Jan. 31, 1967 K. BUYER 3,300,922

ANCHOR ASSEMBLY FOR PRESTRESSED CONCRETE STRUCTURES

Filed June 9, 1964 2 Sheets-Sheet 1

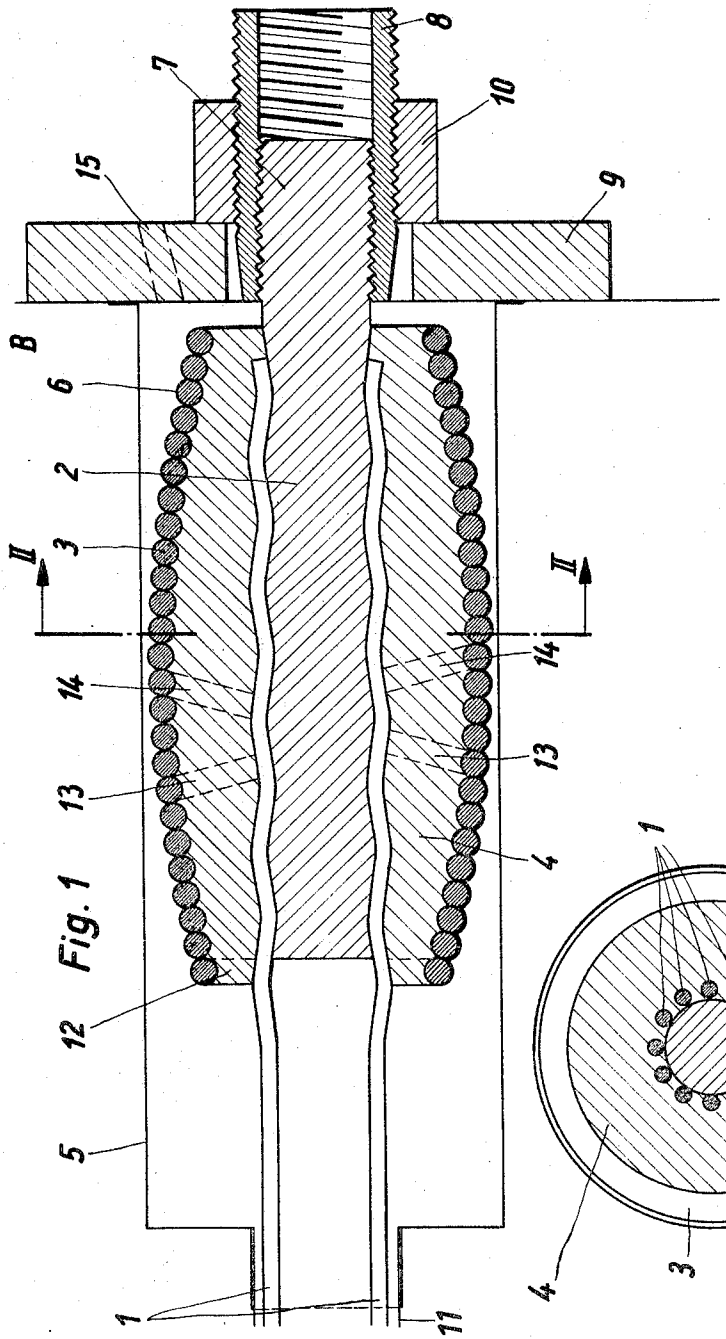

Fig. 1

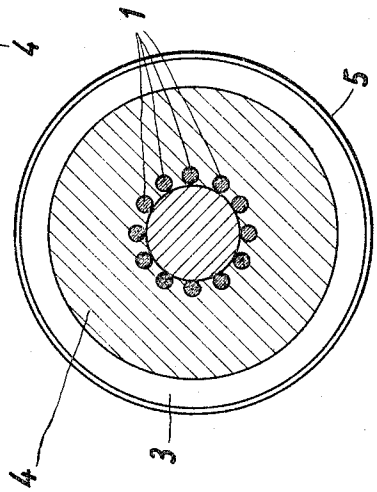

Fig. 2

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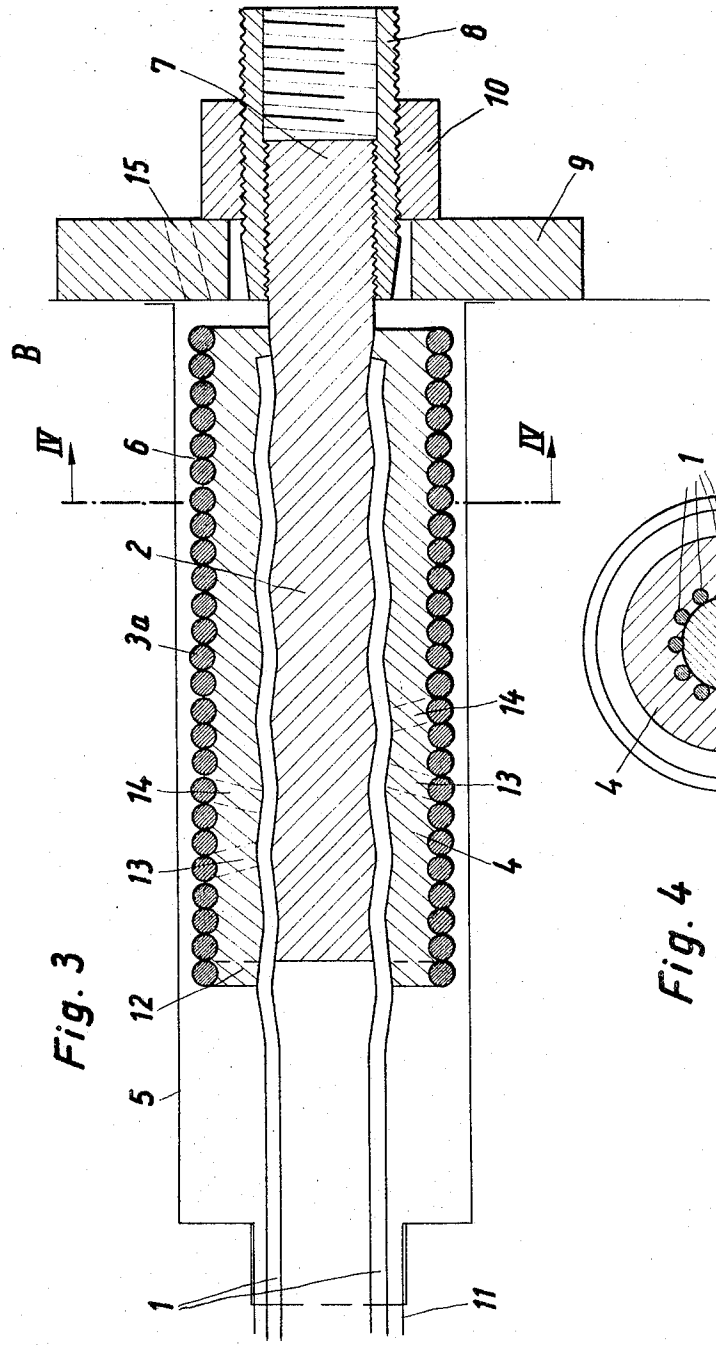

Fig. 3

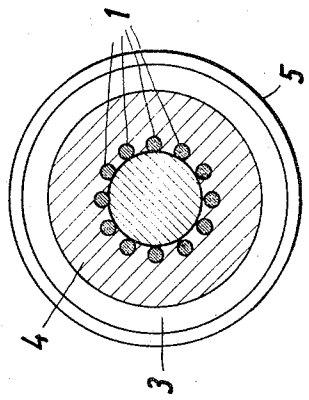

Fig. 4

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ANCHOR ASSEMBLY FOR PRESTRESSED CONCRETE STRUCTURES

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The invention relates to a method of pre-stressing and subsequent attachment of the stressed members which consist of several individual pieces of stressed steel; in particular it relates to a pre-stressing method which is suitable for the use of stressed members consisting of cold drawn steel.

Several methods of pre-stressing methods and subsequent attachment have become known, wherein the stressed steel members are guided in stressing ducts, are pre-stressed by being tensioned against set concrete, and are brought into connection with the surrounding concrete by means of pressed-in cement mortar. The different stressing methods differ from one another, as well known, only as regards the anchorage of the stressed steel members.

With single stressed steel members it is, for example, known to carry out the anchorage at the outside of the structure by means of anchor nuts and anchor plates.

With stressed members consisting of several stressed steel members the anchorage is effected, for example, by mechanical means such as wedges of various designs, upset heads, deflector bodies and the like. These anchorages are suitable for cold drawn steel members as well as for heat treated steel members; they are, however, expensive owing to the multitude and complication of the components needed for the anchorage.

More economical and simpler forms of anchorage may be obtained when, for the anchorage of the individual stressed steel elements of a stressed member, the adhesion is used between the surface of the individual stressed steel elements and a concrete seal, in which they are embedded. The concrete seal is located in a correspondingly shaped steel sleeve, the so-called stresser head, which in turn is anchored in a suitable member e.g. by means of an anchor nut and an anchor plate. For increasing the adhesion an increase of the adhesion surface area is aimed at by using, for example, steel elements of oval profile which moreover are provided with an additional transverse ribbing. This method of anchorage has the advantage of greater economy over the methods mentioned hereinbefore; however, it has been applicable hitherto only to heat treated steel elements which owing to their production method have a greater surface roughness. Cold drawn steel elements have not been suitable for this simple economic manner of anchorage because of their comparatively smooth surface. Accordingly there is a demand for making this economically advantageous method of anchorage applicable also for cold drawn steel elements, which moreover have the advantage over heat treated steel elements of equal quality, of being less liable to stress corrosion.

The present invention has the object of providing a pre-stressing method and subsequent connection of stressed members consisting of several individual steel elements, particularly for stressed members consisting of cold drawn steel elements, with the use of a cast concrete body enclosed in a sleeve, or of a concrete seal at the stressed end, wherein the ends of the stressed wires are distributed, preferably in a radially symmetrical manner, around a core piece arranged in the middle.

According to one aspect of the invention an anchor head is provided for wire bundles, particularly of cold drawn wires, wherein the ends of the wires to be stressed

are distributed preferably, in a radially symmetrical way, around a tension bolt which is arranged in the centre of a cast concrete body surrounded by a sleeve, wherein the individual wires are provided over their embedded length with a longitudinal corrugation and contact directly the tension bolt which is provided with a corresponding corrugation.

Another aspect of the invention is a method of pre-stressing and subsequent connection for the stressed members consisting of several separate steel elements, particularly for stressed members of cold drawn steel with the use of a cast concrete body enclosed by a sleeve or of a concrete seal at the tension end wherein the ends of the wires are preferably distributed in a radially symmetrical manner about a core piece arranged in the middle and wherein the individual stressed wires are provided with longitudinal corrugations over their embedded length and directly contact the core piece provided with corresponding corrugations in such a manner that after the setting of the cast concrete body and upon the subsequent stressing of the wires the latter are pressed against said core piece and a displacement of the stressed wires relative to said core piece or relative to the cast concrete body in the axial direction is prevented, when carried out by an anchor head according to the first aspect of the invention.

By this measure it is attained that the ends of the steel elements in spite of their smooth surface are locked relative to the core member as well as relative to the cast concrete body against axial tensile loads, with a sufficient strength. This locking against axial tensile loads between the steel elements and the surrounding cast concrete body as well as between the steel elements and the core member may be explained by the following considerations; between the corrugations of the steel elements and of the core member respectively and between corresponding parts of the inner profile surface of the sleeve of the cast concrete body there exist two sets of conical stressed areas running at an angle to one another through which the corrugations of the steel elements and the core member respectively bear on the parts of the inner profile surface of the sleeve of the cast body which sleeve acts in tension to remit compression stress in the cement body when applying an axial tensile stress between the steel element on the one hand and the core piece or the cast concrete body on the other hand. It will be realised that the aforesaid conical stressed areas act in the manner of "spring washers" and are stressed in compression in the sleeve of the cast concrete body which is particularly well suited to the strength characteristics of the concrete.

This method of anchorage according to the invention is suitable likewise for the fixed end of the stressed member in addition to the end thereof to which the tension is applied.

Accordingly in one embodiment of the invention provision is made such that when applied to the movable end of the stressed member the core piece serves for the connection of the tensioning means, and that the cavity remaining between the sleeve of the cast concrete body and the anchor sleeve is filled with pressed mortar after the stressing.

According to a further embodiment of the invention provision is made that when applied to the fixed end of the stressed element the anchor head consisting of the sleeve for the cast concrete body, the concrete and the core piece is simply included into the structural concrete.

According to a particularly advantageous embodiment of the invention provision is made that the sleeve for the cast concrete body is constructed as an anchor spiral consisting of wire coiled up in rotationally symmetrical way. The anchor spiral may have in a longitudinal section various profiles, for example a cylindrical or a bell

shaped profile. These embodiments, wherein the sleeve of the cast concrete body is constructed as an anchor spiral coiled up from wire, have the advantage of particular simplicity and economy since the sleeve of the cast concrete body in this manner receives the required profile at the inner surface for the support of the conical stressed areas without requiring special treatment.

Moreover the invention extends also to an anchorage head suitable for carrying out the method described hereinabove.

Further advantages and details of the invention result from the following description of two embodiments thereof given by way of example with reference to the accompanying drawing in which:

FIGURE 1 is an axial section illustrating the anchorage of the tension end of the pre-stressed member according to the method of the present invention,

FIGURE 2 is a cross section on the line II—II of FIGURE 1,

FIGURE 3 is a sectional illustration corresponding to FIGURE 1 of a modified embodiment having a sleeve of the cast concrete body of cylindrical longitudinal section,

FIGURE 4 is a cross section corresponding to FIGURE 2 on the line IV—IV of FIGURE 3.

In FIGURE 1 the end of a stressed member at the tensioning end is illustrated in section which member serves for the prestressing of a concrete structure indicated in general by B. By means of enveloping tubes **11** stressing ducts are left open in said structure which duct at the tensioning end are enlarged, at the anchorage sleeve **5**, to a cylindrical space of larger diameter. In said stressing ducts there run the stressed steel elements **1** which in the embodiment illustrated are formed by twelve wires arranged in a radially symmetrical pattern (FIGURE 2).

As shown in FIGURE 1 the steel wires are provided at their ends with corrugation extending over the embedded length which corrugation corresponds with corrugations of a core piece **2**. The corrugated ends **1** of the wires are distributed in a radially symmetrical manner around the core member **2** and are inserted with their corrugations in corresponding corrugations of the core member.

This tensioning end of the stressed member lying within the cavity **6** of the anchorage sleeve **5** is surrounded by a co-axial anchor spiral **3** which is coiled of steel wire and in the longitudinal section has a barrel shaped profile. In the space between the anchor spiral and the core piece provided with the wires, concrete is introduced so that the cast concrete body **4** is formed.

In practical operation one proceeds in such a manner that on a separate machine the ends of the wires provided with the corrugations are arranged outside the concrete structure in the manner described around a core piece **2** likewise provided on a separate machine with corrugations, and are fixed thereon in this arrangement if necessary by means of a simple jig. Thereafter the anchor spiral coiled in the manner described is pushed over the end of the tension member and is retained thereon in a suitable way, for example by means of a closure plug **12** (indicated in FIGURE 1 in chain dotted lines) inserted into one end of the anchor spiral coaxially. Subsequently, the cavity remaining inside the anchor spiral is filled by casting in concrete. After the setting of the cast concrete body **4** the tension end of the stressed member is prepared for anchoring.

As mentioned before the method of anchorage according to the invention is suitable likewise for the fixed end as well as for the tension end of the stressed member. In FIGURE 1 the application to the tension end of the stressed member is illustrated; for this purpose the core piece **2** has an extension **7** protruding outwardly which serves for the connection of the stressing press and is for example provided with an external screw thread which

is in engagement with the internal screw thread of a turnbuckle **8** provided with internal and external screw threads over part of its length; the remaining part of the inner screw thread receives the end of a pull rod of the tension press (not shown). In this manner the core piece **2** may be subject to tensile stress, a certain connection between the core piece **2** and the ends **1** of the stressed steel elements in engagement with the corrugations thereof being secured by the cast concrete body **4** being clamped by the surrounding anchor spiral **3**. It may be assumed that the clamping of the ends of the stressed steel elements within the cast concrete body **4** and relative to the core piece **2** is effected in such a manner that two conical concrete surfaces, inclined relative to one another at an angle (two conical surfaces are indicated in FIGURE 1 as **13** and **14** in dotted lines), between the corrugated parts of the stressed wires and of the core member and the corresponding circumferential portions of the anchor spiral bear against the corresponding parts of the inner circumference of the anchor spiral which are stressed in tension, when applying an axial tension between the core piece and the ends of the stressed wires and between the cast concrete body and the ends of the stressed wires. The aforesaid imaginary conical concrete shells are, as will be seen, thereby stressed in compression which is a manner of stressing particularly adapted to the strength characteristics of concrete. Additionally as a secondary effect the wedge action of the cast concrete body as a whole may act on the converging ends of the anchor spiral. It should, however, be remarked that this additional wedge action generated by the belled profile of the anchor spiral is not absolutely necessary, and that even with cylindrical profiles of the anchor spiral a sufficient locking of the ends of the stressed wires through the core piece **2** and to the cast concrete body **4** may be attained. The stressed member may abut on the outside of the concrete structure B in the stressed condition in a conventional manner, for example by means of an anchor plate **9** and of the turn-buckle **8** provided with an external screw thread in engagement with the anchor nut **10**. Subsequently the cavity surrounding the end of the stressed member with the anchor spiral within the anchor sleeve **5** is filled by means of pressed-in mortar which is pressed in a conventional manner for example through an aperture **15** in the anchor plate. After the setting of this filling in the cavity **6** the outer abutment (anchor plate **9** with anchor nut **10**) may be removed. The anchorage is now secured in a safe manner by the adhesion of the ends of the stressed wires within the cast concrete body **4**. Various provisions may be made for the removal of the outer abutment in the stressed condition, for example the anchor plate or the anchor nut may be constructed in pieces which may be separated from one another.

The application of the method according to the invention to the fixed end of the stressed member takes place in a similar manner; only in this case the core piece **2** need not have a protruding projection **7**. In a typical embodiment the individual components may have the following dimensions: the wires are of cold drawn steel wires of 6 mm. diameter; the anchor spiral is coiled from a steel wire of 10 mm. diameter, the length of the anchor spiral amounting to 25 cm., the largest diameter in the middle of the barrel shape profile amounting to 12 cm., the smallest diameter at the ends to 8 cm.

Obviously the embodiment described by way of example may be modified in many ways as regards details. As regards the longitudinal profile of the anchor spiral it has already been mentioned that this may be of various shapes, for example of a cylindrical shape instead of the barrel shape as shown in the embodiment.

Accordingly in FIGURES 3 and 4 a modified embodiment is illustrated wherein the sleeve for the cast concrete body is likewise formed as an anchor spiral **3***a* coiled of wire but having a cylindrical longitudinal pro-

file. Preferably the anchor sleeve 5 is likewise provided with a corrugated profile, in order to prevent an abrupt re-arrangement of stress concentration at the taking-off of the tension end and in order to secure the introduction of forces as far as possible over the entire length of the anchor spiral. The desired corrugation of the anchor sleeve 3 may be attained in a simple manner, for example with the usual anchor sleeve coiled of a strip of sheet metal by a suitable control of the coiling machine. Moreover the sleeve 3 of the cast concrete body need not necessarily be made as a coiled wire anchor spiral: other for example compact embodiments, say in the form of a steel cylinder, are applicable the inside of which is preferably provided with a corresponding profile in order to secure the support of the aforesaid conical stressed areas.

The manner of connection of the tensioning press to the core piece may be modified in any manner desired, for example the extension 7 and the turnbuckle 8 may be constructed integral with the core piece 2.

As regards the number and the gradient of the corrugations provided on the core piece corresponding to the end of the steel wire ends modifications are likewise possible within wide limits in accordance with the loads coming into question.

What we claim is:

1. An anchor head for wires to be pre-stressed comprising:

a stressed cast concrete body having an outer sleeve and a solid central tension bolt extending along the axis thereof, said tension bolt having a longitudinal corrugated outer surface;

wire ends distributed around said bolt in a radially symmetrical manner and shaped to correspond to the corrugated surface of said bolt, said wires being in engagement with said bolt;

said bolt and wire ends being embedded in the concrete member so as to maintain axial tensile forces and to force the wire ends against the outer surface of the central bolt.

2. The anchor head of claim 1, wherein said central bolt is extended outward from said concrete member to form an extension and said extension is threaded so that by means of a turnbuckle it can be connected with the pullrod of a tension press.

3. The anchor head of claim 1, wherein said central bolt is extended outward from said concrete member to form an extension, and said extension is threaded into a tubular socket having an internal and external thread.

4. The anchor head of claim 1, wherein said central bolt is extended outward from said concrete member to form an extension, and at the intersection of said concrete member and extension is firmly affixed an abutment plate.

5. The anchor head of claim 1, wherein said outer sleeve is comprised of a coiled wire surrounding said concrete member.

6. The anchor head of claim 5, wherein said outer sleeve is barrel-shaped.

7. The anchor head of claim 5, wherein said outer sleeve is cylindrical.

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