Sept. 3, 1957 J. C. GRANT 2,805,058

ELASTIC TENSION MEMBER

Filed Nov. 15, 1954 2 Sheets-Sheet 1

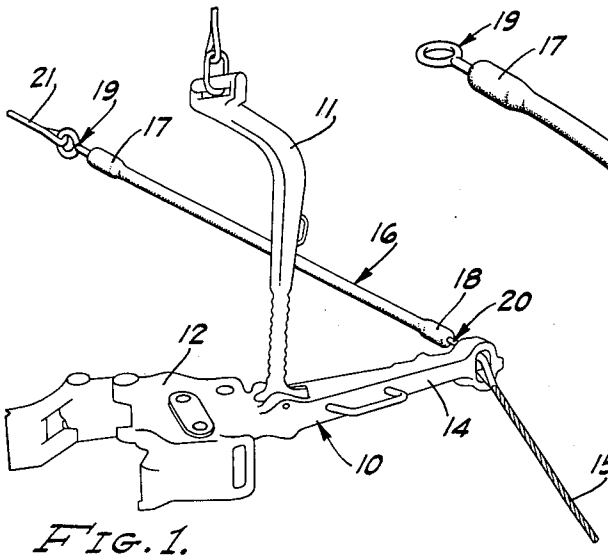

FIG. 1.

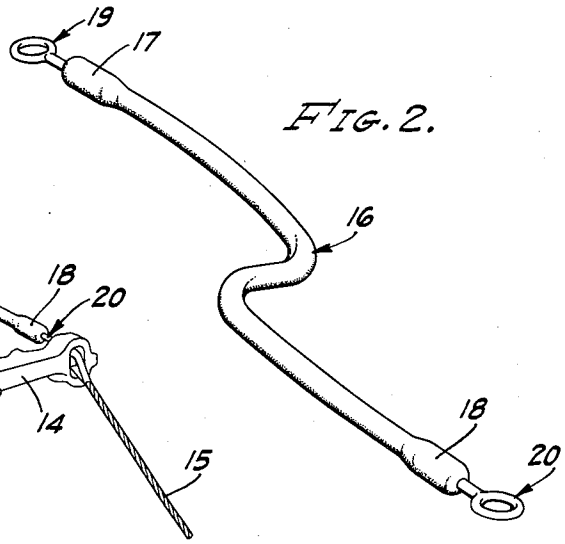

FIG. 2.

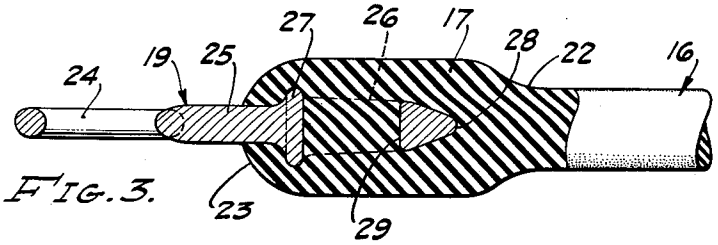

FIG. 3.

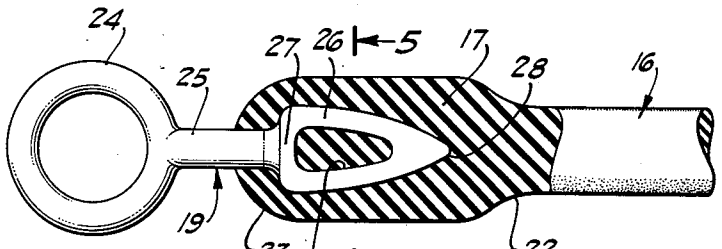

FIG. 4.

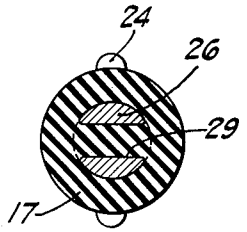

FIG. 5.

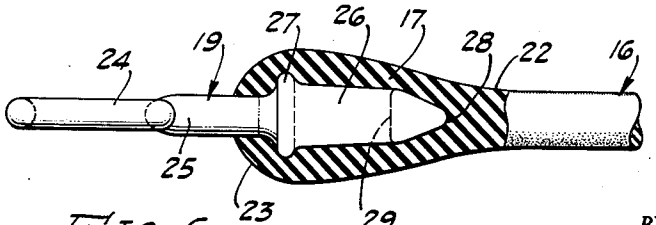

FIG. 6.

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ELASTIC TENSION MEMBER

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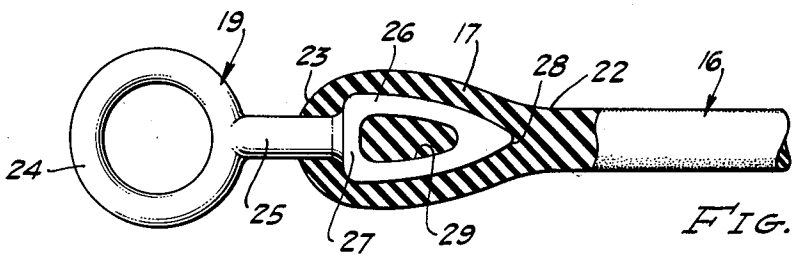

FIG. 7.

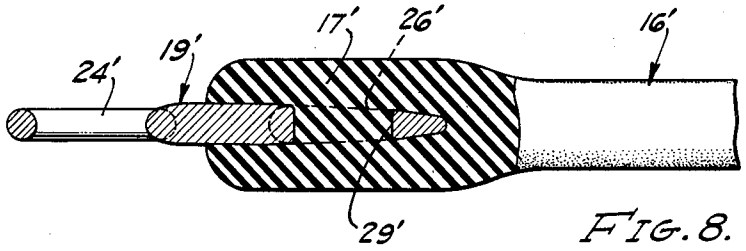

FIG. 8.

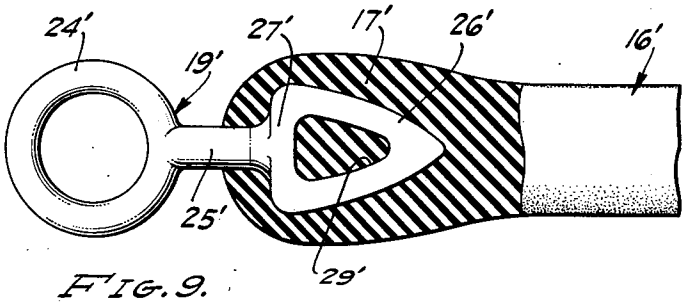

FIG. 9.

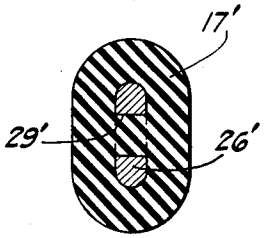

FIG. 10.

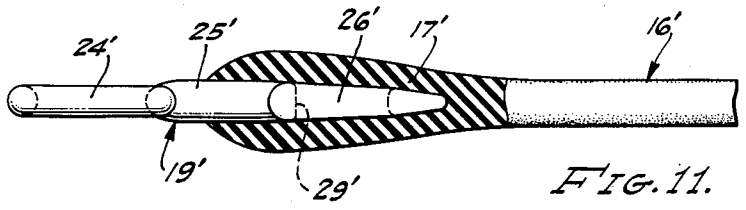

FIG. 11.

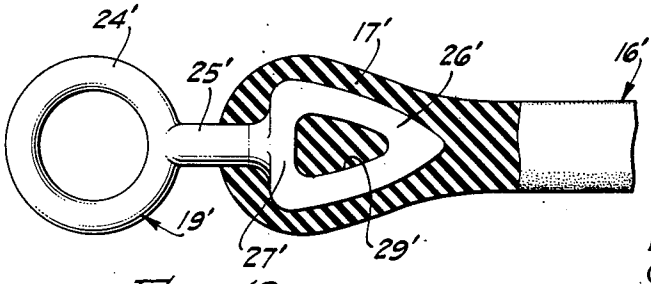

FIG. 12.

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2,805,058

ELASTIC TENSION MEMBER

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Application November 15, 1954, Serial No. 468,699

8 Claims. (Cl. 267—69)

This invention relates generally to elastic tension members, and is directed particularly to an improved arrangement for securing a metallic connector to the end of an elastic tension member of rubber or similar material.

Elastic tension members in the form of elongated straps of rubber, neoprene or the like, have been developed for various uses as substitutes for coiled steel springs, particularly where considerable elongation and contraction are required intermittently, and where size and weight are factors. A typical example of such use is as a pull-back strap for drill pipe and casing tongs used in drilling and completing oil wells. Particularly when making up the threaded joints of well casing, the make-up tong must be oscillated or "ratcheted" a number of times. The power stroke is effected by a cable, referred to as the tong line, which has one end attached to the outer end of the tong lever and the other end portion is wrapped about a small drum or cathead driven by the hoisting equipment of the drilling rig.

In order to relieve the tong operator of the manual effort involved in swinging the tong through each return stroke, it has been customary to use various types of pull-back devices which automatically effect the return stroke when the tension on the tong line is released. Rubber straps have been used for this purpose, but difficulty has been encountered in providing suitable connecting means of adequate strength and durability for detachably connecting the ends of such straps respectively to the tong lever and to an anchoring means. The most suitable type of such connecting means are metallic inserts each having a portion moulded into the respective ends of the rubber strap and each having an exposed eye or clevis for attachment respectively to the tong and to the anchoring means.

This and other applications of such an elastic strap or tension member present a difficult problem of providing adequate strength and tear-resistance in the union of the metallic insert with the end portion of the strap. The difficulty is created by the transition from uniform deformation of the main body of the strap, when under tensile load, through non-uniform deformation of the rubber in the region of the bond with the insert, to no deformation at the bonding surface. The maximum overall strength in the composite metal-and-rubber end portion of the strap can be attained only by a proper balance and distribution of tensile and shear stresses in the rubber and at the bond.

A general object of the present invention is to provide a novel and improved means for securing a metallic connecting member to the end of an elastic tension member.

It is another object of the invention to provide for the secure embedding of a portion of a metallic connecting member in the end of an elastic tension member of rubber or similar material.

A further and more specific object of the invention is to provide for the embedding of a portion of a metallic connecting member in the end of a tension strap of rubber or the like, in such manner as to minimize the danger of severing the metal-to-rubber bond between the strap and the connecting member when tension is applied to the strap and to the connecting member.

A further object of the invention is to provide a metallic connecting insert having a portion thereof embedded in the end of an elastic tension strap wherein the end of the strap and the embedded portion of the insert are of such configurations as to insure a smooth gradation of stresses in that portion of the strap material which surrounds the insert.

Still another object of the invention is to provide an elastic tension strap having metallic connector inserts partially embedded in the ends thereof, and wherein the construction of the ends of the strap and of the embedded portions of the connector inserts is such as to provide a smooth transition from strap material subjected to full deformation to strap material bonded to the inserts and hence undergoing no deformation under tensile loading.

These and other objects and advantages of the present invention will be apparent from a consideration of the following specification taken in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view of a pipe tong showing the arrangement of tong line and pull-back strap, as a typical application of the invention.

Figure 2 is a perspective view of one form of tension strap embodying the present invention.

Figure 3 is an axial sectional view of one end of the strap shown in Figure 2, with the strap in relaxed condition.

Figure 4 is a view similar to Figure 3 but taken in a plane at right angles to the plane of Figure 3, and showing the insert in elevation.

Figure 5 is a transverse sectional view taken on line 5—5 of Figure 4.

Figure 6 is a view similar to Figure 3 but showing the relation of the parts when a tensile load sufficient to effect approximately 100% elongation of the strap is applied thereto.

Figure 7 is a view similar to Figure 4 showing the relation of parts when under tensile loading.

Figures 8, 9, 10, 11 and 12 are views corresponding respectively to Figures 3, 4, 5, 6 and 7 but illustrating the invention as applied to a tension strap of substantially rectangular cross-section.

In those forms of the invention herein shown as illustrative of the general inventive concept, the connecting means comprise a ring or eye formed integral with the end of a cylindrical shank, the opposite end of which is formed with a longitudinally tapered insert portion embedded in the end of the strap. The strap is preferably formed of rubber, neoprene, or other elastic and resilient material formed at the connecting end with an enlargement adapted to receive the insert. It will, of course, be understood that in the manufacture of the device the insert is moulded into the enlarged end of the strap. The insert is preferably provided with a transverse slot or opening into which the strap material flows during the moulding process to interlock the insert and the strap material. In the first form of the invention herein shown and described, the strap is of circular cross section and the enlarged end thereof is substantially cylindrical when no load is applied. The insert diminishes in cross-sectional dimensions in a streamlined manner from its enlarged head adjacent the eye to a bluntly pointed inner extremity. In a second form of the invention herein disclosed, the strap is generally rectangular in cross-section and the cross-sectional dimensions of the insert are correspondingly modified to provide substantially the same thickness of strap material surrounding the insert as in the first embodiment.

Referring more particularly to the drawings, a tong 10 of generally conventional form is illustrated in Figure

1, and is suspended by a hanger **11**. The jaw structure of the tong is identified by the numeral **12** and the extended tong lever bears the numeral **14**. In Figure 1 of the drawing the pipe or casing is not shown but it will be readily understood that in operation the tong jaws are adapted to encircle such pipe or casing and to be secured in such encirclement to grip the pipe joint and to secure the same against rotation with respect to the jaws. A tong line **15** is attached to the outer end of the tong lever in any suitable manner and extends to the cathead of the usual draw works so that when the tong line is wound onto the cathead the tong, and the pipe section gripped thereby, are rotated in unison about the pipe axis in a clockwise direction as viewed in Figure 1.

A tong pull-back strap, representing a typical application of the present invention, is shown in Figure 1 as including a body **16** of rubber or similar material, of circular cross section and having enlarged terminal ends **17** and **18** within which are embedded the connectors **19** and **20** in a manner hereinafter to be described. The connector **20** is secured to the tong lever in any suitable manner as by means of a tong line pin (not shown) extending through the eye of the connector and mounted in the outer end of the tong lever. The connector **19** is attached to a suitable anchor means such as a cable **21** forming an extension of the pull-back strap and having its other end secured to a stationary part of the drilling rig.

Referring more particularly to Figures 3 to 7 inclusive, it will be seen that the enlarged end portion **17** of the main strap body **16** is of substantially cylindrical form, merging into the main body **16** by a gradually tapering neck portion **22**, the outer end of the enlargement **17** being rounded, as shown at **23**. The connector **19** comprises a circular ring or eye **24** integrally formed on the outer end of a shank **25** at the opposite end of which is integrally formed an insert portion **26**. This insert portion **26**, as shown most clearly in Figure 3, has a streamlined taper from its head portion **27** down to a bluntly pointed inner extremity **28**. A transverse slot **29** extends through the insert throughout a major portion of its length. In moulding the insert **26** within the enlargement **17**, the head portion **27** thereof is spaced inwardly from the rounded end **23** of the enlargement by a distance approximately equal to the thickness of strap material laterally surrounding the head portion **27** of the insert, in order to provide a substantially uniform thickness of strap material over the entire head portion of the insert.

It will be observed that the enlarged portion **17** of the strap extends beyond the pointed inner extremity **28** of the insert **26**, to provide an increase in cross-section of solid strap material, with an attendant decrease in unit tensile stress, between the main body of the strap and the portion thereof which surrounds the insert **26**. It will also be observed that by reason of the uniform diameter of the enlargement **17** and the inwardly tapering configuration of the insert **26**, the cross-sectional area of the strap material surrounding the insert gradually diminishes in successive transverse planes from the pointed inner end **28** of the insert to the head portion **27** thereof.

When the strap is subjected to tension, as by clockwise swinging of the tong **10** by the tong line **15** in the typical application herein described, the main body of the strap **16** is uniformly stressed and hence is uniformly deformed by elongation and corresponding reduction in cross-sectional area. In the region of the neck portion **22**, the gradually increasing cross-sectional area results in a progressive decrease in unit tensile stress and a corresponding progressive decrease in axial and transverse deformation of the rubber.

The most critical condition obviously prevails in the region between the inner extremity **28** and the head portion **27** of the insert **26**. In this region the inner surface of the annular body of rubber is bonded to the insert and hence is restrained against axial displacement, whereas the outer surface thereof is free. Consequently a differential axial displacement or deformation occurs, wherein at successively greater distances radially outwardly of the insert the extent of axial deformation increases. Also, by virtue of the tapered configuration of the insert **26**, the bonded area per unit of axial length progressively increases from zero at the point **28** to a maximum at the head **28**, whereby the restraint offered by the bond against axial displacement of the rubber progressively increases from the point **28** to the head **27**.

Figures 6 and 7, which correspond respectively to Figures 3 and 4, illustrate the approximate distribution of rubber around the insert **26** upon application of a tensile load sufficient to effect approximately 100% elongation of the main body **16** of the strap. It will be observed by reference to Figure 7 that as 100% elongation is approached the rubber is contracted to substantially uniform thickness over the metal-to-rubber bonding surface, throughout the length of the insert. It will also be observed that in the stressed condition, the main body **16** of rubber starts to flare outwardly, to provide an increasing cross-sectional area of solid rubber, at a point spaced a substantial distance axially inwardly of the point **28**.

The combined and ultimate effects of the aforementioned relationships and conditions is as follows:

First, a gradual reduction in unit tensile stress in the rubber from that in the main body **16** to a lower value at a transverse plane through the point **28**, where bonding restraint begins.

Secondly, a gradual increase in restraint offered by the rubber-to-metal bond against axial deformation, progressively from the point **28** to the head **27**.

Third, as tension increases from zero to the ultimate strength of the rubber, the thickness of the layer of rubber surrounding the insert approaches a substantially uniform condition throughout the length of the insert, resulting in a smooth distribution of stress. The contracting of the rubber creates a pressure normal to the bonding surface so that the bond can withstand greater shear stress.

Fourth, the shear stress at the rubber-to-metal bond is evenly distributed.

Fifth, the direction of stress in the rubber adjacent the bonding interface is substantially parallel to such interface, thus subjecting the bond primarily to shear stress rather than to tensile stress.

Sixth, the provision of the transverse slot **29** in the insert affords additional strength to the structure by providing a unitary mass of rubber mechanically interlocked with the insert, thus decreasing the duty on the bond.

Seventh, the transverse back face of head **27** provides bearing surface to resist the tensile force applied to the strap. The bonding of the rubber to this back face moves the end of the bond, which normally is an area of high stress concentration. back to the shank **25** where there is no stress concentration.

In Figures 8 to 12 there is shown a modified construction wherein the principles and features of the invention are adapted and applied to a tension strap **16'** of generally rectangular cross-section. In these figures parts corresponding to those of Figures 3 to 7 are designated by corresponding primed reference numerals. It will be observed from Figures 8 and 11 that in this form of the invention the insert portion **26'** of the connector **19'** is substantially flat-sided in the plane of the major transverse dimension of the strap body **16'** and is materially reduced in thickness, and the head portion **27'** is correspondingly increased in width, as shown in Figures 9 and 12, in order to provide substantially the same thickness of rubber overlying the various portions of the insert as in the previously described form.

When this form of the invention is subjected to tensile loading, the stress distribution in the rubber and at the bonding surfaces will be substantially the same as in the embodiment of Figures 3 to 7. Figures 11 and 12 show the approximate distribution of rubber

around the insert 26' as 100% elongation of the main body 16' of the strap is approached.

From the foregoing description of two embodiments of the invention it will be apparent that in my improved combination of tension member and metallic connector the likelihood of rupture of the rubber-to-metal bond or of the sheath of rubber enclosing the insert, under tensile loading below the elastic limit of the main body of the tension member, is greatly minimized.

It should be understood that the invention is not limited to the specific embodiments disclosed. Various other configurations will be suggested to one skilled in the art. For example, the head portion could be modified so that instead of having a transverse back face it would have a tapered back surface similar to its inner portion. Or the shank could be widened and made contiguous with the insert portion. Such modifications or equivalents, are considered to be within the scope of the invention as defined in the following claims.

What I claim is:

1. A pull-back comprising an elastic strap having an enlarged end portion, said strap adapted to be subjected to tension applied at the ends thereof, a connector to which tension may be applied, said connector having a longitudinally tapered insert bonded within said end portion of the strap, said end portion having a varying wall thickness and deforming so that under tension it approaches a condition of substantially uniform wall thickness as measured transversely outward from the insert.

2. In a pull-back, an elastic strap having an enlarged end portion, said strap adapted to be subjected to tension applied at the ends thereof, a connector having a tapered insert portion bonded within said end portion, said end portion being of uniform cross-sectional dimension and having a wall thickness increasing with relation to said tapered insert portion from said enlarged end portion to the extremity of said tapered insert portion, the longitudinal extent of the enlarged end portion being selected so that upon the application of tension, the strap wall deforms to be of substantially uniform thickness around the insert.

3. A pull-back comprising an elastic strap, said strap being adapted to be subjected to tension applied to the ends thereof, said strap having an enlarged end portion having a greater mass of material than the body of said strap, a connector having a tapered insert portion bonded within said enlarged end portion, said insert having a head and a transverse bonding surface contiguous with and back of said head, whereby a strong bond between the connector and the strap is obtained, said enlarged end portion providing an excess mass of elastic material at the point of initial stress for preventing rupture of the member.

4. A pull-back comprising a strap formed of elastic substance, said strap being adapted to be subjected to tension applied to the ends thereof, said strap having an enlarged end portion having greater mass of material than the body of said strap, a connector having a tapered insert bonded within said enlarged end portion, a transverse opening through said insert portion filled with said elastic substance, said insert having a head and a transverse bonding surface back of and contiguous with said head, whereby a strong bond between the connector and the strap is obtained, said enlarged end portion providing an excess mass of elastic material at the point of initial stress for preventing rupture of the member.

5. A pull-back comprising a strap formed of elastic substance, said strap adapted to be subjected to tension applied at the ends thereof, said strap having an enlarged end portion, a connector having a tapered insert portion bonded within said end portion of the strap, the insert including a head and a transverse bonding surface back of and contiguous with said head, a transverse opening through said insert filled with said elastic substance, whereby a strong bond between the connector and the strap is obtained, said end portion having a wall thickness increasing with relation to said tapered insert portion from said head to the extremity of said tapered insert portion.

6. An elastic tension member comprising an elongated body of rubber-like material adapted to be subjected to tension applied at the ends thereof, said tension member having an enlarged end portion of uniform cross-sectional dimension, and a connector having an insert portion embedded within said enlarged end portion of said body, said insert portion tapering from a head down to a point in a direction away from said end portion, said enlarged end portion providing an excess mass of rubber-like material at the point of initial stress for preventing rupture of the member.

7. An elastic tension member comprising a strap of rubber-like material adapted to be subjected to tension applied at the ends thereof, said tension member having an enlarged end portion of uniform cross-sectional dimension, and a connector to which tension may be applied, said connector having an insert portion bonded within said enlarged end portion, said insert portion having an aperture extending transversely therethrough and being longitudinally tapered in a direction away from said one end, said enlarged end portion providing an excess mass of rubber-like material at the point of initial stress for preventing rupture of the member.

8. An elastic tension member comprising an elongated body of resilient material adapted to be subjected to tension applied at the ends thereof, said tension member having an enlarged end portion of uniform cross-sectional dimension, and a connector having an insert portion embedded within said enlarged end portion, said insert portion being tapered in form from its outer to its inner extremities, the enlarged end portion aforesaid providing a wall of resilient material about said tapered insert portion, said wall increasing in thickness from the outer extremity to the inner extremity of said tapered insert portion and deforming when the tension member is under tension so that said walls approach a condition of substantially uniform wall thickness as measured from the tapered insert portion.

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