United States Patent

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[72] Inventors **Carl A. Damm**
Upper Black Eddy;
Albert C. Eichmann, Huntingdon Valley;
William J. Halpern, Philadelphia, Pa.

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[73] Assignee **the United States of America as represented by the Secretary of the Navy**
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[54] **CONDUIT OF ADJUSTABLE STIFFNESS**
2 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **339/101,** 174/168, 285/91, 285/114, 285/305
[51] **Int. Cl.** **H03k 17/02**
[50] **Field of Search** 285/305, 114, 91; 24/123.5; 138/129; 285/91; 339/101; 174/168

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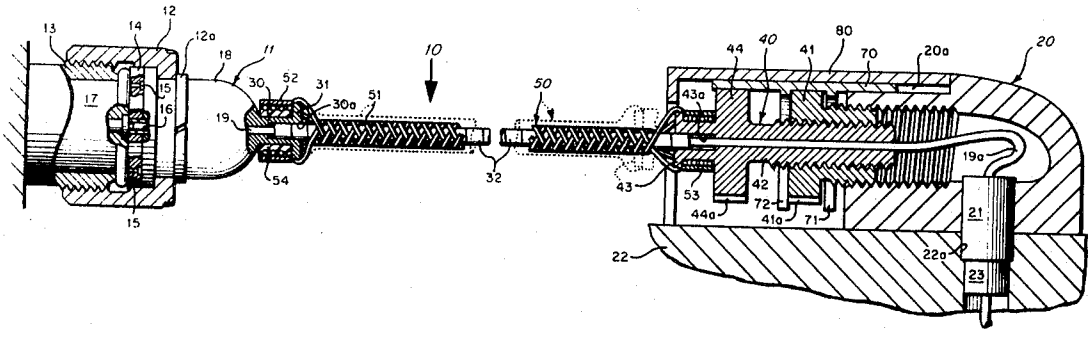
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Primary Examiner—Dave W. Arola
Attorneys—Edgar J. Brower, Henry Hansen and B. Frederick Buchan, Jr.

ABSTRACT: An electrical connector including a flexible armored sheath having an insulated conductor threaded therethrough and 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 turnbucklelike 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.



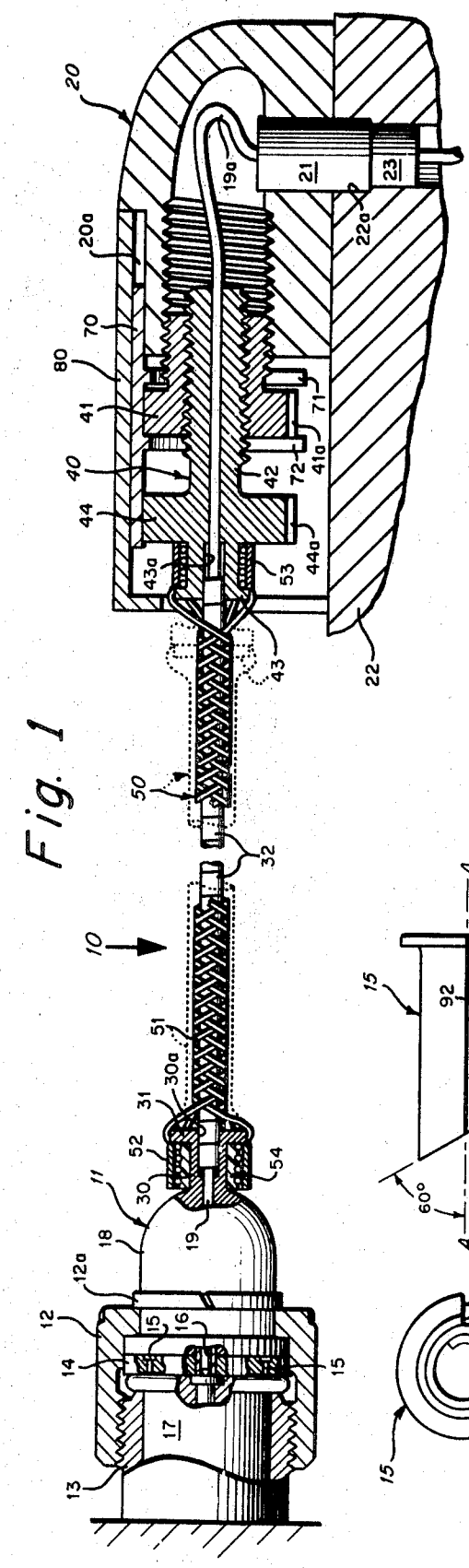


Fig. 1

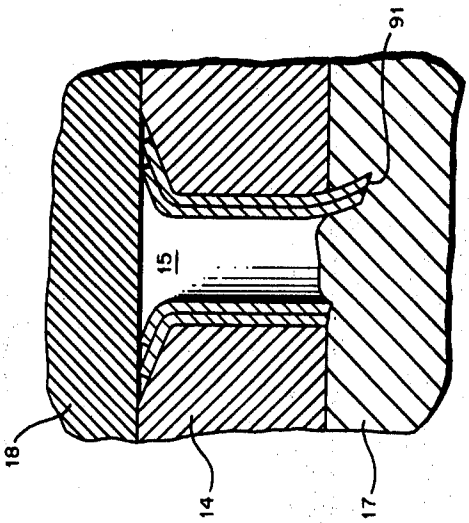


Fig. 5

Fig. 3

Fig. 4

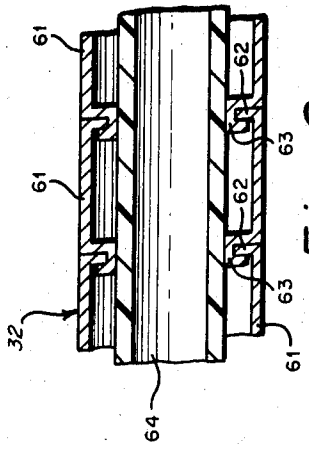


Fig. 2

INVENTORS
CARL A. DAMM
ALBERT C. EICHMANN
WILLIAM J. HALPERN
BY
ATTORNEYS

CONDUIT OF ADJUSTABLE STIFFNESS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a division of application Ser. No. 719,629 filed Apr. 8, 1968 now U.S. Pat. No. 3,504,592.

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 conduit for an 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 adapted to carry 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 mechanically 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 a turnbuckle 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.

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 included 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. Pat. application Ser. No. 700,603, now U.S. Pat. No. 3,490,332, 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 flanged coupling **12** which is connected to a barrel **13** of an ejector assembly (not shown) such as that generally described in U.S. Pat. No 3,036,852 to C. W. Mullison, issued May 29, 1962, and in U.S. Pat. application, Ser. No. 657,738, filed Jul. 21, 1967, by Carl A. Damm for "Ejector Assembly with Lockable Store-Engaging Presser Foot." 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 turnbucklelike 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 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 pine 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 pinpoint 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 1/16-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 pinpoint splaying and impairing reuse of the connector 10. While 45° points usually have been found to be satisfactory for three 1/16-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 aluminum cartridges. When the spent cartridge 17 is disengaged from the pins 15, the pinpoints 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 pinpoint material tends to be stressed beyond its elastic limit upon being forced into a cartridge casing and, consequently, tends to be permanently deformed. Permanent pinpoint 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 projections, 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 springlike 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.

We claim:

1. A conduit of adjustable stiffness comprising:

a helically coiled strip forming an elongated flexible tube whose resistance to flexure increases when subjected to radial compression;

an elongated tubular sheath whose transverse dimension changes as a function of change in its length, said tube being arranged inside said sheath and having confronting boundaries for providing surface contact between said tube and said sheath;

anchor means connected to one end of said sheath;

a threaded coupling having a protruding boss secured to the other end of said sheath and an axial bore slidably receiving the adjacent end of said tube;

a threaded fitting threadably engaging said coupling for changing the length of said sheath in a direction to cause said confronting boundaries to engage each other exerting radial compression on said tube and reducing the flexibility thereof;

an anchor member having a threaded chamber receiving said fitting;

said coupling, said fitting and said anchor member each having slots of which are registrable with each other;

a key engageable with said slots in registration preventing rotation of said coupling and said fitting; and

means for retaining said key in said registered slots.

2. A conduit according to claim 1 further comprising:

an electrical conductor freely carried within said tube; and

said coupling, said fitting and said anchor member defining a channel through which said conductor extends, one end of said conductor forming a terminal in said anchor member.