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ELECTRICAL CONNECTOR

Filed April 8, 1968

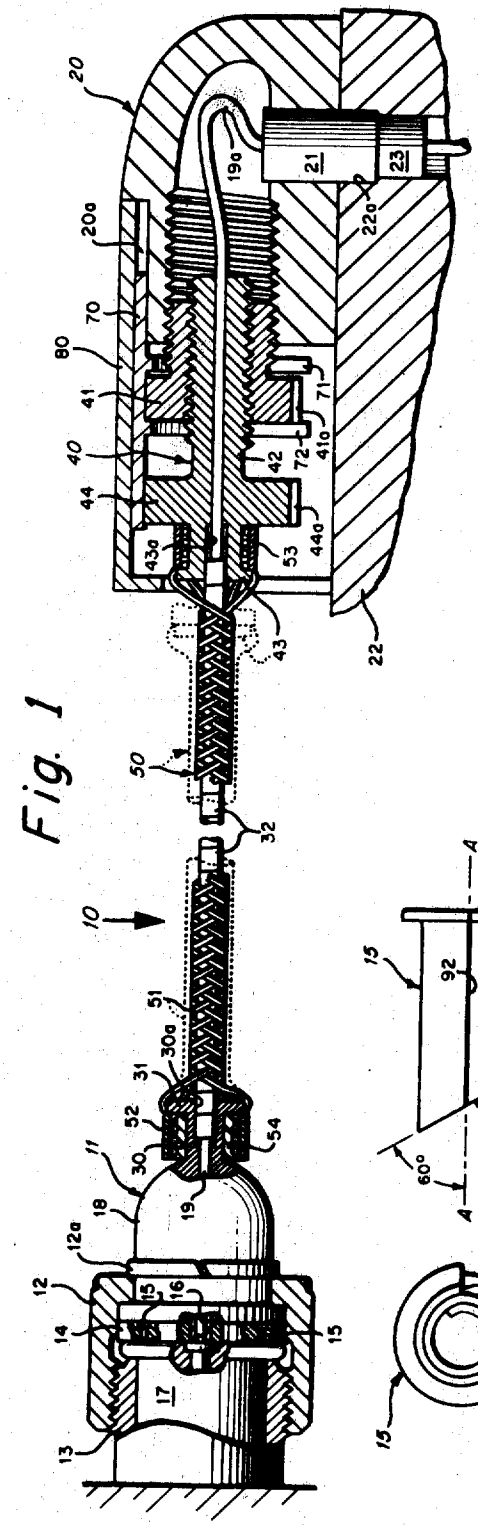


Fig. 1

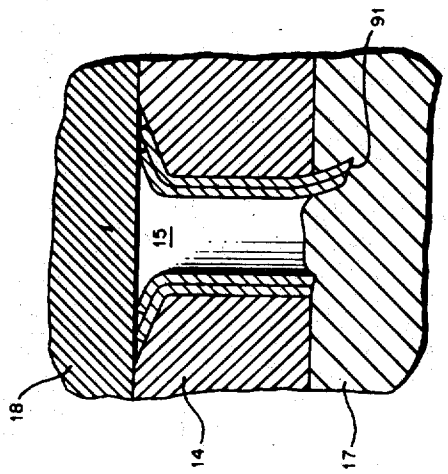


Fig. 5

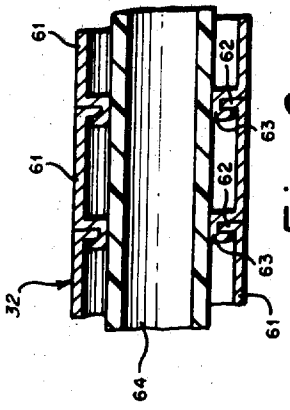


Fig. 2

Fig. 3

Fig. 4

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ELECTRICAL CONNECTOR

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ABSTRACT OF THE DISCLOSURE

An electrical connector including a flexible armored sheath having an insulated conductor threaded therethrough an electrically connected between a plug unit and a breech cap which is adapted for applying a firing signal to a pyrotechnic cartridge and which has flanged spring pins formed to function both as ground contacts and as spent cartridge extracting means. A braided sheath encircles the armored sheath and is mechanically connected at one end to the breech cap and at the other end through a turnbuckle-like sheath stretching assembly to the plug unit. The stretching assembly enables the braided sheath to be longitudinally stretched so that it tightly grips the armored sheath and forms therewith a more rigid conduit.

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

Pyrotechnically actuated bomb racks are frequently rendered inoperable by reason of the electrical failure of a connector which terminates at one end in a breech cap adapted for applying a detonation signal to a pyrotechnic cartridge carried in an ejector assembly. The connector needs to be flexible and cannot be secured to adjacent structure of the bomb rack because the breech cap must be removed to load cartridges. Flexible connectors are subjected to buffeting by air turbulence during flight which causes the connector to vibrate with consequential weakening and eventual severance of the electrical conduction path.

SUMMARY OF THE INVENTION

It is the general purpose of this invention to provide an improved electrical connector which assures that a good electrical conduction path will be maintained and which can be made stiff enough to resist the deleterious effects of buffeting by air turbulence and yet does not interfere with easy disconnection of the breech cap from its associated pyrotechnic ejector assembly. Briefly, this is accomplished by providing a flexible armored sheath through which extends an untensioned length of conductor electrically interconnecting the breech cap and an anchor and plug unit; by providing a stretchable sheath which encases the flexible armored sheath and is mecanically connected in a linkage between the breech cap and the anchor unit; and by providing adjustable stretching devices, such as a breech cap coupling or an assembly interconnected between an end of the stretchable sheath and the cap or the anchor unit, for longitudinally stretching the encasing sheath and causing it to grip the periphery of the armored sheath and form a more rigid conduit which can withstand intense air turbulence. Additionally, the invention further contemplates that a good electrical conduction path to the pyrotechnic cartridge be maintained by providing ground contact pins of an improved design. The ends of the tubular pins are obliquely cut to facilitate piercing and gripping the cartridge casing when the breech cap has been coupled in operative position to the associated ejector assembly cartridge chamber and to facilitate extracting the spent cartridge.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 represents a side view partially in cross section of a connector according to the invention;

FIG. 2 represents an enlarged view in longitudinal cross section of a portion of a flexible armored sheath included in the connector of FIG. 1;

FIG. 3 represents an enlarged side view of a disengaged ground contact pin including in the connector of FIG. 1;

FIG. 4 represents an end view of the pointed end of the pin of FIG. 3; and

FIG. 5 represents an enlarged cross-sectional view of the pin in piercing engagement with a cartridge casing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the connector **10** terminates at one end in a breech cap **11** generally of the type described in U.S. patent application Ser. No. 700,603, filed Jan. 25, 1968, by Carl A. Damm for "Breech Cap for Applying Signals to Explosive Cartridges." The breech cap **11** includes a rotatable, inwardly flange coupling **12** which is connected to a barrel **13** of an ejector assembly (not shown) such as that generally described in U.S. Patent No. 3,036,852 to C. W. Mullison, issued May 29, 1962, and in U.S. patent application, Ser. No 657,738, filed July 31, 1967, by Carl A. Damm for "Ejector Assembly with Lockable Store-Engaging Pressor Foot" now U.S. Patent No. 3,431,824 issued Mar. 11, 1969. The breech cap further includes an apertured breech closing plate **14** through which protrude force fit, flanged ground contact pins **15**, hereinafter more fully described, and a spring-loaded primary contact **16**. The pins **15** and **16** establish good electrical contact with a pyrotechnic cartridge **17** which is received within the barrel **13** and is of the type detonated by an electrical firing signal. The tubular coupling **12** may include a plurality of key slots (not shown) longitudinally extending from the barrel adjacent end of the coupling **12** and sized to receive a spring loaded key (not shown) for preventing relative rotation of the coupling **12** and the barrel **13**.

The breech cap **11** also includes a flanged, stainless steel pressure dome **18** which is welded to and closed by the plate **14** and which, among other things, sandwiches the ground contact pins **15** in position. The rotatable coupling **12** is retained adjacent the flanged end of the dome **18** by a metal snap ring **12***a* seated in a peripheral groove formed in the dome **18**. A flexible, insulated conductor **19** which extends into the dome **18** has a stranded signal lead (not shown) electrically connected at one end with the primary contact **15** and has an inner ensheathing, braided ground shield (not shown) insulated from the lead and mechanically and electrically connected to the dome **18**. The other end of the conductor **19** extends into a hollow anchor unit **20** and is electrically connected to a plug **21** which protrudes from the anchor unit **20**. The anchor unit **20** is rigidly connected as by bolts (not shown) with a framing structure **22** rigidly connected to the bomb rack after insertion of the plug **21** into an aperture **22***a* formed in the structure **22** for establishing an electrical connection with a recessed receptacle **23** mounted in the aperture **22***a*. The receptacle **23** is electrically connected with a control unit (not shown) which provides the electrical firing signal to be applied by the cap **11** to the cartridge **17**.

The conductor **19** extends through an aperture formed in the end of the dome **18** remote from the barrel **13** and

is threaded through a tubular boss **30** which is fixed to and protrudes from the dome **18**. The extended end of the boss **30** terminates in a radially extending flange **31** and has a coaxial bore **30***a* extending thereinto which is sized to slidingly receive an end of a flexible armored sheath **32** through which the conductor **19** is threaded. The other end of sheath **32** is slidingly received by a turnbuckle-like stretching assembly **40** through which the conductor **19** is threaded.

The stretching assembly **40** includes a coaxially apertured, internally threaded adjusting bolt **41** which has a hexagonal head and oppositely directed, similarly pitched, external threads and which is threadably engaged by the anchor unit **20**. One end of a coaxially apertured fitting **42** is threaded into the bolt **41**. The other end of the fitting **42** terminates in a flanged boss **43** having a coaxial bore **43***a* extending thereinto which is sized to slidingly receive the other end of the armored sheath **32**. The medial portion of the fitting **42** includes a radially projecting, locking flange **44**. The fitting **42**, the adjusting bolt **41** and the anchor unit **20** are so interconnected that threading the bolt **41** into the anchor unit **20** causes the fitting **42** and its boss **43** to be drawn toward the anchor unit **20**.

It is preferred that the conductor **19** not be tensioned. By loosely threading the conductor **19** through the armored sheath **32** and forming a loop or bend **19***a* therein within the cavity of the anchor unit **20**, a connector configuration is established wherein little vibration is transmitted to the conductor lead which could eventually cause an electrical failure.

A tubular braided sheath **50** of stainless steel having a plurality of double-stranded interwoven helical coils **51** is firmly connected at its ends to the bosses **30** and **43** of the cap **11** and the fitting **42** of the stretching assembly **40** as by swaged sleeves **52** and **53**. While the braided sheath **50** may be joined to the boss **30** of the cap **11** by any desired method, the preferred embodiment includes a thin polyurethane sheath **54** which extends along the periphery of the boss **30** and which provides a seat into which the strands **51** of the braided sheath **50**, which have been bent over the flange **31**, may be imbedded by the swaged sleeve **52**. Another desirable method (not shown) of swaging the braided sheath **50** to the boss **43** of the stretching assembly **40** contemplates the use of a pair of swaged sleeves made of materials having differing shrink rates so that the inner sleeve made of a material such as plastic is swaged directly to the boss **43** and provides the seat into which the strands **51** may be imbedded by the overlying swaging sleeve.

The length of the braided sheath **50** relative to the length of the armored sheath **32** is chosen so that in the particular installation the substantially untensioned sheath **50** assumes the greater diametered profile, generally indicated in exaggeration by dotted lines in FIG. **1**, when the coupling **12** is unthreaded or the assembly **40** is adjusted to have its greatest integral length. For installing the connector **10** in a particular rack, the assembly **40** is adapted for a sufficient initial reduction in length when the cap **11** has been firmly seated against the cartridge **17** so that the braided sheath **50** can be longitudinally stretched and reduced in diameter so that the helical strands **51** are stretched and tensioned to firmly grip the underlying periphery of the armored sheath **32** and form therewith a conduit of desired rigidity. The boss **43** is long enough so that the end of the armored sheath **32** remains within the bore **43***a* after the assembly **40** has been shortened to cause the braided sheath **50** to be necked down for tightly gripping the underlying armored sheath **32**. Thereby, a substantially rigid conduit may be formed which can withstand the buffeting effects of air turbulence. At any time thereafter, the stiffness of the conduit may be relaxed by loosening the coupling **12** to untension the braided sheath **50**. When the breech cap **11** is disconnected from the barrel **13**, the armored sheath **32** may be flexed or bent to facilitate extracting the spent cartridge **17** and loading another cartridge **17**. Further adjustment of the assembly **40** is usually unnecessary unless the coupling **12** is unable to sufficiently stretch the sheath **50**.

Referring to FIG. 2, the armored sheath **32** is formed from a helically coiled strip **61** having an inwardly depending tongue **62** which interlocks with a trough **63** inwardly depending from the confronting edge of the adjacent turn of the strip **61**. Since the strands **51** of the braided sheath **50** tightly grip the periphery of the coiled strip **61** when the stretching assembly **40** has been tightened, flexure or bending of the connector **10** is inhibited. Also, when the braided sheath **50** is stretched to radially compress the armored sheath **32**, the tongue **62** tends to more closely engage the trough **63** and resist longitudinal sliding movement characteristically present when the armored sheath **32** is bent. The armored sheath **32** also includes a flexible plastic liner **64** which facilitates conductor insertion and protects the conductor **19** from damage by the sheath **32**.

Referring again to FIG. 1, the head of the adjusting bolt **41** has a plurality of longitudinal slots such as **41***a* formed therein, any one of which may be longitudinally registered with keying slots **20***a* and **44***a* formed in the anchor unit **20** and the locking flange **44** of the fitting **42**. An elongated key **70** is held in locking position by a pair of bifurcated spring clips **71** and **72** spaced to be arranged on opposite sides of the head of the bolt **41** for clipping engagement of the shanks of the fitting **42** and the bolt **41**. The key **70** is positioned to prevent rotation of the adjusting bolt **41** once the desired degree of the longitudinal stretching of the braided sheath **50** has been imposed. A snap-on plastic cover **80** functions to streamline the connector configuration, reducing the causation of turbulence, and to protect the stretching assembly **40** from the accumulation of dirt and ice which could impair its operation.

Referring to FIG. 3, the stainless steel ground contact pins **15** are fabricated from flanged, cylindrical spring pins made of about two turns of spirally wound rectangles of spring steel. As shown in FIG. 4, the piercing point **91** of the pin **15** has been formed by obliquely truncating a cylindrical pin as by cutting or grinding to form an elliptical pin terminus lying in a plane extending obliquely of the longitudinal axis A of the pin **15**. It has been found that, as shown in FIG. 5, when the pin **15** is being forced into the aluminum casing of the cartridge **17** by threading the coupling **12** onto the barrel **13** to seat the plate **14** against the cartridge **17**, the laminated walls of the pin point **91** tend to slightly diverge outwardly of the pin axis A and be forced obliquely into the aluminum casing. The furthest projecting portion of the point **91** is deflected outwardly the greatest degree. The above-described pin configuration not only provides an excellent electrical contact with the cartridge **17** but also facilitates spent cartridge extraction in that, as the uncoupled breech cap **11** is withdrawn from operative position, the points of the pins **15** tend to continue to grip the cartridge **17** and extract it from the barrel **13**.

Several factors influence the design of the pins **15**. For example, it has been discovered that the distance that the points of the stainless steel spring pins **15** project beyond the plate **14** should be about eighteen-thousandths of an inch when three ground contact pins having one-sixteenth inch diameters are to pierce an aluminum cartridge casing. Longer point projections prevent complete pin penetration and leave a gap between the plate **14** and the cartridge which can cause the pins **15** to be subjected upon detonation to sufficient cartridge kickback to stress the pins **15** beyond their elastic limits and impair the reuse of the cap **11** and connector **10**. It has been found that when the projecting ends of the pins **15** are too blunt, e.g., define a plane substantially normal to the pin axis, the pins will not pierce the aluminum cartridge casing a

sufficient degree for gripping engagement. On the other hand, if the points **91** are too sharp, e.g., in the above specific example, define a plane which is about 30° oblique to the pin axis A, seating the cap **11** on the barrel **13** and tightening the coupling **12** causes the material in the points **91** to be stressed beyond its elastic limit, thereby causing pin point splaying and impairing reuse of the connector **10**. While 45° points usually have been found to be satisfactory for three one-sixteenth inch diametered pins used to pierce aluminum, a more blunt point such as one defining a plane which is about 60° oblique to the pin axis A is preferred in order to maintain a good electrical conduction path and to assure the feature of ability to extract spent luminum cartridges. When the spent cartridge **17** is disengaged from the pins **15**, the pin points **91** spring back to their normal orientation and are ready for reuse.

Another factor to be considered in designing reusable pins **15** is the peripheral location along the point **91** of the projected end of the outer longitudinally extending wound rectangle edge **92**. When the end of the edge **92** lies along the furthermost projecting half of the point **91**, the pin point material tends to be stressed beyond its elastic limit upon being forced into a cartridge casing and, consequently, tends to be permanently deformed. Permanent pin point splaying can be avoided by locating the edge **92** in the other half of the pin **15** which projects the least. Thus, the portion of the point **91** being forced into the casing which will undergo the greatest deflection from the longitudinal axis generally maintains the cross-sectional configuration of an unbroken double-layered elliptical arch during the piercing process. Since the material of the portion being inserted is more uniformly stressed, point deformation within the elastic limits of the material is better assured.

It is preferred that the edge **92** be peripherally located halfway between the longitudinal locations of the greatest and least point projection, i.e., that the length of the edge **92** be equal to the average length of the pin. This configuration facilitates mass production of the pins **15** by enabling the use of a pair of jigs having at one end contiguous, coplanar edges slanted at the desired angle for the points **91** and having a plurality of opposed semicylindrical bores extending normal to the slanted edge for receiving a plurality of unfinished pins **15**. The edges **92** of the pins **15** may be easily indexed into alignment with the longitudinal boundaries of the bores in one of the jigs prior to positioning the mating jig. The proper peripheral location of the edge **92** is thereby assured for each pin **15**.

The invention provides an electrical connector **10** of greatly improved design which vastly increases the reliability of the bomb rack in that a good electrical connection between the cartridge **17** and the signal source via the receptacle **23** is continually assured. Vibration incident to in-flight conditions does not tend to cause failure of the electrical interconnection between the cartridge **17** and the signal source in that the ground contact pins **15** engage or grip the cartridge casing with spring-like action and in that the conductor **19** does not tend to vibrate and remains in an untensioned state, preserving the conduction path to the primary and ground contacts **15** and **16**. The flexible armored sheath **32** and the tensioned braided sheath **50** coact to form a substantially rigid conduit through which the conductor **19** is loosely threaded. The relaxable conduit formed thereby resists buffeting and vibration stimulated by air turbulence which could cause severance of the conductor **19** or other failure of the connector **10**.

It is contemplated, of course, that other known plug configurations not shown should be utilized. For example, the plug **32** could be mounted on the end of a conduit rigidly secured to the frame which threadably receives a coupling member connected to the plug **21**. It is further contemplated that the connector **10** could include thermal insulation liners extending along the length of the armored sheath **32** for preventing possible melting of the shield and lead of the conductor **19** in the presence of rocket blasts.

It should be understood, of course, that the foregoing disclosure relates only to a preferred embodiment of the invention and that numerous modifications or alterations may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A connector comprising:

first and second connecting means;

a flexible sheath extending between said first and said second connecting means;

a tubular stretchable sheath having said flexible sheath threaded therethrough and having one of its ends mechanically connected to one of said first and second connecting means, said stretchable sheath having a diameter which varies as a function of elongation; and

adjustable stretching means mechanically interconnected between said stretchable sheath and the other of said first and second connecting means for elongating said stretchable sheath relative to said flexible sheath a sufficient degree to enable said stretchable sheath to peripherally grip said flexible sheath.

2. A connector according to claim **1** wherein:

said stretchable sheath comprises a plurality of helically coiled strands interwoven to form a longitudinally stretchable tubular sheath.

3. A connector according to claim **2** wherein:

said flexible sheath comprises a helically coiled strip having a trough depending inwardly from one lateral boundary thereof and a tongue depending inwardly from the other lateral boundary thereof for interlocking engagement with said trough of an adjacent turn of said helical strip.

4. A connector according to claim **1** wherein:

said first and second connecting means each include means for transmitting an electrical signal; and

said connector further includes an untensioned electrical conductor electrically interconnecting said first and second means and extending longitudinally through said flexible sheath.

5. A connector according to claim **4** wherein:

both said stretching means and said one of said first and second connecting means each include protruding therefrom a boss having said conductor extending therethrough and having a bore extending thereinto of a size for receiving an end of said flexible sheath;

the ends of said stretchable sheath are mechanically connected to said bosses; and

said flexible sheath is longitudinally slidable within at least one of said bores of said bosses.

6. A connector according to claim **5** wherein said first connecting means comprises:

a breech cap having the other of said bosses protruding therefrom and formed for closing a breech of a pyrotechnic ejector assembly, said breech cap including a mechanical coupling member for connection to the ejector assembly and including primary contact means and ground contact means for applying a detonation signal to an electrically actuatable pyrotechnic cartridge.

7. A connector according to claim **6** wherein said second connecting means comprises:

a hollow anchor unit threadably engaging said adjusting member;

said conductor having a bend formed in a portion thereof extending within said housing for relieving tension in said conductor; and

a plug member electrically connected to said conductor and protruding from said anchor unit for establish-

ing a mechanical and electrical connection with a signal source.

8. A connector according to claim **5** wherein said stretching means comprises:

a fitting having one of said bosses protruding therefrom; and

an adjusting member formed for threadably engaging said fitting, said adjusting member including an oppositely threaded portion threadably engaged by said other of said first and second connecting means.

9. A connector according to claim **1** further comprising:

said flexible sheath being formed to be more resistant to flexure when subjected to radial compression; and

said adjustable stretching means being adjustable to cause stretchable sheath elongation of a sufficient degree enabling said stretchable sheath to radially compress said flexible sheath and reduce its flexibility.

10. A connector according to claim **9** further comprising:

said adjustable stretching means including a turnbuckle having a conductor ensheathing bore extending therethrough and having one end connected to said stretchable sheath and the other end connected to said other of said first and second connecting means; and

said connector further includes an untensioned electrical conductor extending through said flexible sheath and said turnbuckle bore and electrically interconnecting said first and second connecting means.

11. A connector comprising:

a flexible sheath;

an untensioned electrical conductor extending longitudinally through said flexible sheath;

a breech cap having a boss protruding therefrom which has said conductor extending therethrough and which has a bore extending thereinto of a size for receiving one end of said flexible seath, said breech cap being formed for closing a breech of a pyrotechnic ejector assembly, said breech cap including a mechanical coupling member for connection to the ejector assembly and including primary contact means electrically connected to one end of said electrical conductor for applying a detonation signal to an electrically-actuatable pyrotechnic cartridge;

said breech cap further having ground contact means including a breech closing plate having an aperture and a tubular pin formed from a sheet of resilient electrically conductive material wound upon itself about an axis and arranged in said aperture to protrude from said plate, the protruding end thereof defining a plane oblique to said axis of said pin and being formed for piercing engagement of a cartridge casing;

a stretchable sheath having said flexible sheath threaded therethrough and having one of its ends mechanically connected to said boss of said breech cap;

connecting means for transmitting an electrical signal electrically interconnected to the other end of said electrical conductor;

adjustable stretching means for mechanically interconnecting said stretchable sheath with said connecting means, said stretching means including protruding therefrom a boss which has said conductor extending therethrough and which is mechanically connected to the other end of said stretchable sheath, said boss having a bore extending thereinto of a size for receiving the other end of said flexible sheath; and

said flexible sheath is longitudinally slidable within at least one of said bores of said bosses.

12. A connector according to claim **11** wherein:

said pin includes an outer longitudinally extending edge of said material which has a length not longer than the average length of said pin.

13. A connector according to claim **12** wherein:

said pin includes an outer longitudinally extending edge of said material which has a length equal to the average length of said pin.

14. A connector comprising:

a flexible sheath;

an untensioned electrical conductor extending longitudinally through said flexible sheath;

first and second connecting means each including means for passing an electrical signal and electrically interconnected by said conductor, one of said connecting means including protruding therefrom a boss which has said conductor extending therethrough and which has a bore extending thereinto of a size for receiving one end of said flexible sheath;

a stretchable sheath having said flexible sheath threaded therethrough and having one of its ends mechanically connected to said boss;

a fitting having a boss which has said conductor extending therethrough and which has the other end of said stretcable sheath mechanically connected thereto, said boss having a bore extending thereinto of a size for receiving the other end of said flexible sheath;

said flexible sheath being longitudinally slidable within at least one of said bores of said bosses;

an adjusting member formed for threadably engaging said fitting, said adjusting member including an oppositely-threaded portion threadably engaged by said other of said first and second connecting means;

said fitting, said adjusting member and said other of said first and second connecting means each having slots formed therein which are registrable with one of those of each of the others; a key engageable with said slots in registration of said fitting, said adjusting means and said other connecting means for locking said adjusting members; and

means for retaining said key in said registered slots.

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SAMUEL W. ENGLE, Primary Examiner

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