United States Patent

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[33] **Great Britain**
[31] **41808/64**

[54] **ANCHORS FOR STRUCTURAL TENSILE MEMBERS**
10 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **24/114.5,** 24/122.3, 24/126, 52/223, 287/20.3
[51] **Int. Cl.** **E04c 5/12,** E04b 1/22
[50] **Field of Search** ..... 52/223-—230; 287/75, 83, 116, 20.3; 24/122.7, 122.6, 126, 136, 114.5; 25/118 T

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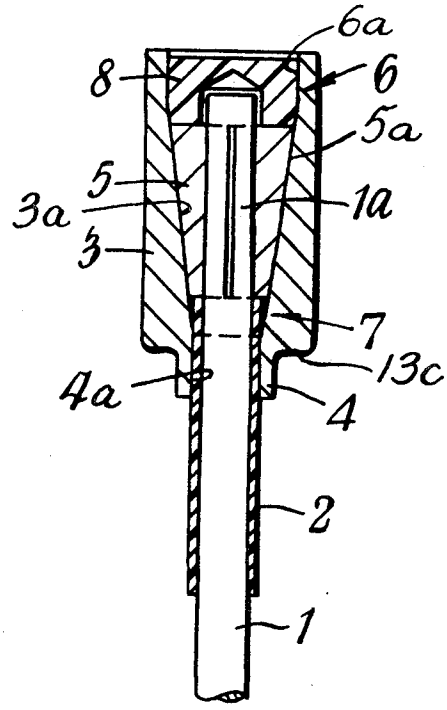
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ABSTRACT: An anchor for a grouted structural tensile member of the type coated throughout that part of its stressed length otherwise exposed to aggressive media characterized in that a rigid load-transmitting sleeve provided with at least one external surface disposed transversely to said tensile member is secured by wedging around a stripped or otherwise uncovered length of said member to enclose said stripped length and a small unstripped length at one or both ends of the stripped length and is sealed to the unstripped length or lengths by flexible sealing means so that the complete anchor structure forms a sealed protective and load-transmitting casing around the length of the tensile member which is closed thereby continuous with the coating which covers the remainder of the member.

The foregoing abstract is not intended to be a comprehensive discussion of all of the principles, possible modes or applicatios of the invention disclosed in this document and should not be used to interpret the scope of the claims which appear at the end of this specification.



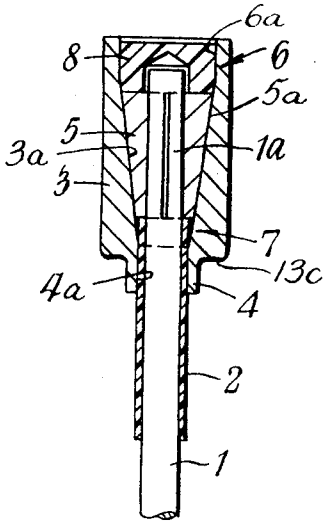


FIG.1

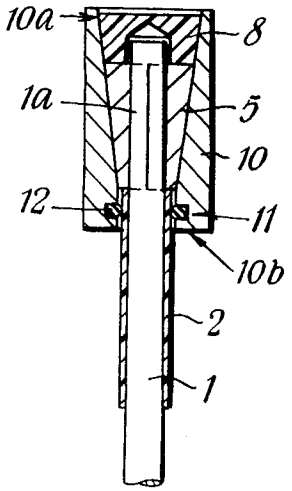


FIG.3

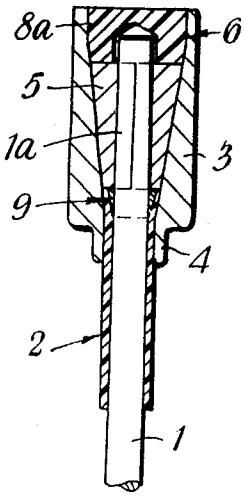


FIG.2

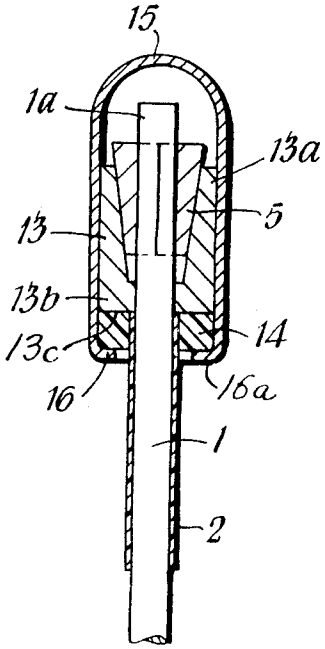


FIG.4

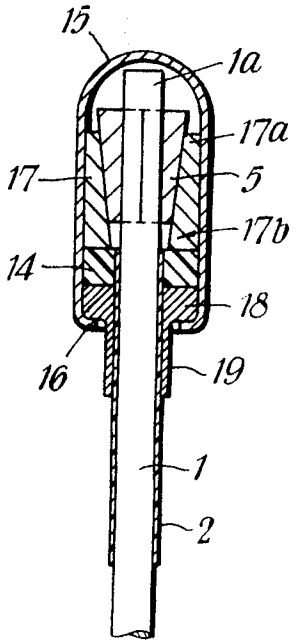


FIG.5

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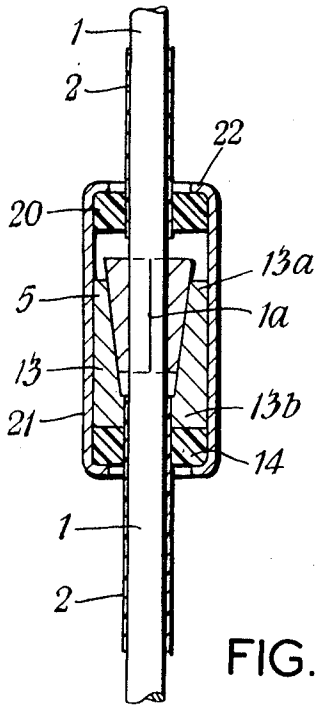


FIG.6

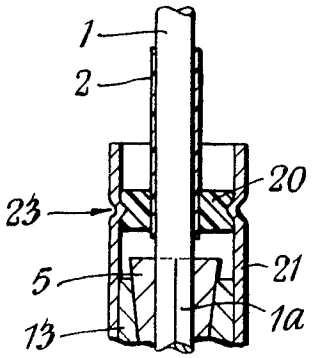


FIG.7

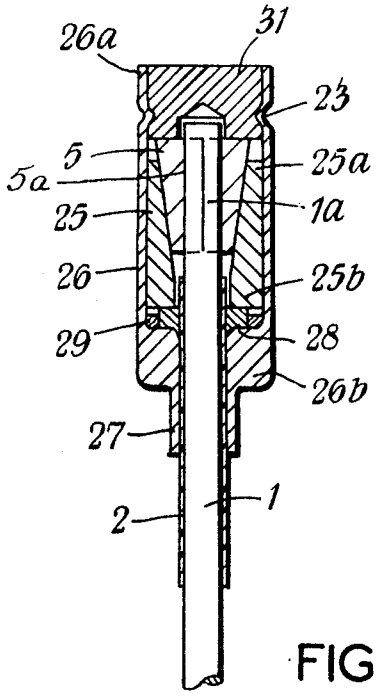
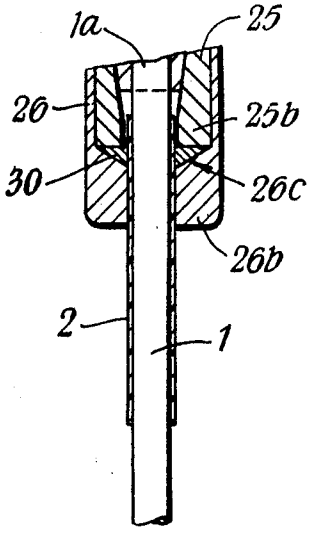


FIG.8

FIG.9



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ANCHORS FOR STRUCTURAL TENSILE MEMBERS

This invention relates to the anchorage of structural tensile members of high-tensile steel wire, rod, or like material of circular section, secured by grouting into rock or other rigid media. More particularly it relates to anchors in which protection is provided against corrosion caused by aqueous or other aggressive media throughout the anchor and adjacent extending tendons of each high-tensile member.

One known method of protecting high-tensile steel wires against corrosion involves packing the void spaces among and around the wires with grease or like corrosion inhibitor and wrapping the bundle of cables so as to contain the grease locally. In this construction the cement grout itself provides the protection within the anchor.

A further known method is to fill the void spaces among the wires and between the wires and the walls of the containing cavity or duct with a cement grout which is placed in position after the wires are stressed. Whilst these methods provide a high degree of protection, extreme care is needed to ensure that the envelopment of the tendons is complete.

It is also known to protect wires against corrosion in applications other than anchorages by coating or sleeving the wire with an impermeable corrosion resistant cover. Such coatings are not ordinarily able to withstand the high stresses within the anchorage.

SUMMARY OF THE INVENTION

The main object of the present invention is to facilitate the use of coated or covered wires in anchor applications by providing simple means for anchoring such wire capable of transferring load between the wire and the surrounding grout at a place where the coating has been removed from the wire by presenting at least one surface to the grout which is transverse to the wire and also capable of maintaining the continuity of the protection of the wire against corrosion through that place.

Accordingly, the invention provides an anchor for a grouted structural tensile member of the type coated throughout that part of its stressed length otherwise exposed to aggressive media characterized in that a rigid load-transmitting sleeve provided with at least one external surface disposed transversely to said tensile member is secured by wedging around a stripped or otherwise uncovered length of said member to enclose said stripped length and a small unstripped length at one or both ends of the stripped length and is sealed to the unstripped length or lengths by flexible sealing means so that the complete anchor structure forms a sealed protective and load-transmitting casing around the length of the tensile member which is closed thereby continuous with the coating which covers the remainder of the member.

BRIEF DESCRIPTION OF THE DRAWING

In order that the invention may be clearly understood and readily carried into effect, a number of embodiments thereof will now be described in detail with reference to the accompanying drawings in which:

FIGS. **1**, **2** and **3** are part sectional side views showing respectively three alternative anchor forms each attached to a terminal end of a sheathed structural tensile member in accordance with the invention,

FIGS. **4** and **5** are views similar to FIGS. **1**, **2** and **3**, but show two further alternative anchor forms each employing a sealed capsule,

FIG. **6** is a part sectional side view showing a further anchor form of the invention which is secured intermediate the length of a sheathed structural tensile member,

FIG. **7** is a partially broken away view which is similar to FIG. **6** but shows a modification thereof,

FIG. **8** is a view similar to FIGS. **1**, **2** and **3** showing yet another alternative anchor form, and

FIG. **9** is a partially broken away view which is similar to FIG. **8** but shows a slightly modified construction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the embodiment of the invention illustrated in FIG. **1**, a structural tensile member **1** made of steel wire or like material is provided with a sheath or coating **2** made of polypropylene plastics or other impermeable corrosion resistant material. A stripped length of wire **1***a* is provided at the terminal end of the wire **1**, the sheath **2** terminating in a short unstripped length as shown at a location inside an internally tapered sleeve **3**. To the stripped end **1***a* of the wire is attached the internally tapered load-transmitting sleeve **3**, of stainless steel or other suitable material, having a narrowed neck **4** which projects over the sheath **2**. To secure the sleeve **3** in position, wedges **5** are entered into the sleeve through the wider open end **6** of the latter which is remote from the neck **4**. These wedges **5**, which are pulled or pushed into the sleeve **3**, serve to clamp and grip the stripped wire and **1***a* within the sleeve as will be understood. Dimensions are so chosen that the wedges **5** abut or almost abut the terminal end of the sheath **2**. The exterior surfaces **5***a* of the wedges taper in the same sense as the interior surface **3***a* of the sleeve **3**.

The tapered inner surface **3***a* of the sleeve **3** preferably, but not necessarily, terminates at the neck and opposite ends **4** and **6** in cylindrical inner surfaces **4***a*, **6***a*. The diameter of the inner surface of the neck **4** is then chosen to fit closely against the outer surface of the sheath **2**. Beyond the neck, within the sleeve **3**, a small washer **7** of deformable material, which may also be polypropylene plastics, is arranged to fit closely around the terminal end of the sheath **2** which immediately precedes the stripped wire length **1***a*. When the washer **7** is made from a plastic material amenable to moulding by pressure, the shape of the washer is of no great significance, but its volume is chosen to suit the space available for the washer beneath the narrowed ends of the wedges **5** within the tapered interior of sleeve **3**. The action of drawing the sleeve **3** over the wedges **5** during assembly, then has the effect of compressing and moulding the material of washer **7** into the space available for it. If the volume of washer **7** is correctly chosen it will subsequently maintain adequate sealing pressure against the outer surface of the terminal end of sheath **2** and against the inner surface of the tapered interior of sleeve **3** adjacent the neck **4**. If the material of washer **7** is less deformable than indicated in the foregoing, it is preferably shaped during manufacture to a form which fits the cavity available to receive the washer.

The diameter of the inner surface of the open end **6** of the sleeve **3** is chosen to accommodate a deformable plug or washer **8** which may also be made of polypropylene plastics. This plug or washer **8** is pushed into place as the final operation of assembly to form a seal beyond the wedged length of wire **1***a* and to complete the closure and sealing of the anchor structure. In order to compress and grip the plug or washer **8** as it is pushed home, steps are taken to ensure that at least part of the washer enters the tapered internal surface **3***a* of the sleeve **3** at the wider end of the latter. The plug or washer **8** may alternatively be held in place or additionally secured by glueing or by flanging or crimping the adjacent end **6** of the sleeve **3** in a manner similar to that which will be later referred to in connection with the embodiments shown in FIGS. **7** and **8**.

The anchor form shown in FIG. **2** is very similar to the anchor form shown in FIG. **1** and corresponding parts have been given the same reference. In FIG. **2**, however, the washer **7** is omitted and replaced by a ring **9** of metal or other rigid material which is pushed over the bared end **1***a* of the wire and under the terminal end of the sheath **2**. The ring **9** has a substantially frustoconical outer surface coaxial with a cylindrical inner surface of a diameter able to slide easily over the bared end **1***a* of the wire. The diameter of the smaller end of the frustoconical outer surface is preferably equal or close to the internal diameter of the ring so that the leading ring edge is left relatively sharp. The slope or semivertical angle of the outer surface of the ring **9** is chosen to match the tapered inner surface of the sleeve **3** adjoining the neck **4**. The diame-

ter of the larger end of the frustoconical outer surface of the ring 9 is chosen so that, when the ring has been pushed beneath the end of the sheath 2 as shown, and when the wedges 5 have been assembled so that their smaller ends abut the ring 9, the sheath 2 is swollen so as to fit tightly inside the sleeve 3 as the latter is drawn into the assembled position over the wedges. As a result, a good seal is formed at the neck end of the sleeve which provides adequate grip between the swollen sheath 2 and the sleeve wall. The position of the wedges 5, and hence of the outwardly flared part of the sheath 2 within the internally tapered sleeve 3, is determined during assembly by the assembly tools in order to obtain the required degree of grip and sealing.

As shown in FIG. 2, the final sealing of the outer sleeve end beyond the wedged wire length 1*a* is effected by a deformable plug or washer 8*a*, the dimensioning in this case being such that the plug or washer 8*a* terminates flush with the end edge of the wider end 6 of the sleeve 3.

In the anchor form shown in FIG. 3, the sheath 2 around the wire 1 is again terminated at or in the vicinity of wire-gripping wedges 5 which grip the stripped wire end 1*a* and are enclosed within a slightly modified form of load-transmitting sleeve 10. This sleeve 10 has an internal taper which narrows progressively from the end of the sleeve 10*a* to terminate in a cylindrical section at the opposite sleeve end 10*b*. The external surface 10*c* of the sleeve end 10*b* provides a load-transmitting external surface on the sleeve disposed substantially transversely to the longitudinal sleeve axis. The cylindrical section at the sleeve end 10*b* surrounds the end part of the stripped sheath 2 and the inside surface of the cylindrical section surrounding the sheath end 2 is provided with at least one groove 11. This groove 11, or each groove, contains a known form of sealing means such as an O-ring 12 or a lip-type seal or packing for the purpose of sealing the cylindrical section of sleeve 10 around the sheath 2. The opposite end of the sleeve 10 is again closed by a plug 8 of deformable material in a manner substantially as described in connection with FIGS. 1 and 2.

In the anchor form shown in FIG. 4, an anchor incorporating a rigid load-transmitting sleeve 13 is again shown secured by wedges 5 to a stripped terminal length 1*a* of a wire 1 which is encased in a sheath 2. The sleeve 13 has a tapered bore which opens at the wider end through the end 13*a* of the sleeve and, at the narrower sleeve end 13*b*, opens through a reduced concentric cylindrical hole having approximately the same diameter as the diameter of the stripped wire length 1*a*. The dimensions are chosen so that the sleeve end 13*b* abuts or nearly abuts the end of the sheath 2. A washer 14 of deformable material such as rubber, lead, plastic, or fiber is located as shown about the sheathed wire 1 immediately adjacent the sleeve end 13*b*. The inner diameter of the washer 14 is chosen to fit closely around the sheath 2 on the wire and its outer diameter is chosen to match the outer diameter of the sleeve 13. The thickness or depth of washer 14 is chosen to permit sufficient deformation for sealing purposes as will be described later.

The assembly consisting of the anchored end part of the wire 1, the wedges 5, the sleeve 13 and washer 14 is contained in and enclosed by a protective cap or capsule 15 of substantially tubular internal form, having one closed end. For assembly purposes, the open end of the capsule is passed down over the sleeve 13 and the washer 14 so as to project slightly beyond the latter. The anchor structure may then be completed by deforming the open end of the capsule in order to form a flange 16 serving to retain the washer 14. Alternatively, the washer could be secured by swagging or crimping the capsule. The capsule 15 is preferably, but not exclusively, made from noncorrodable material.

In service, the anchor form shown in FIG. 4 may be embedded in concrete or similar material or may be abutted against a plate or like structural component. In either case, loading tensions applied to the wire 1 in the lengthwise direction away from the anchor are resisted mainly by compressions generated over the lower face 16*a* of the flange 16. The face 16*a* provides a load-transmitting external surface on the capsule 15 disposed substantially transversely to the longitudinal axis of the sleeve 13. These compressions are transmitted through the washer 14 to sleeve 13 via the sleeve end surface 13*c* provides a load-transmitting external surface on the sleeve 13 disposed substantially transversely to the longitudinal axis of the sleeve 13, whence the compressions are applied through the wedges 5 to resist the tension in the wire 1. The effect of compression upon the deformable washer 14 is to expand its outer diameter to make a tight seal against the adjacent inner surface of capsule 15 and to contract its inner diameter to grip and seal against the adjacent outer surface of the sheath 2. The complete assembly is thus sealed and protected against external aggressive agents.

The anchor shown in FIG. 5 is a slightly more elaborate form of the anchor which is shown in FIG. 4. In this more elaborate anchor form, the main components remain the same except that the load-transmitting sleeve 17 has a tapered bore which extends therethrough over the full sleeve length and has a diameter which progressively decreases from outer sleeve end 17*a* towards the opposite sleeve end 17*b*. There is also an additional bushing 18 provided which is usually of metal and which is located against the washer 14 on the side thereof remote from the sleeve 17. The bushing 18 conveniently has the same diameter as the washer 14 and serves to spread the loads applied to washer 14 in service and to prevent extrusion of the deformable material of the washer 14. As shown, the bushing 18 may optionally also have an extended neck 19 which serves to protect the sheathing 2 of the wire from lateral stresses arising from the concentrated compressions generated in the vicinity of embedded anchors. Irrespective of whether or not the neck 19 is included, the capsule 15 may be flanged at 16 over the bushing 18.

If either of the anchor forms shown in FIGS. 4 or 5 is intended for embedding in soft or weak materials, the bearing surfaces of the anchors may be extended either axially or laterally by the addition of one or more discs or washers of appropriate shape. These discs or washers are then slipped over the wire 1 and sheath 2 in order to abut the flange 16.

In the embodiment illustrated in FIG. 6, an anchor form is shown which is suitable for attachment at any point along the length of a sheathed structural tensile member. This tensile member is again shown conveniently as a length of wire having sheathing 2, the anchor being attached to a stripped length 1*a* of the wire. Alternatively, of course, the anchor which is shown in FIG. 6 could be attached close to the terminal end of a tensile member.

This anchor form again incorporates a load-transmitting sleeve 13, which is similar to the sleeve shown in FIG. 4 except that the concentric cylindrical hole through the sleeve end 13*b* is made sufficiently large to receive the end of sheath 2 therein. Wedges 5 are also employed as in the previous embodiments but the wire 1 now passes completely through the anchor and emerges beyond it. In order to accommodate and seal against the emergent wire, a second washer 20 of deformable material is fitted around the wire 1 and, in this case, also around the sheath part 2 which encases the emergent wire end. To enclose the anchor, a modified capsule 21 is provided which is open at both ends and which is secured over the washer 20 by a flange 22 as shown. Alternatively, the attachment of washer 20 may be by sticking, glueing or crimping.

The washer 20 does not experience compressions generated by the applied load in the manner described in connected with the washer 14. Hence a preferred procedure for securing the washer 20 is to crimp or deform the capsule 21 as shown at 23 in the modified anchor form illustrated in FIG. 7. In this way the washer 20 is compressed laterally so as to ensure a good seal against the capsule 21 and the sheath 2 or wire 1. Such compression may readily be obtained by the transverse application of suitably shaped dies to the capsule 21 or by the use of a rolling deforming tool. The same procedure may, in some cases, also be employed to secure the washer 14 both in the

embodiment of FIG. 6 and also in the embodiments of FIGS. 4 and 5. In cases where the embodiment of FIG. 6 or of FIG. 7 is to be applied to the end of a tensile member, the washer **20** will, of course, be provided without a central hole and the wire **1** will be terminated within the capsule **21**.

In the anchor form illustrated in FIGS. **8** and **9**, the anchor is again shown applied to the end of a wire **1** having a sheath **2** and a stripped end **1***a*. This anchor form is intended for use mainly under high-loading conditions and may alternatively also be applied anywhere along the length of a structural tensile member. The anchor again incorporates a rigid load-transmitting sleeve **25** which is of slightly modified form and again has an internally tapered bore which narrows from the outer sleeve end **25***a* to merge into a concentric cylindrical hole at the opposite sleeve end **25***b*. The wedges **5** which embrace the stripped wire end **1***a* to lock the latter within the sleeve **25** are substantially the same as in the former embodiments but a modified more robust form of outer capsule is incorporated in the anchor structure. This outer capsule has a tubular portion **26**, an open outer end **26***a* and a shouldered inner end portion **26***b*. As shown the end portion **26***b* may be extended by a neck **27**. A deformable washer **28** is located around the wire **1** and sheath **2** adjacent the end **26***b* and is surrounded by a rigid washer **29** of slightly thinner form than washer **28**. The thickness of washer **29** is chosen to limit the permitted compression of washer **28** by the lower surface of the sleeve **25** to a value sufficient to seal against, and if necessary to grip, but not to damage the wire **1** or sheath **2**. Alternatively, as shown in FIG. **9**, the end of the cavity within the capsule at end **26***b* is given a conical form as shown at **26***c* such as is produced by the end of an ordinary metal drill, and a deformable washer **30** is placed in this cavity. The downward movement of the sleeve **25** is then limited by its abutment against the wall of cavity **26***c* at the larger end of the latter and the intrinsic volume of the deformable material of the washer **30** is chosen so that the required degree of compression is obtained when this occurs.

A deformable washer **31** is provided in this embodiment without a central hole, but will have such a hole if the anchor is fixed intermediate the wire length. The washer **31** is secured in place conveniently by a crimp **23** formed in the wall of capsule **26**. Alternatively, washer **31** could be secured by any of the other indicated procedures.

The anchor forms in FIGS. **1**, **2** and **3** are all shown as applied to the terminal end of a sheathed structural tensile member. It will be appreciated, however, that the anchor forms shown in these three Figures could also be applied intermediate the length of a tensile member, the end washers being appropriately apertured for this purpose.

In all the described embodiments an inert fluid or material, for example liquid epoxy resin, may be added to the interior of the anchor during assembly in order to fill any vacant spaces left therein and thus to exclude air. Furthermore, the added material may be chosen to assist the performance of the anchorage by glueing together components which might otherwise work loose in service.

Wherever appropriate the external surfaces of the rigid load-transmitting sleeves or capsules may, of course, be varied in shape in order to suit the environment in which the anchor is required to operate. In particular, the shape might be varied in order to facilitate the transference of load from the anchor to its environment. For example, an anchor intended for embedding in a soft or weak medium might be provided with toothed, serrated or roughened outer surfaces, while an anchor for attachment to a metallic structural element might be provided with a screwed outer surface in order to facilitate bolting or screwing to said member. Furthermore, in appropriate applications, several load-transmitting sleeves as described might be incorporated in one block of material in order to provide a multiple anchorage. Any such variation of the external shape does not materially affect the operation or construction of the invention as described.

We claim:

1. In combination: a structural tensile member of the type subject to being stressed and having at least a portion of the length thereof exposed to aggressive media during use; said structural tensile member having a protective coating thereon throughout part of the length thereof comprising said portion of the length thereof exposed during use to aggressive media, a remainder part of the length thereof being uncoated as respects said protective coating; and an anchor secured on said structural tensile member, said anchor comprising: a rigid, load-transmitting sleeve having two ends, means defining at least one external load-transmitting surface on said sleeve disposed substantially transversely to the longitudinal axis of said sleeve; said sleeve surrounding said uncoated part and adjoining the coated part of the structural tensile member, said structural tensile member entering said sleeve through at least one end of said sleeve; wedge means received in said sleeve engaging said uncoated part and said sleeve for securing said sleeve to said structural tensile member; means sealing both ends of said sleeve; at least the sealing means sealing said sleeve one end through which said structural member enters being flexible and sealing by engaging said sleeve and said coated part in the vicinity of the sleeve, thereby providing a sealed protective and load-transmitting casing about said structural tensile member, which casing is sealed to the said protective coating on said structural tensile member.

2. The combination of claim **1** wherein the sealing means sealing said sleeve one end comprises a first deformable sealing element compressed between said sleeve and said coated part of said structural tensile member in the vicinity of said sleeve; and said sealing means further comprises a second deformable sealing element secured in said sleeve opposite end for sealing off said sleeve opposite end.

3. The combination of claim **2** further comprising means defining an internal circumferential groove in said sleeve adjacent said sleeve one end; said first deformable sealing element comprising a washer received in said groove.

4. The combination of claim **1** wherein said coated part in the vicinity of said sleeve is surrounded by said sleeve; said protective coating being made of flexible material; said sealing means for said sleeve one end comprising a tapered ring of relatively rigid material forcibly received within said sleeve between said protective coating and said sleeve and pressing said protective coating into sealing contact with said sleeve.

5. The combination of claim **1** wherein said structural tensile member projects from said sleeve via the opposite end thereof; a capsule surrounding said sleeve and enclosing said sleeve beyond said opposite end, thereby providing at least part of said sealing means for said opposite end; said flexible sealing means of said sleeve one end comprising a washer of deformable material, said washer encircling and engaging said coated part in the vicinity of said sleeve and engaging said sleeve at said sleeve one end.

6. The combination of claim **5** further including a metal bushing backing said washer of deformable material, said bushing surrounding said structural tensile member immediately adjoining the washer of deformable material on the axially opposite side thereof from said sleeve for spreading loads applied to the washer of deformable material during use and for preventing extrusion of the washer of deformable material.

7. The combination of claim **6** wherein said bushing includes a tubular neck extending axially away from said sleeve, about said structural tensile member for protecting the protective coating adjacent the anchor from lateral stresses arising from concentrated compression generated in the vicinity of said anchor when in use.

8. The combination of claim **1** wherein said sealing means at said sleeve one end comprises a flexible washer encircling said coated part in the vicinity of said sleeve; a tubular capsule surrounding said sleeve and having means at one end thereof sealingly holding said flexible washer securely against said sleeve one end; and means sealing off the opposite end of said tubular capsule.

9. The combination of claim 8 wherein said holding means on said tubular capsule comprises means defining a radially inwardly projecting shoulder on said capsule.

10. The combination of claim 9 wherein the radially inwardly projecting shoulder tapers proceeding axially away from said sleeve to define a conical cavity with said sleeve one end, said flexible washer being compressed between said shoulder and said sleeve one end within said conical cavity.