the main portion of the bundle and its larger base in said anchoring plane, the wires being located in said anchoring plane in relative positions the same as in the main portion of the bundle with the spacing between adjacent wires in the anchoring plane being considerably greater than the spacing between the same wires in the main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the

bundle so as to tension a small number of wires of the order from 1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire in said anchoring plane against longitudinal movement in the direction toward said first end of the bundle in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

5. In the manufacture of load-carrying structural concrete elements pre-stressed to a high tension by means of at least one bundle of high tensile strength metal wires which extend closely adjacent to one another in a longitudinal cavity of the structural element and cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of untensioned high tensile strength wires to extend, throughout the main longitudinal portion of the wire bundle formed by said wires between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers, each including a plurality of closely spaced substantially parallel wires in such a manner that, at any cross-section of said main portion of the wire bundle, the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the bundle against longitudinal movement in the direction toward the other end of the bundle in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, guiding the wires from the end of the main portion of the bundle near the opposite end of the latter through a transverse anchoring plane located between said end of said main portion and said opposite end of the bundle along diverging lines to define an imaginary truncated pyramid having its smaller base at the end of the main portion of the bundle and its larger base in said anchoring plane, the wires being located in said anchoring plane in relative positions the same as in the main portion of the bundle with the spacing between adjacent wires in the anchoring plane being considerably greater than the spacing between the same wires in the main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the bundle so as to tension a small number of wires of the order from 1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire in said anchoring plane against longitudinal movement in the direction toward said first end of the bundle in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with the respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

6. In the manufacture of load-carrying struc-

tural concrete elements pre-stressed to a high tension by at least one bundle of high tensile strength metal wires which extend closely adjacent to one another in a longitudinal cavity of the structural element and cooperate to form a single unit for the maintenance of the desired high tension in the structural element, a method of forming the wire bundle and imparting thereto the desired high tension, said method comprising the steps of arranging a plurality of high tensile strength metal wires in a longitudinal cavity left in a pre-cast concrete element to extend, throughout the main longitudinal portion of the wire bundle formed by said wires between two transverse planes located near the respective ends of the bundle, in several closely spaced substantially parallel layers each including a plurality of closely spaced substantially parallel wires in such a manner that, at any cross-section of said main portion of the wire bundle, the wires are substantially uniformly distributed over the entire area of such cross-section, anchoring the wires at one end of the hardened structural concrete element against longitudinal movement in the direction toward the other end of the structural element in relative positions of the several wires with respect to one another the same as in said main portion of the bundle, guiding the wires from the end of the main portion of the bundle near the opposite end of the structural concrete element through a transverse anchoring plane located substantially at said opposite end of said structural element along diverging lines to define an imaginary truncated pyramid having its smaller base at the end of the main portion of the bundle and its larger base in said anchoring plane, the wires being located in said anchoring plane in relative positions the same as in the main portion of the bundle with the spacing between adjacent wires in the anchoring plane being considerably greater than the spacing between the same wires in the main portion of the bundle, exerting at the other end of the bundle a predetermined, uniform, longitudinal tensioning stress on a fraction of the total number of wires in the bundle so as to tension a small number of wires of the order from 1 to 4 at a time while maintaining all the wires throughout said main portion of the bundle in their mutually spaced, parallel positions, anchoring each tensioned wire in said anchoring plane at the opposite end of the structural concrete element against longitudinal movement relative to the structural element in a relative position of said wire with respect to the other wires the same as in said main portion of the bundle, and repeating the tensioning and anchoring steps with respect to a small number of the order of 1 to 4 at a time of the remaining wires of the bundle until all the wires of the bundle have been uniformly tensioned and anchored.

ARMAND EUGÈNE ADOLPHE BLATON.

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Schorer	June 19, 1945
Cueni	Aug. 14, 1945
Muntz	Jan. 7, 1947
Fitzpatrick	June 28, 1949
Barber	June 13, 1950

FOREIGN PATENTS

Number	Country	Date
541,835	Great Britain	Dec. 15, 1941
543,249	Great Britain	Feb. 16, 1942
273,004	Switzerland	Apr. 16, 1951