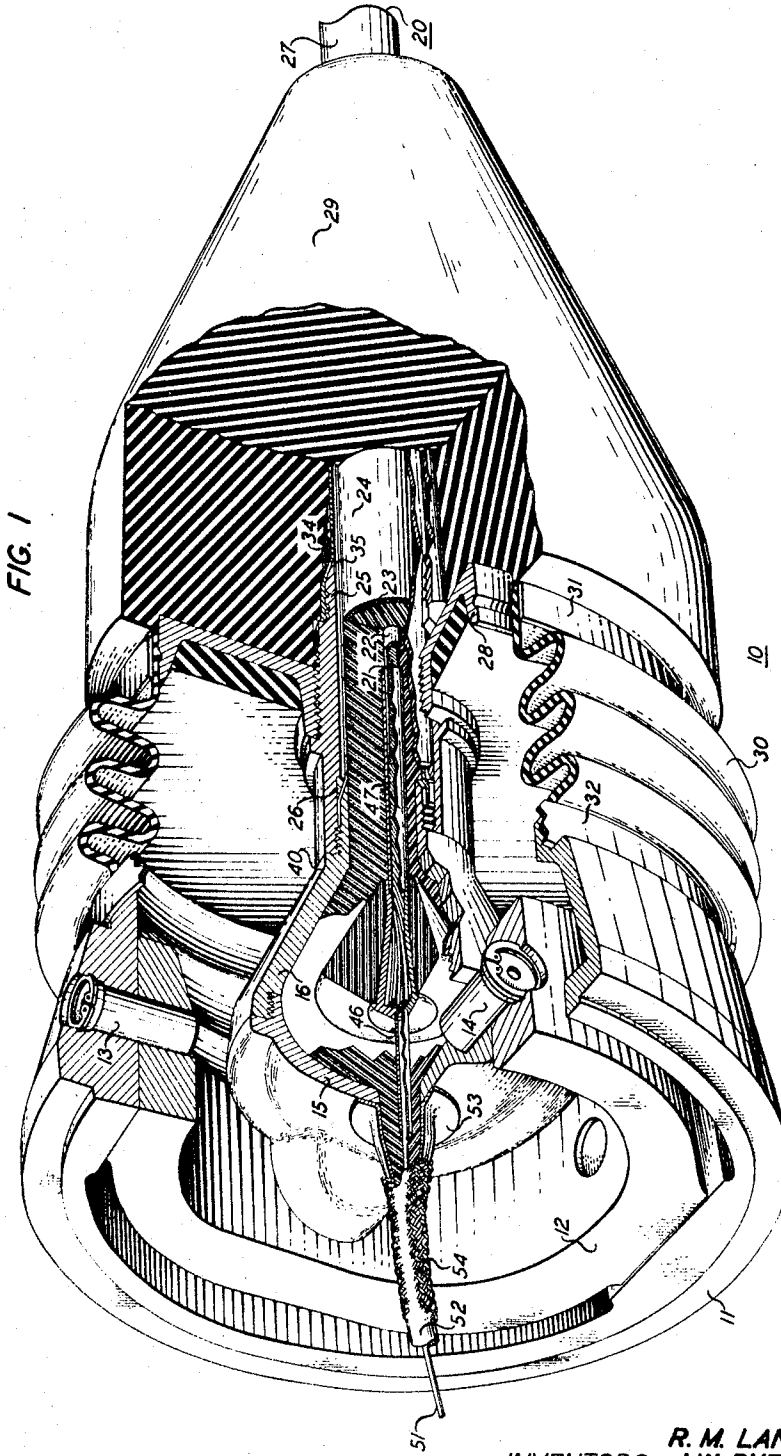
July 8, 1969 R. M. LANGMACK ET AL 3,454,707

SUBMARINE CABLE COUPLING WITH IMPEDANCE MATCHING MEANS

Filed Oct. 30, 1967 Sheet 1 of 2

FIG. 1



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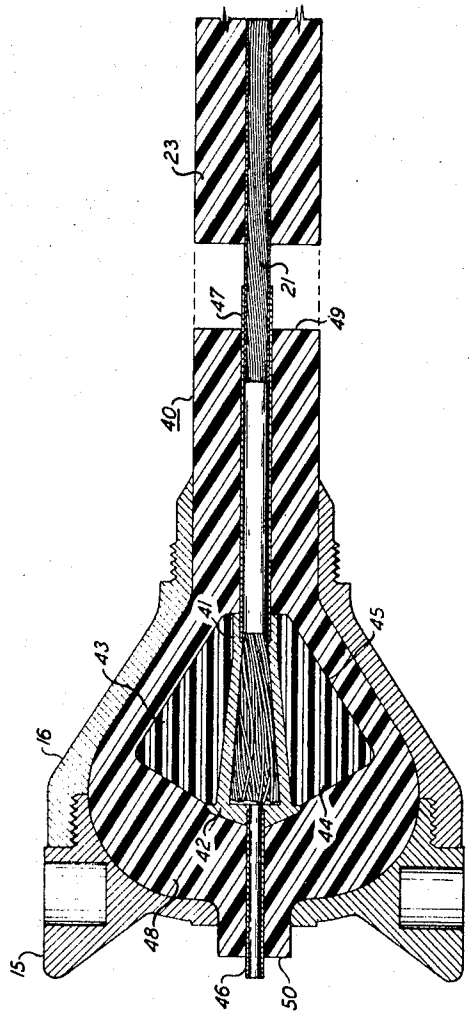
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SUBMARINE CABLE COUPLING WITH IMPEDANCE MATCHING MEANS

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FIG. 2



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SUBMARINE CABLE COUPLING WITH IMPEDANCE MATCHING MEANS

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U.S. Cl. 174—70 7 Claims

ABSTRACT OF THE DISCLOSURE

A flexible undersea coupling between a submarine coaxial cable and a repeater employs a gimbaled tension transfer member that maintains an impedance match between the cable and repeater. The structure primarily employed is metallic cone for anchoring the inner cable conductor, a ceramic bulk affixed to the cone and a polyethylene envelope cast around the cone and the ceramic.

This invention relates to coaxial cable couplings and more specifically to an underwater cable coupling for connecting armorless cable to its repeaters without introducing impedance mismatch.

Background of the invention

In underwater cable systems, couplings are the electrical and mechanical interface between the cable proper and one end of a repeater. Broadly, their function is two-fold: to mechanically link the cable strength member firmly to the repeater; and to electrically connect the conductive and dielectric portions of the cable with the repeater. In practice, these functions often are performed concurrently by the same structural members. In past coupling designs however, an optimal mechanical link has been a less than satisfactory electrical connection in important respects.

One problem characteristic of previous couplings was the impedance mismatch between coupling and repeater, introduced by the mechanical requirements of tension transfer between cable strength member and coupling. The mismatch has been remedied by adding compensating networks to each repeater, which increase the cost of the system while decreasing its reliability. A solution to the problem at its source, however, has been elusive for want of a sturdy tension transfer member whose mechanical design measures the same impedance-wise as the repeater.

Hence, one primary object of the invention is to balance the impedance of a cable coupling and the associated repeater.

A more specific object of the invention is to effect a strong mechanical tie between cable and coupling without introducing an impedance imbalance between the coupling and its repeater.

Summary of the inventive concept

These and other objects are achieved pursuant to the invention by a cable coupling having as a key element a tension transfer member comprising a ceramic anchor engaged on a strand termination cone and imbedded in a polyethylene body, the anchors outer face running at all points substantially parallel to the dielectric field associated with the polyethylene.

The cone itself is a product of extensive shape optimization geared to accommodate the strength strands in the least possible volume and to provide further an engaging surface for the ceramic anchor. Additionally, the gimbals associated with the tension member are located substantially in the same plane as the coaxial pigtail which electrically connects the strength member to the repeater. Thus, less flexural strength is required at the pigtail.

Features of the invention, accordingly, include but are not limited to:

An improved tension transfer member characterized by a ceramic anchor whose outer face and the coning polyethylene coincide in a plane that is essentially parallel to the dielectric field;

An improved strand termination cone; and

An improved relationship between the gimbaling and the coaxial pigtail.

Detailed description of the drawing

FIG. 1 is a side perspective view showing in breakaway the several elements of the coupling; and

FIG. 2 is a side view of the anchor molding assembly.

Detailed description of an illustrative embodiment

FIG. 1 illustrates an ocean cable coupling, designated **10**, in which the inventive concepts are embodied. Coupling **10** is equipped for bolting to a repeater end surface through its gimbal housing **11**. Gimbal ring **12** is engaged through two gimbal pins **13** (one shown) to housing **11**. Gimbaled to ring **12** through two pins **14** (one shown) is a cone housing cap **15**. Cap **15** in turn is threaded to cone housing **16**.

The ocean cable to be accommodated in coupling **10**, and designated **20**, is of the coaxial type comprising an inner stranded steel wire **21** surrounded by a metallic jacket **22**, the two respectively comprising the strength member and the cable inner conductor. A solid dielectric core **23**, normally polyethylene, surrounds jacket **22**. Around dielectric core **23** is the outer conductor **24** of the coaxial cable. Conductor **24** is a copper tube electrically secured to the coupling between the end of housing **16** and the shoulder of a collar **25** which threads to housing **16**. This joint is further secured by a ring **26**. Cable **20** is provided with an outer jacket **27**, also normally of polyethylene, which surrounds outer conductor **24**.

In the final coupling assembly shown in FIG. 1 the polyethylene core **23** is continuous from cable **20**, through an anchor molding assembly **40**, and on into the dielectric of a pigtail lead **52** to the repeater. The structure which achieves this continuity is shown in FIG. 2 and will be described shortly.

A boot frame **28** is embedded within a heavy rubber boot **29** and is threaded to collar **25**. The rubber boat **29** limits the flexing of cable **20** at the coupling. A bellows **30** made of rubber or the like is secured at one end by strap **31** to a flange of frame **28** and at the other end by strap **32** to a flange of gimbal housing **11**. Bellows **30** protects the inside of coupling **10** while allowing the gimbaling movement to occur. Within the boot assembly **28** and **29**, outer conductor **24** is covered and protected by a spacer **35** of the same material as jacket **27** that is welded into place with the jacket, and extends to ring **26**. A tube of irradiated polyethylene **34** is heat shrunk to a snug fit over collar **25**, spacer **35** and jacket **27** to protect the structure during part of the assembly operation.

FIG. 2 shows the anchor molding assembly **40**. Strength strand **21** is spread and anchored, as with epoxy, to the interior core of a termination cone **41**. Cone **41** advantageously is constructed of beryllium copper. Its interior surface is optimally designed to effect the greatest possible securing strength in the least possible space. This interior design is characterized by a small amount of flare, as in what is known as a bell shape, of a particular exponential curvature, which assures an essentially

uniform decrease in tension in the several wires from the cable end to the coupling end.

Cone **41** includes a forward flange **42** rising from its exterior surface as shown in FIG. 2. To this exterior surface a dielectric anchor **43** made of certain qualities of ceramic or the like is engaged. Anchor **43** has a tapered interior which fits the taper of the exterior of cone **41**. The forward end of anchor **43** is beveled to engage flange **42** of cone **41**. Anchor **43** comprises a forward conical surface **44** and a rear conical surface **45**. Ceramics suitable for constructing anchor **43** include aluminum oxide in one embodiment although other constituents such as beryllium oxide could be used.

Assembly **40** also includes a cone fill tube **46** secured to the nose of cone **41** and through which epoxy or the like is introduced for anchoring the strands **21**. Tube **46** also provides electrical connection between cone **41** and the repeater in well-known fashion. A cone extension tube **47** leads out the interior rear entrance to cone **41** and envelops the inner conductor **22** to provide inner conductor electrical continuity.

Assembly **40** also includes a polyethylene molding **48** as shown in FIG. 2, which surrounds anchor **43**. Molding **48** has an outer surface which is in flush contact with the inner surface of housing **16** and also in flush contact with the inner surface of cap **15** when it is threaded to housing **16**. It is in this region of the inventive structure that the desired impedance balance is achieved, pursuant to the invention, by maintaining an essentially constant level of capacitance between the outer metallic cap **15** and housing **16**, and the inner cone **41**.

More specifically, a certain capacitance level exists between jacket **22** (the inner conductor of the cable) and cable outer conductor **24**. Similarly, at any cross section taken through anchor **43** and assembly **40**, the capacitance between the metallic members must be the same. The choice of the dielectric materials (polyethylene and certain ceramics in the instant embodiment) as well as the relative cross sections of the metallic cap **15**, housing **16** and cone **41** are the critical parameters to be balanced, given the basic guides of a constant capacitive level, and a taper for load handling purposes to both the ceramic anchor **43** and the molding **48**. The configuration shown in FIGS. 1 and 2 is believed optimal.

Molding **48** also is the agent for transfer of load between the rear surface **45** of anchor **43** and the cone housing **16**. Specifically, load from ocean cable **20** is imparted to termination cone **41** through strands **21**; thence to anchor **43** and polyethylene molding **48**.

Dielectric continuity is afforded from cable dielectric **23** to the tail end **49** of molding **48** by a process of hot molding, after strands **21** are assembled to assembly **40** and the latter is encased in cone housing **16** and cap **15** and inner conductor continuity is achieved by connection of cone extension tube **47** and conductor **22** by welding or brazing. Similarly, dielectric continuity is provided between the front end **50** of molding **48** and the dielectric **52** of the repeater connection pigtail by a hot molding process after the pigtail inner conductor **51** has been attached to cone fill tube **46** by welding or brazing.

Electrical continuity between the outer conductor **24** of cable **20** and the outer conductor **54** of the repeater connection pigtail is effected through cone housing **16**, cap **15** and pigtail cap **53** secured to housing cap **15**. Of further advantage is the location of said joint between front end **50** and pigtail dielectric **52** at least partly in the plane of the point of intersection of assumed projections from gimbal during the gimbaling and hence is subject to less fatigue jeopardy.

It is to be understood that the embodiments described herein are merely illustrative of the principles of the invention. Various modifications may be made thereto by persons skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A load transfer device between an ocean cable having a center strength member and a repeater housing, comprising:

a termination cone receiving said center strength member, said cone comprising conical interior and exterior surfaces and a forward flange;

a dielectric anchor engaged upon said cone exterior surface and abutting said flange, said anchor comprising a truncated conical load-bearing outer surface; and

a polyethylene load-bearing body encapsulating said cone and said anchor, said body also effecting a dielectric continuum between said ocean cable and said repeater housing,

the outer surface of said anchor running substantially parallel to the dielectric field.

2. A load transfer device in accordance with claim **1** wherein said dielectric anchor is a ceramic.

3. A coupling between a coaxial cable including a center strength member and an outer conductor and a repeater, comprising:

means supporting a gimbaled housing;

means for transferring tension between the cable center strength member and said housing comprising a termination cone including a conical interior receiving said strength member, a conical exterior surface, and a forward flange; a dielectric anchor engaged upon said cone exterior surface and abutting said flange, said anchor comprising a truncated rear conical load-bearing surface; and a polyethylene load-bearing body encapsulating said cone and said anchor;

means including said polyethylene body for effecting a dielectric continuum between said ocean cable and said repeater; and

means including said polyethylene body for effecting electrical connection between said cable and said repeater.

4. A coupling in accordance with claim **3** wherein the outer surface of said anchor runs substantially parallel at all points to the dielectric field.

5. A coupling in accordance with claim **4** wherein said dielectric anchor is a ceramic and said termination cone is composed of beryllium copper.

6. A coupling in accordance with claim **5** further comprising means including a metallic pigtail situated at least partly on either side of the gimbals of said housing for effecting electrical connection between the outer conductor of said cable and said repeater.

7. A coupling in accordance with claim **6** wherein said electrical connection means further comprises said gimbaled housing.

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U.S. Cl. X.R.

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