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2,934,935

CAST TENSIONING HEAD FOR ANCHORING TENSIONING
MEMBERS, PREFERABLY FOR PRE-STRESSED CONCRETE

Filed Jan. 22, 1957

3 Sheets-Sheet 1

FIG. 1



FIG. 2

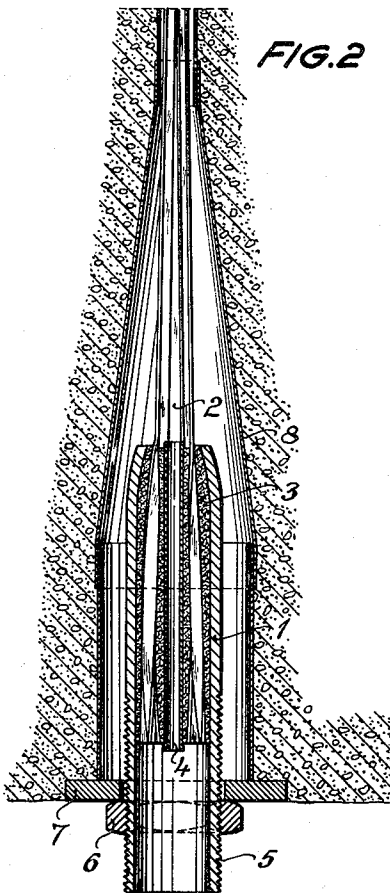


FIG. 4



FIG. 3

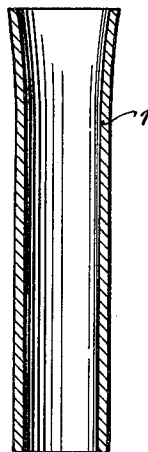


FIG. 6

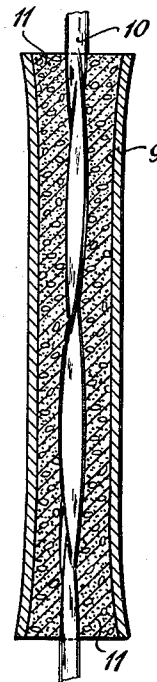


FIG. 5

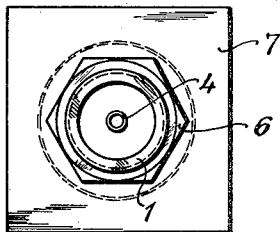
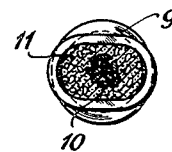


FIG. 7



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FIG. 9

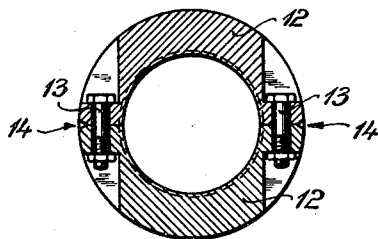


FIG. 10



FIG. 8



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FIG. 11



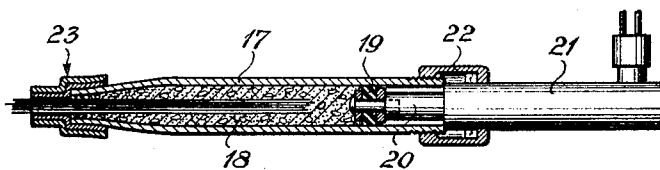
FIG. 12



FIG. 13



FIG. 14



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CAST TENSIONING HEAD FOR ANCHORING TENSIONING MEMBERS, PREFERABLY FOR PRE-STRESSED CONCRETE

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10 Claims. (Cl. 72-108)

This invention relates to a tensioning head for tensioning members, preferably for pre-stressed concrete.

It is known that if tensioning members for pre-stressed concrete or other purposes consist of individual tensioning wires, they can be anchored by being cemented into a tensioning head. In most cases a conical sleeve made of cast steel is used, the sleeve surrounding the cement seal. The individual tensioning wires are formed at their ends with bent hooks or are alternatively, or additionally, bent in the form of a cylindrical or conical spiral of considerable pitch. Tensioning members anchored in this way can be tensioned either by forming screw-threading on the tensioning head and screwing the spindle of a hydraulic jack onto such screw-threading, or by gripping the tensioning head between claws and then pulling the head. The tensioning force of the tensioned member can be resisted either indirectly by means of screw-threaded nuts on a steel support plate or directly against the hardened concrete seal.

The tensioning heads known hitherto have the following disadvantages:

(1) The particular steel castings for the tensioning heads are comparatively expensive, especially if only a small number of such castings of a specific size are required.

(2) Owing to the conical construction of the cast steel tensioning heads, there is the risk that, when they are being fitted, the cement seal will be damaged by being loosened and slipping out of the relatively large opening. Furthermore, during the initial tensioning of the tensioning member it is easy for the concrete seals in the conical head to slip out.

(3) In various anchoring processes the tension in the tensioning member is resisted only by the hardened concrete seal, which, however, is often not desirable owing to the varying quality of the concrete. Therefore only screw-threaded nut abutments need be considered. The requisite length of screwthreading generally depends on the tensioning distance necessary. With cast steel tensioning heads, this necessitates either a preparation of tensioning heads with different thread lengths or an increased outlay in material even where it is not required. In no other way is it possible to guarantee that the thread length necessary for tensioning each tensioning member with the actual force required will be available.

(4) A known anchoring process utilises internal and external threading on the cast steel tensioning head, this being disadvantageous for economic reasons owing to the cost of forming double screwthreading. There are also the disadvantages mentioned under point 3 above.

(5) With high-quality steel tensioning wires, a considerable amount of work is involved in bending the ends of the wires in order to form the cylindrical or conical spirals. In addition it is dangerous to make the radii of bending too small owing to the brittleness of the wires. It is also doubtful whether the tensioning wires can be

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sufficiently securely anchored in the cement seal even when the wires are provided with ribs if the wires are only supported by the relatively low ribs.

According to one aspect of the invention there is provided a method of forming a tensioning head for anchoring tensioning members for pre-stressed concrete, comprising the steps of entering the end of at least one tensioning member in one end of a thick-walled, heat-treated steel tube, which end of said tube is formed with a substantially elliptical mouthpiece, and securing the end of the, or each tensioning member in position by means of a sealing mass of concrete which is allowed to harden.

According to another aspect of the invention there is provided a tensioning head for anchoring tensioning members for pre-stressed concrete, comprising a thick-walled, heat-treated steel tube, a substantially elliptical mouthpiece at one end of said tube, at least one tensioning member passing through said mouthpiece with the end of the, or each tensioning member disposed within said tube, and a concrete seal surrounding said end of the, or each tensioning member and securing the same within the tube.

A tensioning head constructed in this way first of all affords the advantage that it can be manufactured in a very simple manner and more quickly and more cheaply than can the conventional tensioning heads made of special steel castings. It is not necessary to keep a stock of a relatively large number of different heads since the tensioning heads required can be manufactured at any time from heat-treated steel tubing, and any screw-threading required can easily be cut to the necessary length. It is of particular advantage that, due to the narrowing of the steel tube in one direction, which narrowing can be effected easily by flattening without any particular tools, the steel tube or tensioning head is also widened in the direction perpendicular to the flattening so that the concrete seal in the tube can be held fast against movement in either axial direction, and the steel tube is prevented from bending out of shape.

Moreover, the number and arrangement of tensioning wires in a tensioning member and in the tensioning head is optional and can be closely adapted to actual requirements. It is also possible to tension a single steel member with the tensioning head and the space required for the tensioning head is very small. It is also easy to prepare the tensioning wires at the anchoring end and this can be done particularly quickly and simply in the case of oval cross-section wires by turning them twice through 90°. It is also possible for tensioning wires of circular cross-section, stranded wires or cable to be anchored reliably and economically in the tensioning head.

The tensioning head can also be used with the ordinary hydraulic jack and spindle so that the tensioning member can be tensioned reliably, quickly and simply.

A particularly expedient constructional form is obtained by embedding a small steel tube together with a tensioning member in the tensioning head, the tube being disposed along the axis of the tensioning head, thereby to provide a passage through which the sealing mass of concrete can be pressed out into the sliding channel. The sliding channel can then be sealed particularly quickly and simply. The small tubular steel element through which the pressed-out sealing mass is introduced is concealed within the head and is, therefore, not liable to be damaged.

A further important advantage resides in the fact that the tensioning head can be used in the field of prestressed concrete, with subsequent binding for a further purpose. With very long tensioning members there is a considerable loss in tensioning force owing to friction. It is therefore desirable to arrange so-called intermediate tensioning points. This is known, and such intermediate

tensioning points generally comprise a cable clip of steel which grips the exposed tensioning member at the intermediate tensioning point so that a hydraulic tensioning apparatus can be applied to the cable. Owing to the considerable forces necessary, a good deal of expense was entailed which was only worthwhile in the case of tensioning members working with very great tensioning force and was only then possible owing to the considerable space required. Also it was not possible to be certain whether the middle tensioning wires of the bundle were held sufficiently securely.

The second use here proposed for the tensioning head eliminates these disadvantages, and enables intermediate tensioning points for tensioning members of small or medium tensional force to be constructed reliably, easily and economically, by securing the tensioning head at any point on the tensioning member by a sealing mass e.g. concrete, and using it as an intermediate tensioning head, for reducing frictional losses.

In order to improve the binding effect between the steel tube and the seal, the inner wall of the steel tube can be provided, in the region of the seal with a roughened portion in the form of a coarse screwthread. The good binding effect inter alia reduces the surface pressures which occur at the place or places where the steel tube is narrowed. For a bond between the steel tube and the tensioning member it is important that the tensioning wires should be uniformly distributed within the concrete seal at almost every cross-sectional plane of the seal. The spreading of the tensioning wire bundle which is necessary to achieve this is brought about automatically by the aforesaid twisting of the oval cross-section tensioning wires.

Owing to the roughening of the inner surface of the steel tube in the region of the seal, the bond between the seal and the steel tube is so great that the surface pressures at the inclined parts of the inner surface of the steel tube cannot exceed the permissible value. This prevents the seal from being destroyed at these points, and prevents the anchoring of the tensioning member from being impaired.

If the tension is to be resisted by the hardened concrete seal, the release of the loaded anchoring nut of the tensioning head sometimes presents difficulties owing to the torque required for this purpose, and nuts with relatively large diameters often cannot be released in practice, except with subsequent re-application of the tensioning apparatus in order to loosen the anchoring nut, this being not only wasteful but even harmful to perfect anchoring of the tensioning member, since it can cause the concrete immediately behind the tensioning head to crumble.

These disadvantages are obviated by using an anchoring nut which is axially divided into at least two individual parts which can be connected together for example by small screws to form the nut. Wedge-shaped notches are formed in the nuts between the surfaces of those parts which contact one another. The anchoring nuts can either be screwed on to the screwthreading of the tensioning head in the manner of a normal nut or, where long tensioning distances are employed, need only be assembled, after the tensioning distance has been achieved, on the lower portion of the external screwthread of the tensioning head. After the concrete seal has hardened, the anchoring nut is again removed. This is effected by loosening the screws and knocking lightly, for example with a chisel, against the wedge-shaped notches ground in the joint surfaces between the parts of the nut.

Then tensioning force is taken up on the pressed-out concrete seal without difficulty with the use of the divided anchoring nut, and the advantage is afforded that the tensioning jack does not have to be re-applied to the tensioning head in order to enable the nut to be removed. The pressed-out concrete seal is completely undamaged even in the vicinity of the tensioning head. An unimportant loss of tensioning force occurs merely owing to the creep

of the pressed-out concrete. But this loss is very slight in comparison with the slipping of other tensioning member anchoring systems. Since the tensional force loss is known exactly beforehand, it can be anticipated by over-stressing.

The reduction of the tension on the hardened concrete seal also enables the steel plate and anchoring nut to be recovered in an easy and technically satisfactory manner.

A divided anchoring nut also enables tensioning members to be tensioned with the aid of a tensioning head which is formed with both internal and external screwthreading. In the region of this screwthreading, in hitherto known tensioning heads, greater thickness of material is required than if only one screwthread is used. This leads to higher outlay both in material and in accessories, especially since in such cases the external screwthread is often only required in a limited region for anchoring the tensioning head. In the present tensioning head, the internal screwthread is formed at the end of the steel tube and the external screwthread is staggered relatively to the said internal screwthread, in such a manner that the cross-section of the tube wall is not weakened at any point by two screwthreads formed simultaneously on the interior and exterior of the tube. The internal screwthread is formed at the end of the tensioning head and can be used for screwing on a threaded rod which is connected, for example, to another tensioning head. The external screwthread is only formed in that region of the tensioning head which is required for screwing on the divided anchoring nut. Since the internal and external screwthreads are staggered relatively to one another the thickness of the steel tube can be the same as that of a normal tensioning head, even though the tube is formed with screwthreading for the reception of the divided anchoring nut. The tensioning apparatus is connected to the internal screwthread.

With the tensioning head for anchoring tensioning members, all commercially used types of tensioning steel elements can be used. With profiled or corrugated tensioning wires it is only necessary to use a short length of seal to obtain sufficient adherence between the wire and the concrete, so that additional measures are not required for anchoring them in the seal. The same applies to stranded wires and cables opened out at the end, but, in this case, the tensioning wires must pass through the seal in the most uniformly distributed manner possible. In order to reduce the length of seal while obtaining the maximum possible adherence between the wires and the seal with tensioning wires having a small round cross-section, the wire ends can be permanently corrugated at those parts of the wires which are to be embedded in the seal. With round steel wires of relatively large diameter, the ends are wound about with a pretensioned spiral of thin, high-quality steel wire. The two last-mentioned features can also be used jointly.

If the seal of the tensioning head consists of concrete, the latter can be compacted adequately with an external vibrator. But this method has the disadvantage that the tensioning members with the tensioning heads must be clamped perpendicularly in a concreting apparatus, entailing relatively considerable outlay. Therefore it is preferred to press-in the concrete by means of a plunger under high pressure into the steel sleeve of the tensioning head.

In this way the seal can be produced very simply and economically, especially when concrete is used. The plunger can easily be applied at any point, and the consolidation pressure achieved can be tested accurately.

The sealing mass leaves the beginning of the steel tube free so that the projecting tube end can be cut away after the tensioning member has been tensioned and embedded in the pressed-out material.

For a better understanding of the invention, and to show how the same may be carried into effect, reference

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will now be made to the accompanying drawings in which:

Figure 1 is a cross-sectional view of a tensioning member consisting of a plurality of oval tensioning wires,

Figure 2 is a longitudinal sectional view of a tensioning head serving to tension the tensioning member shown in Figure 1,

Figure 3 is a longitudinal sectional view in a plane turned through 90° relatively to the sectional plane of Figure 2, of part of the tensioning head shown in Figure 2,

Figure 4 is a plan view of the part shown in Figure 3,

Figure 5 is a plan view of the tensioning head shown in Figure 2,

Figure 6 is a longitudinal sectional view of an intermediate tensioning point,

Figure 7 is an end view of the intermediate tensioning point shown in Figure 6,

Figure 8 diagrammatically shows a modification of the tensioning head,

Figure 9 is a cross-sectional view of an anchoring nut,

Figure 10 is a longitudinal section of the anchoring nut shown in Figure 9,

Figures 11 to 13 respectively each show one form of a tensioning wire, and

Figure 14 is a longitudinal sectional view of a tensioning head against which a piston is applied for pressing-in concrete.

Referring now to Figures 1 to 5 of the drawings, there is shown, in Figure 1, a tensioning member to be tensioned by means of a tensioning head. The tensioning member consists of eight oval tensioning wires 2. However, although eight oval tensioning wires are shown in the drawings, it will be appreciated that the arrangement, construction and number of the tensioning wires are immaterial for the fundamental construction of the tensioning head. The tensioning member illustrated in Figure 1 is to be tensioned by means of a tensioning head which is illustrated in the fitted condition in Figure 2. The tensioning head consists of a thick-walled, heat-treated steel tube 1 which is slightly flattened at one end, this being shown particularly in Figures 3 and 4, which represent a longitudinal sectional view and an elevation of the mouthpiece respectively. The tensioning wires 2 are fixed in the steel tube 1 by a concrete seal 3. The length of each wire 2 which has to be embedded in the seal 3 is considerably shortened by twisting each of the individual oval tensioning wires 2 twice through 90° about its central longitudinal axis. In order to anchor the tensioning wires effectively, it is necessary to spread out the twisted tensioning wires 2 behind the mouthpiece of the steel tube 1. This is achieved by means of a concreted-in small steel tube 4 through which pressed-out concrete can subsequently pass.

At its other end remote from the flattened mouth piece, the steel tube 1 is formed with external screwthreading 5 on which is arranged a nut 6 which transmits the tension in the tensioning member 2 to a steel plate 7 and thus to the concrete of the structural unit. The external screwthreading 5 may be short or long as required depending upon the necessary tensioning distance. The concrete seal 3 is arranged to fill only part of the tube 1, so that the portion of the steel tube 1 which projects beyond the nut 6 after the tensioning member has been tensioned, can be cut off. Finally the sliding channel (i.e. the annular space between the tensioning member and the concrete of the structural unit) is filled with pressed-out concrete mortar by means of a cap adapted to be screwed onto the screwthreading 5. The concrete flows through the small tube 4 into the sliding channel. The front face of the tensioning member is illustrated in Figure 5. An envelope tube 8, see Figure 2, protects the tensioning head during the production of the concrete of the structural unit, as is the normal practice.

Figures 6 and 7 illustrate an intermediate tensioning point or head. It consists of a steel tube 9 which is

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flattened at each end in the manner described hereinbefore. The steel tube 9 surrounds oval cross-section tensioning wires 10 of the tensioning member over the requisite length for anchoring the tensioning wires 10 in a concrete seal 11. The length of the seal 11 is particularly short in the case of oval cross-section tensioning wires 10, since the tensioning wires 10 are twisted twice in this region—as described hereinbefore. It has been proved that this cold deformation does not detrimentally affect the quality of the tensioning wires and it is also possible to use intermediate tensioning points with stranded wires, cables or other tensioning members. Such intermediate tensioning points or heads are very economical, since the better utilisation of the tensioning wires more than compensates for the slight cost of the intermediate tensioning head, and since the steel tube for the intermediate tensioning head is unworked except for the flattened portions at its ends.

As is known, subsequent tightening is effected by an hydraulically operated apparatus which acts on the intermediate tensioning head. The space required for the intermediate tensioning head is very small so that it can be left in the structural unit after the tensioning members have been surrounded with pressed-in concrete or mortar.

Figure 8 shows a tensioning head provided with double screwthreading. The internal screwthread 16 is formed at the end of the tensioning head whilst the external screwthread 15 is staggered relatively in an axial direction to the internal screwthread, so that the tube is not weakened in the region of the screwthreading by having internal and external screwthreading formed on the inside and outside of the tube in any one cross-sectional plane.

Figures 9 and 10 show an anchoring nut, which consists of two semi-circular rings 12 formed with recesses and flanges which are connected together by bolts 13. Ground into the rings 12 at the locations where the flanges contact one another are wedge-shaped notches 14 so that, when the anchoring nut is to be removed, the individual rings can easily be detached from one another by separating them by means of a flat chisel inserted in one of the notches. It will be appreciated that the nut can consist of more than two annular segments 12.

Figures 11 to 13 illustrate several constructional forms of round tensioning wires which are particularly adapted for enabling a shorter seal to be employed in the tensioning head. The wire shown in Figure 11 has been permanently deformed with corrugations in the region of its length which is embedded in the sealing mass.

Figure 12 shows how a shorter seal may be employed with a round tensioning wire by winding another and pretensioned steel wire 16 spirally about the first-mentioned tensioning wire.

Finally, Figure 13 shows a corrugated tensioning wire similar to that shown in Figure 11, but which is also wound about spirally with a pre-tensioned steel wire 16.

Figure 14 shows an apparatus for pressing concrete into a tensioning head 17. The tensioning head 17 is first of all filled by hand with the sealing concrete 18. Then a rubber piston 19 is inserted in the end of the head 17, the rubber piston 19 being connected to the piston 20 of a small hydraulic jack 21. A connection between the hydraulic jack 21 and the tensioning head 17 is established by a screw connection 22, and the hydraulic jack 21 is then operated. The concrete 18 is thereby compressed under great pressure into the steel tube 17, consolidated, and forced to encase the tensioning wires which are to be embedded. A sealing and support member 23 ensures that only a very small quantity of concrete can escape from the flattened end of the tensioning head 17 and that the tensioning wires are held fast immovably in the tensioning head. The sealing and support member 23 remains on the tensioning head 17 until the cement has hardened sufficiently.

The construction of the tensioning head is important

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not only in the field of pre-stressed concrete since all tensioning wires, braided wires, cables and the like for any purpose can be anchored economically and rapidly in the head. It is applicable, for example, to the tensioning and supporting cables of suspended roofs, or for the ties of double-hinged frames.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A tensioning head for anchoring tensioning members comprising a thick-walled, heat-treated steel tube, a substantially elliptical mouthpiece at one end of said tube, at least one tensioning member passing through said mouthpiece with the end of the tensioning member disposed within said tube, and a concrete seal surrounding said end of the tensioning member and securing the same within the tube.

2. A head as claimed in claim 1 wherein the tensioning member is of substantially flat cross-section, and is twisted at least twice through 90° about its central longitudinal axis.

3. A head as claimed in claim 1 wherein the inner surface of the steel tube is roughened in the region of the sealing mass.

4. A head as claimed in claim 1 wherein said thick-walled steel tube is formed with internal and external screwthreading, the internal screwthreading being formed at the end of the tube remote from said mouthpiece, and the external screwthread being formed at a location staggered relatively in an axial direction to said internal screwthreading.

5. A head as claimed in claim 1 wherein the tensioning member is of circular cross-section, and wherein provision is made for reducing the length of the seal required while maintaining the requisite length of tensioning member needed to obtain satisfactory adherence between such member and the seal.

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6. A head as claimed in claim 4, having an anchoring nut secured over such screw-threading, the nut being divided into at least two parts and there being means for securing such parts together to form the nut.

7. A head as claimed in claim 6, wherein a wedge-shaped groove is formed in the anchoring nut between the surfaces of at least two parts of the nut which are to contact one another, thereby to facilitate dismantling of the nut when the same is assembled.

8. A head as claimed in claim 5, wherein said provision is made by corrugating the end of the tensioning member.

9. A head as claimed in claim 5 wherein a high tensile steel wire is wound spirally about the tensioning member.

10. A tensioning head for reducing friction losses in tensioning members comprising a thick-walled, heat-treated steel tube, a substantially elliptical mouthpiece at each end of said tube, at least one tensioning member passing through said tube, and a concrete seal surrounding the tensioning member and securing the same within the tube.

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