June 26, 1956 W. NAKONZ 2,751,660

METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Fig.1

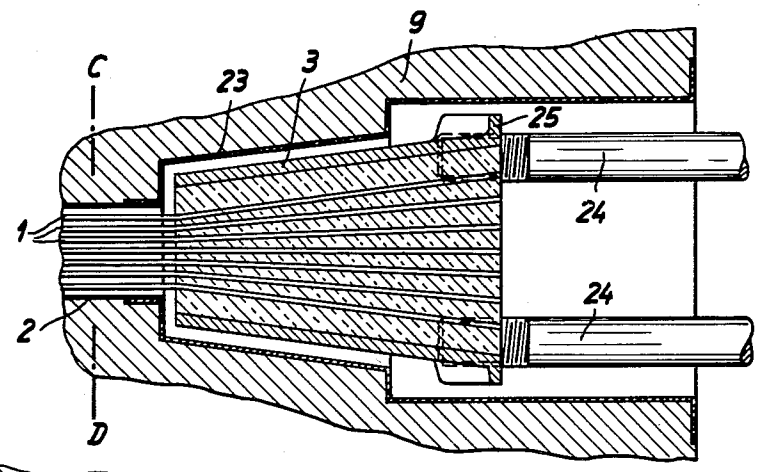


Fig.2

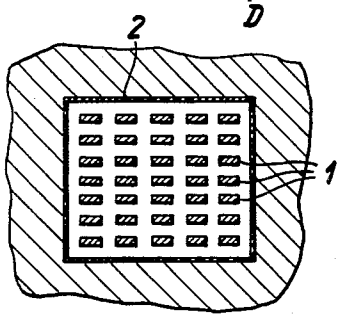
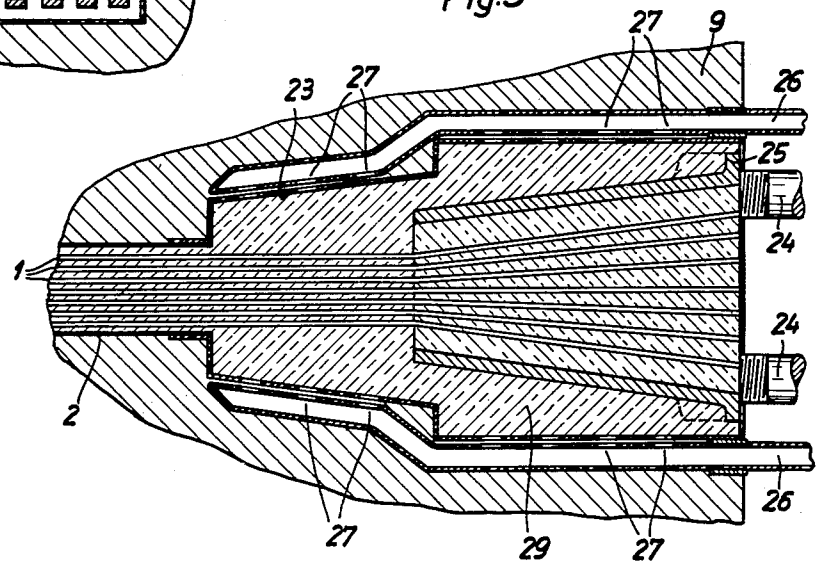


Fig.3



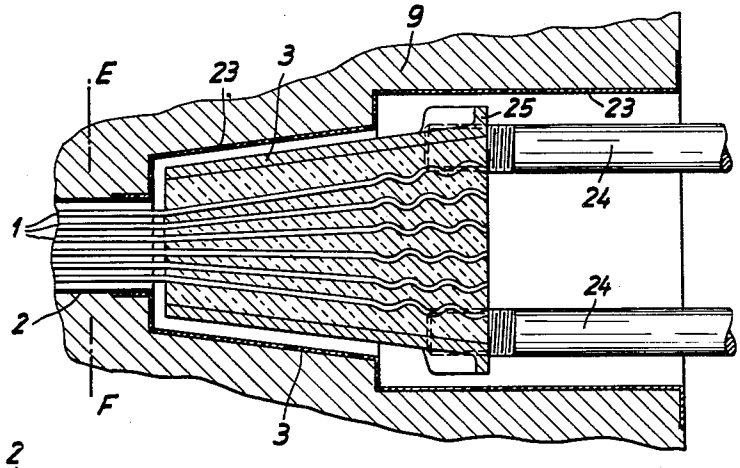
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METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Fig.4



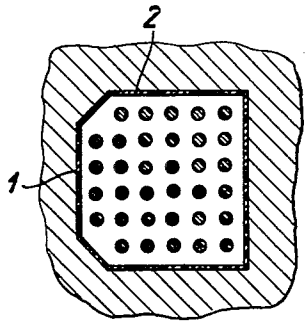
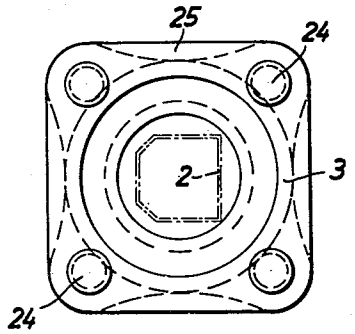


Fig.5

Fig.6



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METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Fig.7

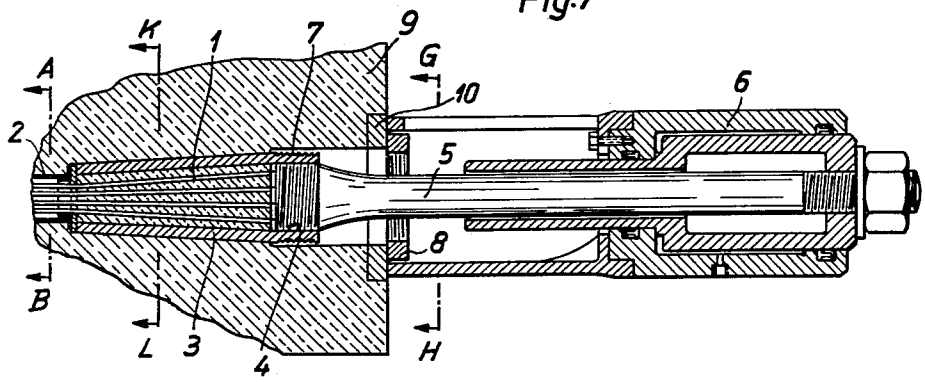


Fig.8

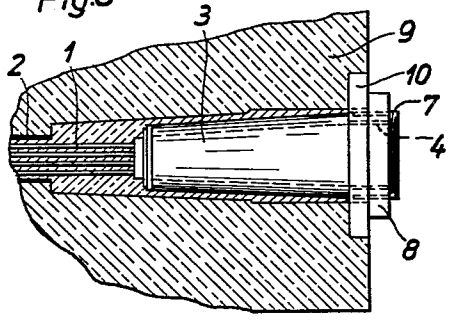


Fig.9

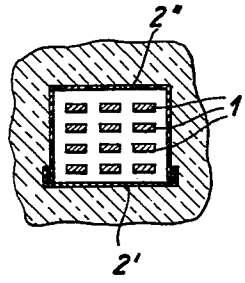


Fig.10

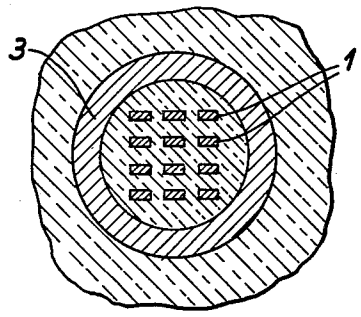
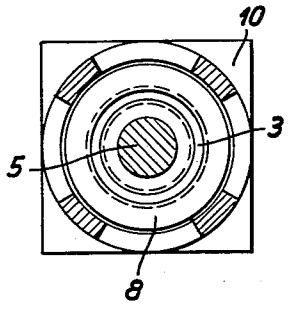


Fig.11



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METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Fig.14

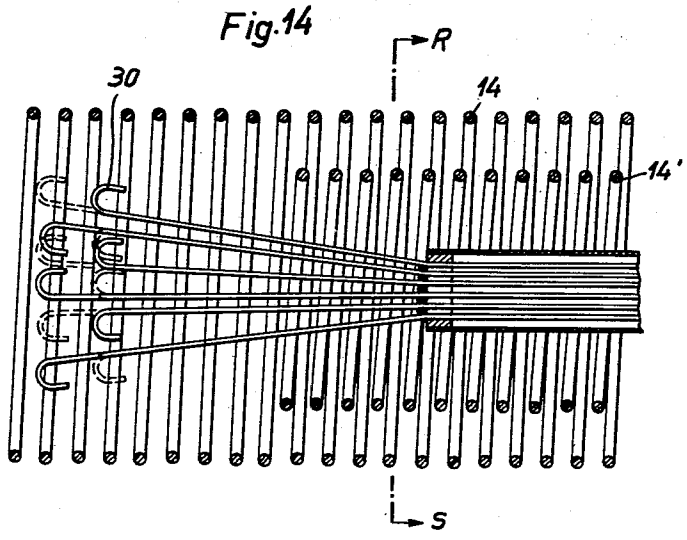


Fig.15

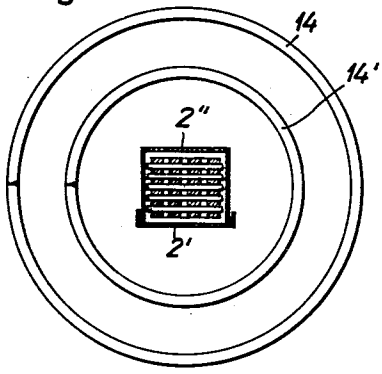


Fig.13

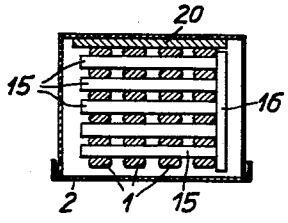
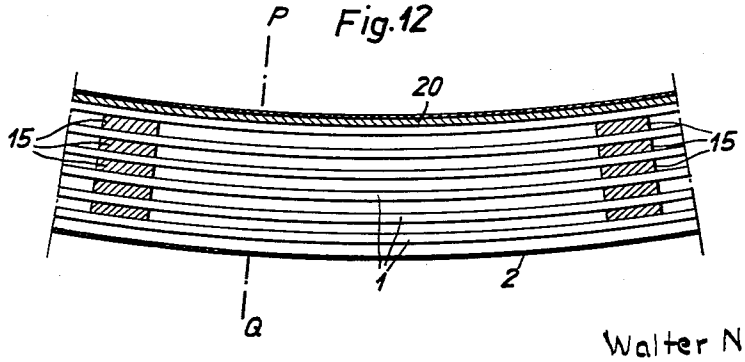


Fig.12



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METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Fig.16

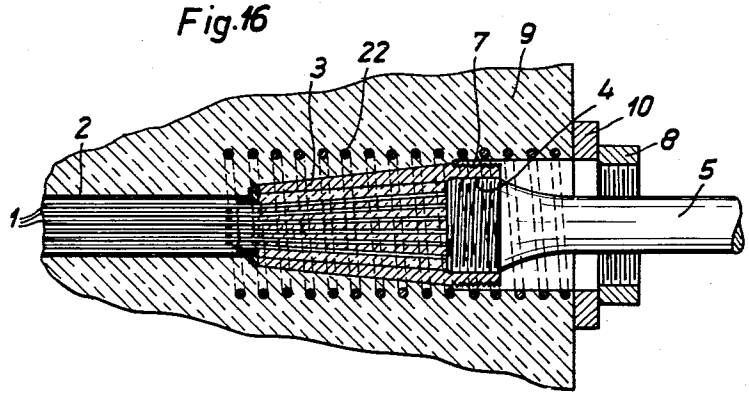


Fig.17

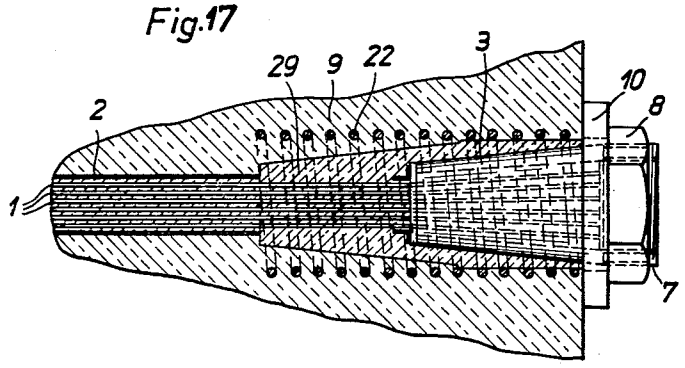
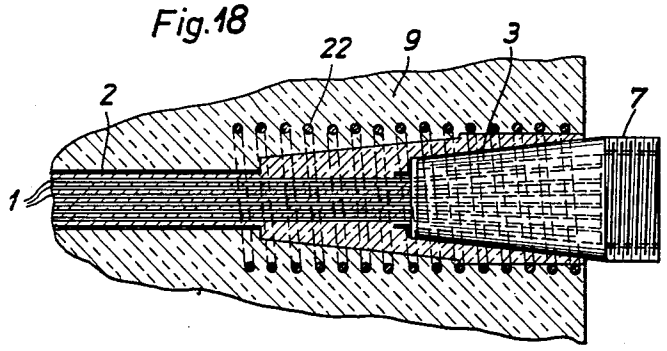


Fig.18



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United States Patent Office 2,751,660 Patented June 26, 1956

2,751,660

METHOD OF PRE-STRESSING REINFORCED CONCRETE STRUCTURAL ELEMENTS

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Application January 26, 1952, Serial No. 268,383

Claims priority, application Germany February 3, 1951

2 Claims. (Cl. 25—154)

The present invention is concerned with methods of pre-stressing reinforced concrete structural elements using bundles of steel bars of flat or round section, and an object thereof is to provide particularly simple and reliable methods of stressing the reinforcing bars relatively to the set concrete body. To this end the invention resides in the facts that the reinforcing bars, which are introduced in a bundle into a tubular recess in the concrete body, are cemented into a rigid conical (hereinafter intended to include frusto-conical) head which is displaceably arranged in a mouthpiece which adjoins the tubular recess and forms a hollow space around the conical head, that the cone is drawn outwards after setting of the cement, so as to effect the pre-stressing, and that the hollow space between the head and the mouthpiece is filled or packed with cement grouting with the cone in the withdrawn position.

Examples of embodiment of the invention are illustrated in the accompanying drawings in which:

Figure 1 is a section through part of a reinforced concrete body prior to stressing of the reinforcing bundle composed of steel rods of flat section.

Figure 2 is a cross section through the bundle of reinforcing bars, this section being taken on the line C—D of Figure 1.

Figure 3 is a section through the portion of the concrete body illustrated in Figure 1, as seen after the reinforcing bars have been placed under tension.

Figure 4 is a section through a portion of a concrete body similar to that of Figure 1, but illustrating the use of steel bars of round section, this figure indicating the condition prior to tensioning of the bundle.

Figure 5 is a cross section through the reinforcing bundle taken on the line E—F of Figure 4.

Figure 6 is an elevational view, from the exterior, of the tensioning head.

Figure 7 is a longitudinal section through a device for effecting the pre-stressing, in conjunction with a further form of concrete element according to the invention.

Figure 8 illustrates the parts of Figure 7 in the end position and after the press has been removed.

Figure 9 is a cross section on the line A—B of Figure 7.

Figure 10 is a cross section on the line K—L of Figure 7, and

Figure 11 is a cross section on line G—H in Figure 7.

Figure 12 is a further cross section, in this case taken through part of a guideway for a bundle of bars, this part being of curved formation.

Figure 13 is a cross section on the line P—Q of Figure 12.

Figure 14 is a longitudinal section through means which are adapted to be employed at the other side of the constructional element for anchorage of the bundle of reinforcing bars.

Figure 15 is a cross section on the line R—S of Figure 14.

Figures 16 to 18 illustrate, in longitudinal section, the

pre-stressing device in three stages of operation, and in accordance with a further embodiment of the present invention.

In carrying the invention into effect, reinforcing bars 1 of suitable material and cross section are assembled in a bundle and mounted, by suitable spacing holders or binders, in tubular recesses in the set concrete body 9, each such tubular recess being defined, in the present instance, by a sheet metal tube 2.

In the embodiment according to Figures 1 to 3, bars 1 of flat section are employed (see Figure 2) and these may conveniently be provided with indentations, grooves, or the like for the purpose of increasing their adherent qualities, whilst the tube 2 is conveniently of rectangular cross section. Adjoining the tube 2 is a mouthpiece 23, also of sheet metal. The reinforcing bars 1 terminate in a rigid conical head 3, encased in a steel casting or the like, and displaceable in mouthpiece 23.

The ends of the reinforcing bars are gripped in the cone 3 by cement mortar, the length of this cone being so chosen that, generally speaking, the steel cement adhesion is sufficient alone to hold the bars fast and with certainty.

In the embodiment according to Figures 4 and 5, bars of round section are employed in the bundle of reinforcing bars. In this connection, see Figure 5, the cross section of the tubular element 2 is somewhat different from that of Figure 2 by virtue of the fact that two of the corners are chamfered off. Basically, however, the cross sectional shape of the tube and of the bundle of reinforcing bars is not material, and generally speaking it is only necessary to ensure that there is a certain minimum distance from bar to bar to enable the bundle to be set in position later by the pouring in of cement grouting or to enable complete consolidation of such grouting. If round bars of smooth circumference are used, i. e. in which the adherent capacity is not augmented by special indentations or the like, adequate anchorage of the bars can, as in Figure 4, be ensured by bending the ends of these into the form of a flat and wide spiral or, instead or additionally, forming small hooks at the ends thereof by bending.

In both embodiments described the tensioning of the bundle of reinforcements after setting of the cement grouting in the conical head 3 is effected by drawing these outwards, into the Figure 3 status, by an appropriate device. This action can, for example, be carried out using a press of known form and by means of screw bolts 24 which are screwed into a flange 25 on the cone 3 from the exterior.

After the conical head 3 has been drawn outwards, the hollow space 29 between this head and the mouthpiece 23 is filled or extruded with cement grouting. If mortar is poured or extruded into the tube 2, the filling or packing of the interspace 29 between the cone 3 and the mouthpiece takes place simultaneously. The position of the mortar-supply pipe can be varied within a wide range, depending on the form of building construction concerned. In the present instance, and in accordance with Figure 3, two pipes 26 are passed alongside the mouthpiece 23 and supply the pressure-applied cement mortar through registering apertures 27 in the pipe 26 and the mouthpiece 23 to the interspace 29. When the cement grouting has sufficiently set the prestressing device, by means of which the cone 3 has been drawn outwards, is detached.

In the method of carrying out the invention illustrated in Figures 7 to 11, the rigid conical head 3 is supported against a side face of the constructional element concerned, after stressing of the reinforcing bars 1, through a part which is adapted to be mounted on the projecting end of the conical head. In consequence, immediately

after the supporting of the tensioning head has been provided for, the press is removed and placed ready for the pre-stressing of the next bundle of bars. After removal of the press, the hollow space between the tensioning head and the mouthpiece is filled with cement grouting as in the method already particularly described.

The individual reinforcing bars **1** are again assembled into bundles and first introduced loose into a metal tube **2** which is subsequently packed with cement grouting after performance of the pre-stressing operation. The ends of each bundle are gripped in the conical tensioning head **3** of annular cross section and cast in this latter with best mortar or concrete. At its outer end the tensioning head is provided with internal threading **4** for the screwing thereinto of a draw bolt **5** of a circular press **6** of known form, and with outer threading **7** to enable a nut **8** to be screwed up thereon. Concreted into the end face of the concrete structural element **9** is a support plate **10**. A centering device which connects the tensioning head **3** and the support plate **10** together during this concreting procedure and ensures their accurate relative positioning, can be removed after setting of the structural concrete and before the pre-stressing is carried out.

The stressing procedure begins by screwing the draw bolt **5** into the inner threading **4** in the tensioning head **3** and slipping the annular press **6** over this bolt **5** and pushing it against the support plate **10**. Accurate positioning of the annular press is ensured a priori by the draw bolt. The stressing can then immediately commence.

The conical shape of the tensioning head **3**, the outer surface of which can be greased before the introduction of concrete, permits ready disengagement thereof from the concrete. The external threading **7** is provided, before the casting in of the concrete, with a temporary winding so that it will not bind in the surrounding concrete or the support plate **10** during the stressing procedure. The stressing head **3** has been mounted at a depth in the structural element **9** to be pre-stressed such that, during this stressing of the bars **1**, it is drawn out by the press a sufficient distance beyond the end wall of the structural element **9** or the support plate **10** to enable the nut **8** to be screwed up on the external winding **7** and thus held fast when the end position is reached. When the end position has thus been arrived at and the nut secured, the annular press **6** is relieved and removed. Following thereon the space **29** around and behind the stressing head **3**, which has now become empty, and the whole of the interior of the tubular element **2**, are filled with cement grouting.

The stressing procedure described can also be carried out at both ends of the bundle of bars as can also the process described in connection with Figures 1 to 6. If, as in many instances, it is sufficient in the case of short bundles to effect the pre-stressing of one end only of the bundle, the bars of the bundle can, as a preliminary, be firmly concreted in at the other end. For this purpose the bars of a bundle may advantageously be broadened out fantail fashion at their ends as in Figure 14. The fantails so formed are surrounded once or a plurality of times in helical fashion with robust wire spirals **14**, **14'**. If appropriate, the security of the anchorage formed in this way can be further increased by bending round the ends of the bars to form short hooks **30**.

In order to maintain the requisite intervals between the rows of bars along the complete bundle length, particularly in those cases where there are bends in this length, whilst ensuring unobstructed packing of tubular element **2** and excluding the danger of any rust formation over a period of time, distance pieces in the form of flat, bar-like irons **15** are, as indicated in Figure 12, arranged between the individual rows of bars throughout the length of the tube, and these may be connected together comb-fashion by a web **16**, as in Figure 13. Moreover at the places where the sheet metal tube is contoured, the first layer of bars can be mounted on a loose sliding plate **20** located beneath the adjacent top wall of the tube **2**.

This tube, as indicated in Figure 9, is advantageously made in two parts, viz. a bottom piece **2'**, which is provided at each of its two longitudinal sides with folds, and a piece **2''** which forms the top and the two side walls. The bottom piece **2'** is first placed in position, followed by the placing of the bundle of bars into position, and the piece **2'** is disposed over the bundle so that the side walls of the latter engage at the bottom in the folds of the bottom piece **2'**. Depressions, burrs (projections), or the like can be rolled into the walls of the element **2** to augment the gripping qualities.

The economical nature of this method of construction, which is based on the fact that the press, after supporting the withdrawn stressing head, can immediately thereafter be used for the pre-stressing of a further bundle of bars, is enhanced by the method of construction illustrated in Figures 16 to 18 in that the supporting means, for example the aforesaid nut and support plate, are removed after the setting of the (injected) mortar which is introduced for filling the tubular recess or element and the hollow space located between the stressing head and the mouthpiece.

Consequently these parts are also free to be used elsewhere, so that the operating costs are further reduced.

The invention is based on recognition of the fact that, even without this support, a reliable anchorage of the bundle of tension bars is ensured firstly by the connection with the consolidated mortar and secondly by the rigid stressing head of conical formation.

As in the embodiment depicted in Figures 7 to 10, the ends of the reinforcing bars **1**, which are first introduced loose into the tubular element **2**, are set in the conical tensioning head **3**, advantageously of steel, in the position indicated in Figure 16 by best quality mortar or concrete.

The draw bolt **5** of a press is screwed into the inner threading **4** of the stressing head **3** and the press applied against the support plate **10**. In the present method of construction, this plate is advantageously not, as in Figure 7, let into the side wall of the structural element **9** but is mounted exteriorly on this wall. Consequently the leading end of the stressing head **3** will be drawn, by a press of the kind illustrated in Figure 7, beyond the front face of the structural element and of the support plate **10**, and the nut screwed up on the outer threading **7** of the stressing head **3** in this position, see Figure 17. Thereupon the press is relieved and removed, and following on this the evacuated space **29** around and behind the head **3**, and the whole of the tubular element **2** is filled with cement mortar. When this latter has set, the nut **8** and the support plate **10** are also removed and used elsewhere, so that the anchorage of the tensioned bundle is effected merely by the bonding with the filling mortar, in combination with the wedge-shaped stressing head **3**.

If necessary, the lateral forces imposed by the stressing head on the concrete can be further absorbed by surrounding the hollow space **29** with a robust wire spiral **22** of steel or the like which is concreted into the structural element.

I claim:

1. A method of pre-stressing concrete structures reinforced by at least one bundle of steel bars mounted in a tubular recess terminating in a conical enlargement, the method comprising in combination, cementing the ends of the steel bars in a hollow metal cone of a configuration complementary to the configuration of said conical enlargement of the tubular recess and mounted displaceably within said conical enlargement, drawing the cone, after setting of the cement, in the outward direction relatively to the concrete structure, and filling the annular space formed between the conical enlargement of the recess and the cone with further cement mortar.

2. A method of pre-stressing concrete structures rein-

forced by at least one bundle of steel bars mounted in a tubular recess terminating in a conical enlargement, the method comprising, in combination, cementing the ends of the steel bars in a hollow metal cone which is of a configuration complementary to the configuration of said conical enlargement of the tubular recess, and mounted displaceably within said conical enlargement, drawing the cone, after setting of the cement, in the outward direction relatively to the concrete structure, and filling the annular space formed between the conical enlargement of the recess and the cone and the tubular recess of the structure with further cement by the injection of cement under pressure into said annular space.

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