April 11, 1967 R. MACCHI 3,313,560
PRE-TENSIONING WIRES ANCHORING SYSTEM FOR CONCRETE PRE-COMPRESSED STRUCTURES AND THE LIKE
Filed June 16, 1964 3 Sheets-Sheet 1

Fig. 1

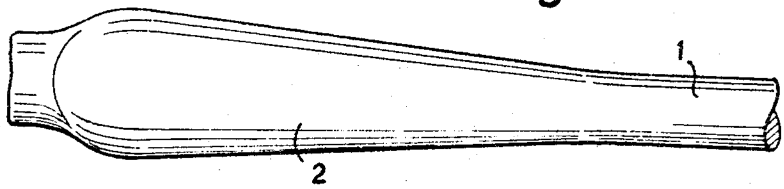
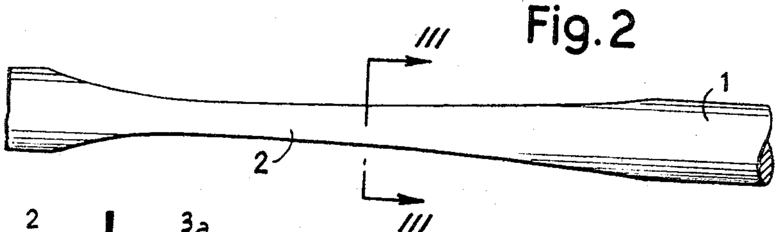


Fig. 2



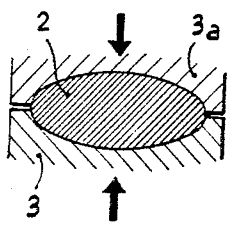


Fig. 3

Fig. 4

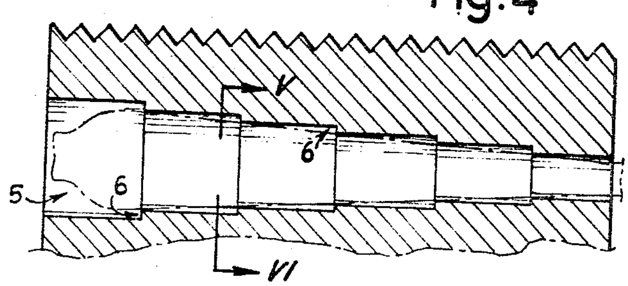


Fig. 5

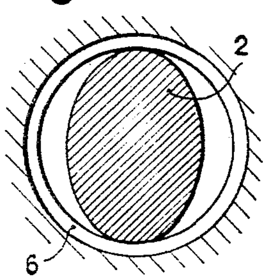


Fig. 6

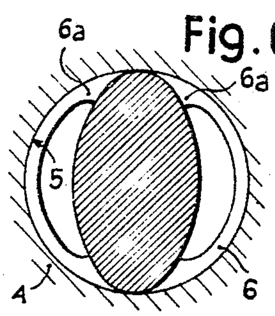


Fig. 7

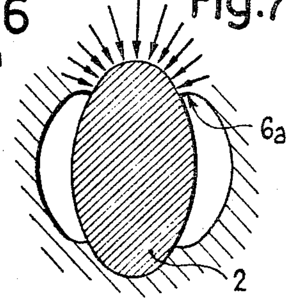


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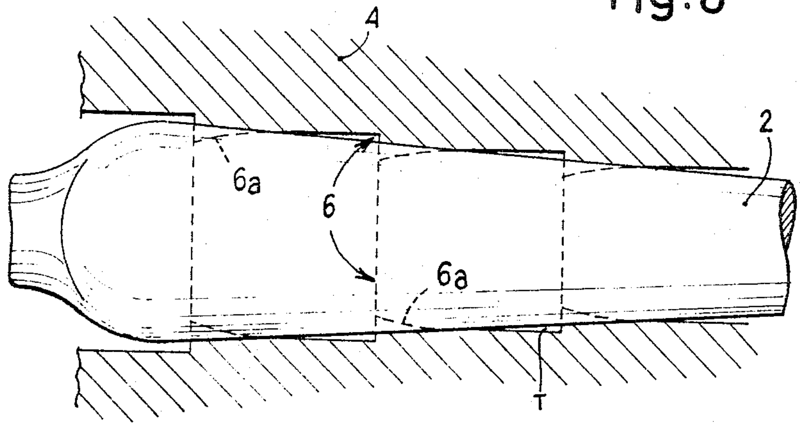
Fig. 8



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PRE-TENSIONING WIRES ANCHORING SYSTEM FOR CONCRETE PRE-COMPRESSED STRUCTURES AND THE LIKE
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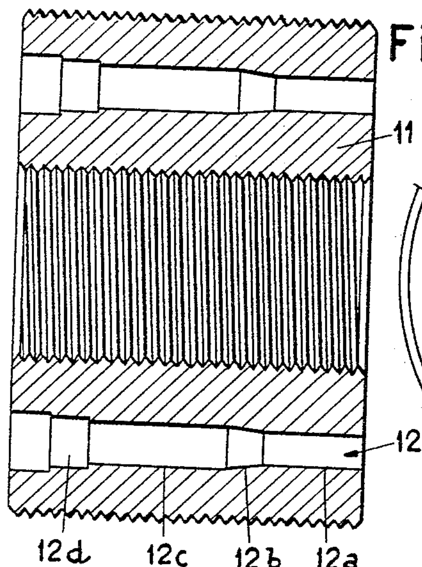

Fig. 9

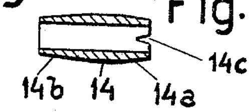

Fig. 11

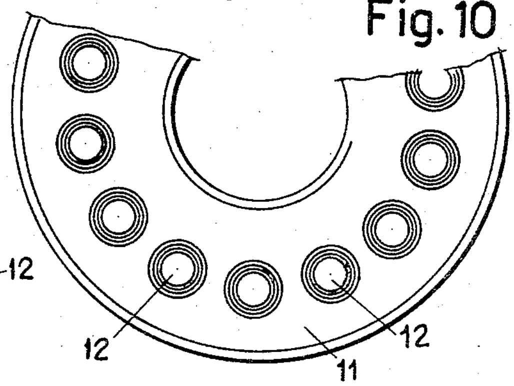

Fig. 10

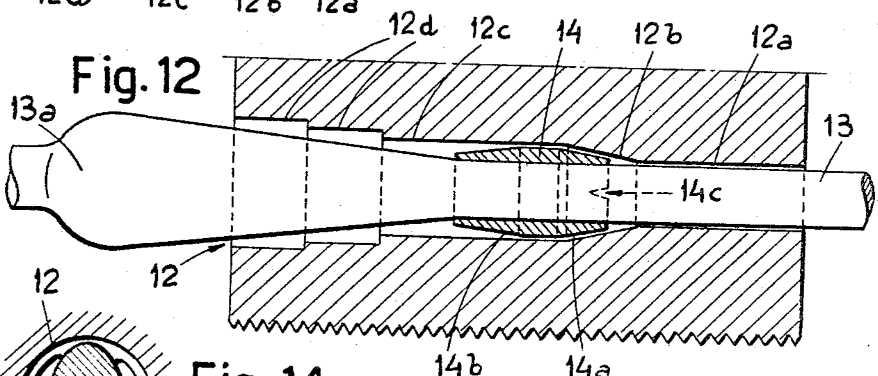

Fig. 12

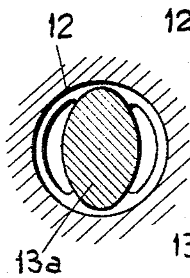

Fig. 14

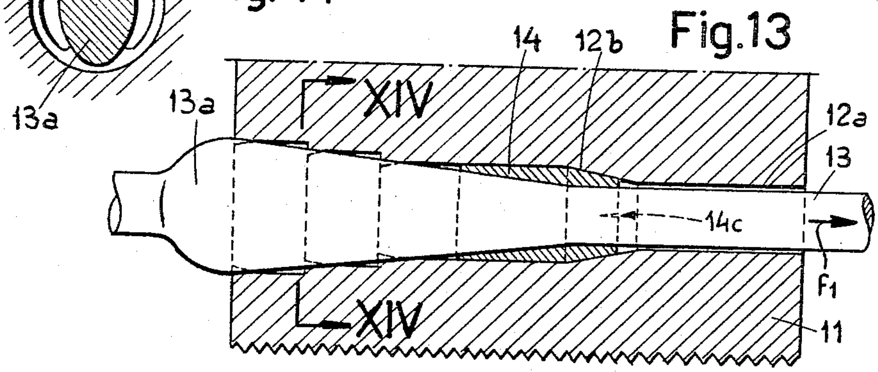

Fig. 13

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PRE-TENSIONING WIRES ANCHORING SYSTEM FOR CONCRETE PRE-COMPRESSED STRUCTURES AND THE LIKE

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Filed June 16, 1964, Ser. No. 376,306
Claims priority, application Italy, Apr. 7, 1961, 646,855; June 17, 1963, 12,598/63
6 Claims. (Cl. 287—20.3)

This is a continuation-in-part of application Ser. No. 184,712 filed Apr. 3, 1962, and now abandoned.

The invention relates to a system for anchoring and pre-tensioning the reinforcement wires of prestressed concrete structures.

Processes are presently used, in a special manner characterized by the use of a movable anchoring body or head, to which the wires to be stretched are previously anchored by means of small heads formed in the ends of the wires.

The present invention provides a process in which the wires are anchored by means of a head obtained by a simple lateral pressing, which modifies only the cross-sectional configuration of the end of the wire.

The active portion of the head is received in an anchoring socket member. The socket member has formed therein a coaxial series of cylindrical recesses. There is a series of flat annular shoulders between adjacent recesses which define a series of circular gripping edges which lie on an imaginary frusto-conical surface the angle of convergence of which is the same as the angle of convergence of the rectilinear sides of the head portion. Effectively, the anchoring heads have cross-sectional configurations of generally elliptical shape; in particular, the cross-section at any particular portion has an elliptical shape; obtained by means of dies which have laterally compressed the material to define the desired cross-sectional configuration.

Accordingly, a further object of the invention is to provide an anchoring system of the defined type characterized by the use of supplemental tubular sleeve or bushing elements designed to be placed on each wire prior to formation of the head and after the insertion of each wire into its respective hole of the socket member; said tubular elements being shaped to co-operate with the frusto-conical profile of the hole adjacent to the hole having the minimum diameter.

The invention will be better understood from the following specification with reference to the accompanying drawing illustrating a preferred embodiment of the invention.

Referring to the drawing:

FIGURE 1 is an enlarged fragmentary plan view of a reinforcement wire showing a laterally enlarged head portion used in tensioning the wire.

FIGURE 2 is a side view of the wire shown in FIG. 1.

FIGURE 3 is a transverse sectional view taken along the line III—III of FIG. 2, additionally including a sectional view of the press jaws used in forming the head portion of the wire shown in FIGS. 1 and 2, the jaws being shown at the end of the forming stroke.

FIGURE 4 is a fragmentary view in longitudinal section of a threaded member containing a socket for cooperation with the head portion of the wire shown in FIGS. 1 and 2, the socket being shown in its empty condition.

FIGURE 5 is a transverse sectional view taken along the line V—VI of FIG. 4, the wire being shown in place just prior to tensioning engagement between the wire and the socket.

FIGURE 6 is a view similar to FIG. 5 illustrating the interaction under tension between the head portion of the wire and one of the shoulders of the socket.

FIGURE 7 is a force diagram further illustrating the interaction under tension between the wire and the socket.

FIGURE 8 is an enlarged view in longitudinal section showing partial deformation of the socket by the head portion of the wire under tension.

FIGURE 9 is a view in axial section showing a modified form of socket member.

FIGURE 10 is an end elevational view of the socket member of FIG. 9.

FIGURE 11 is a view in axial section of a deformable tubular sleeve member used with the socket member of FIGS. 9 and 10.

FIGURE 12 is an enlarged view in axial section showing one of the holes of FIG. 9 with a wire in place prior to tensioning.

FIGURE 13 shows the arrangement of FIG. 12 after tensioning of the wire.

FIGURE 14 is a transverse sectional view taken along the line XIV—XIV of FIG. 13.

In the drawing, for clarity of illustration, the radial dimensions are exaggerated with respect to the axial dimensions.

Referring to FIGS. 1 through 3, there is shown a reinforcing wire 1 of circular cross-section having a laterally enlarged head portion 2 formed therein intermediate its ends. The cross-sectional configuration of the head portion 2 is elliptical throughout its length. At the right hand side, as shown in FIG. 1, the ratio between the major and minor axes of the ellipse is substantially unity so that the cross-section is nearly circular and this ratio varies continuously and progressively from section to section with the major axis being substantially longer than the minor axis at the widest portion of the head 2. The surfaces are smooth and continuous being free from corners, edges or other discontinuities.

The non-circular cross-sectional configuration of the head portion 2 is obtained by the use of dies, such as those designated 3, 3*a* in FIG. 3 and which are pressed together transversely with respect to the longitudinal axis of the wire, the configuration of the dies being such as to cause the head portion 2 to attain the desired shape, accompanied by a compacting of the deformed material, when said dies reach the position of the maximum approach as shown in FIG. 3. It is to be noted that, in this limiting position, the two dies are substantially contacting each other and the material of the deform wire or rod practically fills the entire space between the dies, with the result that inwardly directed lateral forces are also applied. Therefore, the initial compactness of the material is retained, and additionally, the material is not distorted or weakened by the presence of corners or projecting fins.

It will be observed in FIGS. 1 and 8, that the sloping sides of the head 2 are substantially rectilinear throughout the progressively widening portion of the head. In other words, the length of the major axis of any elliptical section is a linear function of its distance from the right hand end of the head 2 as viewed in FIG. 1 or FIG. 8.

A single socket of a member (not shown) for receiving a plurality of heads 2 is shown in FIG. 4, the head 2 being shown in broken outline. The socket designated generally as 4 is formed by a plurality of holes, arranged as a coaxial series of cylindrical recesses 5 with a flat annular shoulder 6 connecting the cylindrical wall of each recess with the cylindrical wall of the adjacent recess or recesses as the case may be. There is thus formed a series of circular gripping edges of rectangular cross-section in a radial plane passing through the common axis of the recesses. The circular gripping edges of the series lie on or define an imaginary frusto-conical surface which has the same angle of convergence as the rectilinear sloping sides of the head 2 as viewed in FIG. 1, for example. When received in the socket 4, the head 2 simultaneously engages a plurality of the gripping edges. In FIG. 4, the difference between the diameters of adjacent gripping edges has been exaggerated for clarity of illustration. In practice, there is a difference in diameter between adjacent cylindrical recesses of only a few tenths of a millimeter.

Before tensioning, the sloping rectilinear sides of the head **2** contact the corners or gripping edges of the shoulders **6** as shown in FIG. 5. When tension is applied by the anchoring socket **4** to obtain the stretching of the wires **1** a slippage occurs between the head portion **2** and the anchoring body or socket **4**, and the softer material of the socket **4** defining the circular gripping edges is deformed, in such a manner as to form the seating portions or zones **6a** (FIG. 6).

The seating zones **6a** are sharply curved and spaced at an appreciable distance from the wire axis, thus creating a positive and efficient support which is superior to conventional systems having frusto-conical contact surfaces between the heads and the cooperating walls of the holes.

In FIG. 8, the cold flow of the material is shown during an intermediate stage of the slippage, or creep, at the end of which also the spaces T of triangular section may disappear.

In FIG. 7 there are shown, along one of the two arcs of contact profile, arrows representing the forces or stresses which are developed by the deformation shown in FIG. 6 in such a manner as to avoid excessive stress in the direction of the major axis of the head cross-section, and which thus avoids possible failure in the direction of the minor axis of the elliptical cross-section.

According with the FIGS. 9 through 14, the socket member **11** is provided with a plurality of through holes **12**, each of which is designed to anchor a tensioning wire **13**, after the latter has been passed through the hole **12** and then laterally deformed to form a head portion **13a**. The head portion **13a** is similar to the head portion **2**, described above. The transverse cross-sectional area of the head portion **13a** is substantially the same throughout its length and substantially equal to the cross-sectional area of the wire **13**.

In order to facilitate introduction of the wire **13** into the smallest hole **12a**, instead of a flat annular surface, a frusto-conical surface **12b** is provided between the smallest hole **12a** and the cylindrical recess **12c**. Cylindrical recesses **12c** and **12d** provide circular gripping edges, as previously described.

Because of the absence of a circular gripping edge adjacent to the smallest hole **12a**, a deformable tubular sleeve member **14** (which may be formed of stainless steel) is utilized for cooperation with the frusto-conical surface **12b**. The sleeve member **14** is placed on the wire **13** after its insertion in the hole **12** and prior to formation of the head **13a**. The internal diameter of the sleeve member **14** is accurately dimensioned with respect to the wire **13**. Its maximum external diameter is dimensioned to fit the cylindrical recess **12**. One end portion **14a** is of tapering wall thickness and is shaped for cooperation with the frusto-conical surface **12b**. Notches **14c** facilitate deformation by the frusto-conical surface **12b** to provide positive gripping of wire **13** when under tension. The other end portion **14b** is similarly of tapering wall thickness to facilitate deformation by the head **13a**.

After formation of the head **13a** has been completed, the wire **13** and the sleeve member **14** are positioned as shown in FIG. 12, the sleeve member **14** being located in recess **12c** in proximity to the frusto-conical surface **12b**. When tension is applied to the wire **13** in the direction indicated by the arrow f_1 in FIG. 13, the portion **14b** of the sleeve member **14** is deformed by the tapering head **13a** and forced against the wall of the cylindrical recess **12c** by the progressively increasing major axis of the elliptical cross-section of the head portion **13a**. The other end portion **14a** of the sleeve member **14** with notches **14c** is forced into positive gripping of the wire **13** by engagement with the frusto-conical surface **12b**.

The final configuration of sleeve member **14** under tension is shown in FIG. 13. As described above, the circular gripping edges within the recesses **12c** and **12d** become deformed as illustrated in FIG. 14.

While I have shown and described what I believe to be the best embodiments of my invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. In a wire tensioning device, in combination: a wire having a laterally enlarged head portion formed therein, said head portion having an elliptical cross-sectional configuration which varies uniformly and continuously throughout its active length, the length of the major axis of any particular cross-section being a linear function of its distance from one end of said active length, whereby said head portion has rectilinear convergent sides; and a socket member for tensioning said wire by engagement with said head portion, said socket member having a coaxial series of cylindrical recesses formed therein with a flat annular shoulder between adjacent recesses, said wire passing axially freely through the smallest of said recesses, said shoulders defining a series of circular gripping edges which lie on an imaginary frusto-conical surface the angle of convergence of which is the same as the angle of convergence of said rectilinear sides, whereby the active length of said head portion, when initially received in said recess, may simultaneously engage a plurality of said gripping edges, the relative hardnesses of said head portion and said gripping edges causing deformation of said edges to provide seating zones for said head portion therein when tension is applied to said wire by axial displacement of said socket member.

2. The combination according to claim **1**, wherein the cross-sectional configuration of said gripping edges, as viewed in a radial plane passing through the common axis of said recesses, is rectangular.

3. The combination according to claim **1**, wherein the magnitude of the cross-sectional area of said wire is constant throughout its length, said length including said head portion.

4. In a wire tensioning device, in combination: a wire having a laterally enlarged head portion formed therein, said head portion having an elliptical cross-sectional configuration the major axis of which varies uniformly and continuously throughout its active length, the length of the major axis of any particular cross-section being a linear function of its distance from one end of said active length, whereby said head portion has rectilinear convergent sides; a socket member for tensioning said wire by engagement with said head portion, said socket member having a tensioning aperture formed therein through which said wire passes, said aperture being defined by a series of axially aligned holes of differing diameters, said wire passing freely through the smallest of said holes, said smallest hole having a frusto-conical bearing surface adjacent thereto which diverges toward the next larger hole, said next larger hole and other adjacent larger ones of said holes being joined by flat annular shoulders, said shoulders defining a series of circular gripping edges which lie on an imaginary frusto-conical surface the angle of convergence of which is the same as the angle of convergence of said rectilinear sides; and a deformable tubular sleeve member on said wire intermediate said head portion and said frusto-conical bearing surface, the relative hardnesses of said head portion and said gripping edges causing deformation of said edges to provide seating zones for said head portion therein when tension is applied to said wire by axial displacement of said socket member, said axial displacement further causing axial compression of said sleeve member by engagement of one end thereof with said head portion and engagement of the other end with said frusto-conical bearing surface, said compression forcing said sleeve member into positive gripping engagement with said wire.

5. A device according to claim **4**, wherein the wall thickness of said sleeve member is reduced at its end portions with respect to the central portion thereof.

6. A device according to claim **5**, wherein said other end of said sleeve member has axially extending notches formed therein for facilitating deformation thereof to grip said wire.

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FRANK L. ABBOTT, *Primary Examiner.*

A. B. WILLIAMS, A. C. PERHAM, *Assistant Examiners.*