Nov. 28, 1967 V. F. ALIBERT ETAL 3,355,703

COMPONENT INTEGRAL ELECTRICAL CABLE CONNECTOR

Filed June 29, 1965

FIG. 1
PRIOR ART

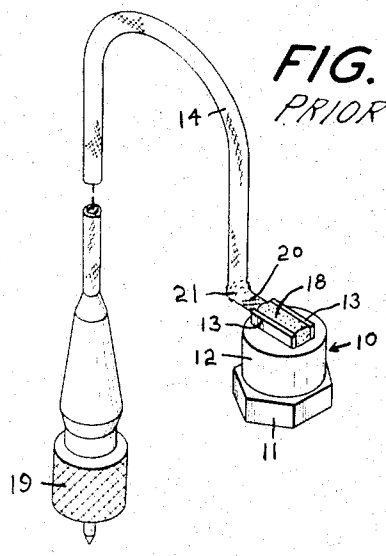


FIG. 2
PRIOR ART

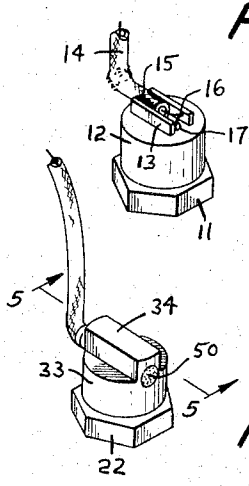


FIG. 3

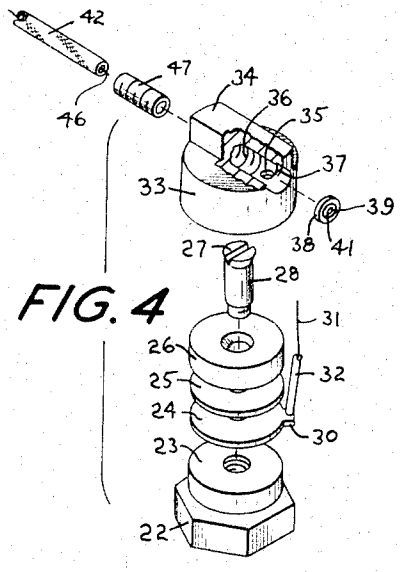


FIG. 4

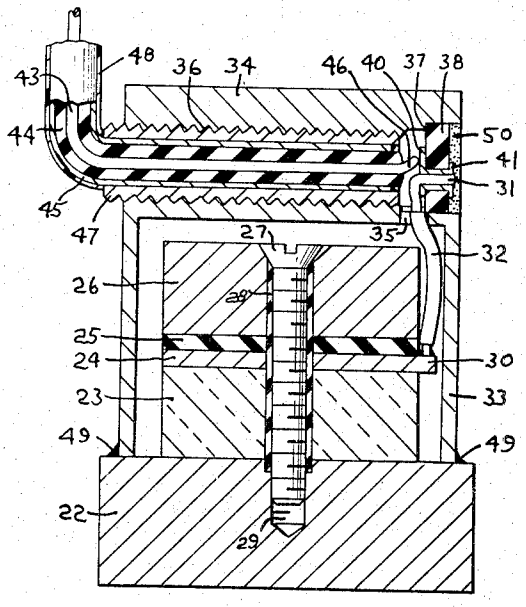


FIG. 5

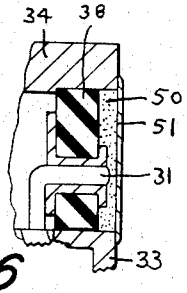


FIG. 6

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COMPONENT INTEGRAL ELECTRICAL CABLE CONNECTOR

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6 Claims. (Cl. 339—177)

This invention relates generally to electrical connectors, and more particularly, relates to very small sized coaxial cable connectors suitable for use with microminiature transducer devices or any device in which physical size and weight must be held to an absolute minimum.

For purposes of illustration, the electrical connector according to the invention is shown in the drawings and described in the following portions of the specification as being used in conjunction with a microminiature accelerometer used to measure vibration and shock. Accelerometers of this type are of very small physical size on the order of one quarter inch in height and diameter and may weigh on the order of 1.5 grams. Devices of this size are utilized in applications where the minimum mass loading of a test specimen is important, and also in those applications where there exists very little space available for the mounting of data collecting devices.

Heretofore, available types of coaxial connectors have been very much larger and heavier than the transducer itself. Consequently such connectors were not usable and permanent nondetachable types of electrical connections were required in order to eliminate the heavy and bulky connectors. Unfortunately, transducers of this type have been rendered inoperative due to cable failure under operating conditions so that it became necessary to replace the entire transducer due to the nondetachable connection of the coaxial signal cables thereto. Transducer replacement is quite costly by comparison with cable replacement so that the inability to merely replace the cable has up to now constituted a vexatious problem. Accordingly, it is a primary object of our invention to provide a novel electrical connector suitable for use with microminiature devices so constructed that substantially no increase in size or mass of such devices results.

Another object of our invention is to provide a novel electrical connector in which one part of the connector may be formed as an integral part of the device to which electrical connections is to be made.

Still another object of our invention is to provide a novel coaxial connector in which the coaxial cable itself becomes a part of the connector.

A still further object of our invention is to provide a novel coaxial connector of exceedingly small size as aforesaid for use in microminiature components wherein one part of the connector is formed as a permanent part of the casework of the component while the mating part of the connector is secured to and becomes part of the physically detachable coaxial signal cable, mechanical interlock between the parts of the connector being effected by a multiturn threaded connection.

The foregoing and other objects of our invention will become clear from a reading of the following specification in conjunction with an examination of the appended drawings, wherein:

FIGURE 1 is a perspective view showing, several times enlarged, of a microminiature accelerometer with permanently attached cable and output connector;

FIGURE 2 is a view of the accelerometer of FIGURE 1 illustrated prior to encapsulation of the electrical connections between the accelerometer and associated coaxial cable;

FIGURE 3 is a perspective view on the same scale as that of FIGURE 1 illustrating the modified form of accelerometer casing coaxial cable connection in accordance with the present invention;

FIGURE 4 is an enlarged exploded perspective view of the assembly of FIGURE 3 showing the various parts of the connector assembly according to the invention, some portions being broken away to disclose details of interior construction;

FIGURE 5 is an enlarged vertical sectional view taken through the assembled structure of FIGURE 3 as would be seen when viewed along the line 5—5 thereof; and

FIGURE 6 is an enlarged detail view of a modified portion of the connector which provides complete electrostatic shielding of the signal circuit.

In the several figures, like elements are denoted by like reference characters.

Referring now to the drawings, and first to FIGURES 1 and 2, there is shown an accelerometer designated generally as **10** having a base **11** and a hollow cylindrical upper case **12** from the top surface of which case upwardly extend a pair of spaced apart parallel flanges or fins **13**, the flanges **13** extending substantially chordally across the case top and being spaced apart a distance substantially equal to the outer dimeter of the coaxial output signal cable designated generally as **14**. The shield braid of the coaxial cable **14** is mechanically and electrically secured to the case **12** by soldering as at **15** to the flanges **13**, and the center conductor of the coaxial cable **14** is soldered to a signal conductor as at **16**, which signal conductor extends into the case **12** through an aperture **17** in the case top wall to a point of electrical connection with the transducer inside the case **12**. As best seen in FIGURE 1, the space between the case flanges **13** is then filled with a hard setting epoxy potting material **18** which permanently locks the cable **14** to the accelerometer **10**. The cable **14** is then rubber coated and a coaxial output connector **19** is fitted to the free end of the cable to complete the transducer assembly.

From the showing of FIGURE 2 it is observed that the continuity of signal conductor shielding is broken in the region of connection **16** between the cable center conductor and the transducer signal conductor, the potting compound **18** providing mechanical support and electrical insulation for the signal conductors but being incapable of restoring the continuity of shielding. Consequently, a certain degree of noise susceptibility results which would not occur if continuous shielding were maintained.

Additionally, because of the soldered connections **15** of the cable shield braid to the case flanges **13** it is very difficult to prevent backflow of solder into the cable braid in the region designated as **20**. This tends to rigidify the cable braid and prevent the cable from being turned up sharply close to the case when desired so that in effect the accelerometer dimension may be undesirably increased. In this circumstance, a sharp bend in the cable causes fraying as at **21** and ultimate breakage of the cable under conditions of vibration where a cable may be whipping quite rapidly. The nature of the connections between cable **14** and case **12** makes it substantially impossible to replace the cable without requiring a complete rebuilding of the transducer. Since the rebuilding cost is comparable to the cost of a new unit, cable failure in effect requires replacement of the entire device and makes such transducers very expensive to use because of their comparatively short useful life.

All of the disadvantages of the constructions shown in FIGURES 1 and 2 are eliminated in the construction according to the invention illustrated in the FIGURES 3, 4 and 5 to which reference should now be made. The transducer includes a base **22** upon the upper surface of

which is fixedly secured a four-layer cylindrical sandwich including a piezoelectric crystal disc 23 surmounted in order by an electrically conductive disc 24, an electrical insulator disc 25 and a seismic mass 26. All of the elements 23 through 26 are vertically centrally apertured so that a bolt 27 in a sheath of insulating material 28 is projectable with a snug fit vertically downward therethrough and into threaded engagement with a tapped hole 29 in the base 22. The conductive disc 24 is provided with a laterally extending ear 30 to which is electrically connected a flexible conductor 31 provided along a portion of its length with an insulating sleeve 32.

The signal generating part of the accelerometer just described is enclosed in a hollow cylindrical casing 33 similar to the casing 12 previously described but differing therefrom in that instead of including the upstanding flanges 13 it is surmounted on its top surface with a generally rectangular parallelepiped shell 34 extending substantially diametrically across the casing top wall. The shell 34 is provided with a bore longitudinally thereof extending completely therethrough, and the top wall of the casing 33 is provided with an aperture 35 extending from the inside of the casing into the bore proximate to but inward from one end of the bore. The bore through the shell 34 is tapped as at 36 from the end of the bore remote from aperture 35 and up to but not beyond the location of the aperture. The untapped end of the rectangular formation is counterbored inward substantially to the near edge of the aperture 35 to form a shoulder 37 proximate thereto.

The diameter of the counterbore is the proper size to smoothly receive a circular disc 38 made of glass or other insulating material provided with an off-axis hole therethrough designated as 39. The opposite faces of the insulator disc 38 are plated with a conductive material which does not extend outward to the edge of the disc 38 and which is continuous through the hole 39 to provide electrical continuity between the conductive plating 40 on the inside face of the disc 38 and the conductive plating 41 on the outside face of the disc, as best seen in FIGURE 5. As also best seen in FIGURE 5, the thickness of the insulator disc 38 is less than the depth of the counterbore so that the disc is projectable completely within the counterbore with its inside face seated against the shoulder 37 and with the conductive platings 40 and 41 on the insulator disc 38 spaced away from the electrically conductive casing 33 and rectangular shell 34.

The coaxial cable 42, which has a diameter on the order of three sixty-fourths of an inch, includes a center conductor 43 surrounded by a dielectric 44 which is in turn enclosed in a metal shield braid 45. The dielectric material 44 and shield braid 45 are trimmed away at one end of the cable to leave an exposed short end 46 of the center conductor 43, and the prepared cable end is then slipped into a close fitting externally threaded conductive sleeve 47, the sleeve 47 being relatively thin-walled with threads corresponding to those tapped into the rectangular shell 34 and designated as 36. The coaxial cable shield braid 45 is soldered or otherwise conveniently electrically and mechanically secured to the threaded conductive sleeve 47 and the cable is then provided with a protective coating, as at 48, up to the end of the sleeve 47.

The free end of the cable 42 may be fitted with any convenient type of output connector, as for example a coaxial connector of the type shown at 19 in FIGURE 1. As best seen in FIGURE 5, the externally threaded conductive sleeve 47 is preferably of such length that when threaded completely into the tapped bore 36 in the casing rectangular shell 34, a small portion extends outward from the end of the threaded bore so that it may be grasped with a small instrument or with fingernails for rotating the entire cable assembly out of the bore in the event that the cable need be replaced.

Assembly of the accelerometer without the coaxial cable portion is carried out in the following manner. First, the base 22 and elements 23 through 26 are secured together by means of the bolt 27, and the case 33 is then slipped downward thereover so that flexible conductor 31 is projected upward through aperture 35 in the casing top wall and outward through the counterbore end of the rectangular shell 34. The case 33 is then electrically and mechanically secured to the base 22 as by peripheral soldering as shown at 49 in FIGURE 5. The conductor 31 is passed through the plated-through hole 39 in insulator disc 38 and the insulator disc 38 is slipped along the conductor until it is disposed in the counterbore with its inner face in abutment against shoulder 37 as shown in FIGURE 5. The conductor 31 is then soldered to the outside face conductive plating 41 of the disc 38 and the excess conductor length is clipped off. The disc 38 is fixedly held in place by a small amount of hard setting epoxy potting compound 50 filled in over the disc in the counterbore.

The case 33 and rectangular shell 34 being electrically connected to the base 22 and hence to the lower face of the crystal 23 form one side of the electrical signal circuit, while the conductive plating face 40 on the insulator disc 38 being electrically connected via conductor 31 to the upper face of the crystal 23 forms the other side of the electrical signal circuit. When now the coaxial cable is threaded into the rectangular shell 34, the outside shield braid 45 is electrically connected through externally threaded conductive sleeve 47 and through the casework to the outside or ground side of the circuit, while the cable center conductor forward end 46 engages the inside conductive plating 40 on the insulator disc 38 and hence connects to the crystal upper face.

The free end 46 of the coaxial cable center conductor is trimmed to a length such that it contacts the insulator disc conductive plating 40 prior to the point where further axial advance of threaded sleeve 47 is prevented by termination of the tapped threads 36 in shell 34. Thus, the continued screw advance of the sleeve 47 biases the coaxial cable center conductor end 46 strongly against the conductive plating 40 to insure a good electrical contact therebetween. The center conductor end 46 is also sufficiently short that it can not be caused to buckle or shift laterally sufficiently to short circuit the output signal to the casework. If desired a conductive coating can be laid over the potting compound 50 to contact the casework and complete the shielding as shown at 51 in the detail of FIGURE 6.

It should be observed that the separable connector structure according to the invention results in no size increase and in substantially no weight increase for the completed accelerometer unit while affording ease of cable replacement as often as required in a manner nondestructive of the transducer itself. This results partly from utilizing the coaxial cable itself as a part of the connector and also partly from utilizing portions of the necessarily present casework of the transducer to form another part of the connector.

Having now described our invention in connection with a particularly illustrated embodiment thereof it will be appreciated that modifications and variations thereof may now occur from time to time to those persons normally skilled in the art without departing from the essential spirit or scope of the invention, and accordingly it is intended to claim the same broadly as well as specifically as indicated by the appended claims.

What is claimed as new and useful is:

1. A coaxial cable connector comprising in combination,

(a) a first part having wall portions defining a bore therein, at least some of the bore wall-defining portions of said first part being electrically conductive and provided with screw threads for a distance extending inward from an open end of the bore,

(b) an electrical insulator part and an electrically con-

ductive contact carried thereby, said insulator part being disposed within said first part bore in engagement with the bore walls so that the conductive contact is insulated from the conductive portion of the bore wall and disposed in axial alignment with and extending radially of the bore axis,

(c) means for introducing an electrical signal conductor into said first part for electrical connection to said conductive contact,

(d) means for connecting an electrical conductor to the electrically conductive portion of said first part bore wall, and

(e) a conductive sleeve second part having an outside surface and an inside surface, said outside surface being provided along at least a portion of its length from one end thereof with external threads complemental to those formed in the bore of said first part, the outer diameter of said threaded sleeve being such that the sleeve is close fittingly and axially projected into said first part bore by threaded engagement with said bore wall, the open internal cross section of said conductive sleeve being just sufficient to permit passage therethrough of a coaxial cable of desired size with an outer conductive shield braid of the cable in electrical contact with the inside surface of said sleeve, the threaded length portion of the bore in said first part being less than the length of the said conductive sleeve second part so that an end portion of said sleeve extends out of said first part when said sleeve is completely threaded into said first part bore,

whereby, a coaxial cable may be projected through said conductive sleeve with the cable outer shield braid electrically and mechanically secured to said sleeve and with a free end portion of the cable center conductor exposed by removal of the surrounding dielectric material and shielding and extending beyond the end of the threaded conductive sleeve so that threading of the sleeve into the bore of the said connector first part axially advances the cable center conductor into engagement with the aforesaid conductive contact carried by the electrical insulator part disposed within the bore and electrically connects the cable shield braid to the electrically conductive portion of said bore wall, such a cable and said conductive sleeve being thereby nonintegrally fixedly securable to said connector first part and removable therefrom for replacement of a cable as desired by unthreading said conductive sleeve from the bore in said connector first part.

2. A combination miniature transducer housing and miniature coaxial cable detachably connected thereto by means of a coaxial connector which has one part formed integrally with the transducer housing and another part secured to and carried by the cable, comprising in combination,

(a) a hollow electrically conductive transducer case having case walls, a thin-walled electrically conductive shell having a cylindrical bore therein defined by a bore wall which is threaded inward from one end for at least a portion of its length toward the opposite end, at least a portion of a wall of said shell being common with at least a portion of a wall of said case, and the common wall between said case and shell being apertured proximate to the said bore opposite end to provide an opening between said bore and the case interior,

(b) an electrical insulator part and an electrically conductive contact carried thereby disposed in said bore proximate to said opening into said case, said contact being insulated from said conductive shell and disposed in axial alignment with the bore axis,

(c) a thin-walled cylindrical conductive sleeve having an outside surface and an inside surface, said outside surface being externally threaded along at least a portion of its length so as to be axially projected into said shell bore by threaded engagement with said bore wall, said conductive sleeve being longer than the threaded length portion of the bore wall in said conductive shell, the open internal cross section of said conductive sleeve being just sufficient to permit passage therethrough of a coaxial cable of desired size with an outer conductive shield braid of the cable in electrical contact with the inside surface of said sleeve,

(d) a miniature coaxial cable having an outer shield braid and a center conductor, said cable being projected through said conductive sleeve with the cable outer shield braid electrically and mechanically secured to the inside surface of said sleeve and with a free end portion of the cable center conductor exposed by removal of the surrounding dielectric material and shielding and extending beyond the end of the threaded conductive sleeve so that the threading of the sleeve into the bore of the said conductive shell axially advances the cable center conductor into engagement with the aforesaid conductive contact carried by the electrical insulator part disposed within the bore and electrically connects the cable shield braid to the electrically conductive shell and case, said cable and conductive sleeve being thereby nonintegrally fixedly securable to the transducer housing and removable therefrom for replacement of said cable as desired by unthreading said conductive sleeve from the bore of said conductive shell,

whereby, a multiterminal electrical device disposable within said conductive case may have one terminal electrically connected to the coaxial cable shield braid through the conductive case and may have another terminal electrically connected to the cable center conductor by connection of its said another terminal through said bore side opening to the said conductive contact.

3. The device as described in claim 2 wherein said electrical insulator part disposed in said bore and carrying said electrically conductive contact comprises a thin disc of insulating material having an aperture therethrough transverse to the plane of said disc, and said electrically conductive contact comprises an electrically continuous conductive substance plated onto the opposite faces of said disc and through said aperture.

4. The device as described in claim 2 wherein said thin-walled externally threaded cylindrical conductive sleeve is of minimally greater diameter than that of said miniature coaxial cable, wherein said thin-walled electrically conductive shell within which said conductive sleeve is threaded is of minimally greater cross-section than said sleeve, and wherein the length of the said free end portion of the cable center conductor is shorter than the distance from the center conductor to the said conductive sleeve and to the bore wall in said conductive shell, whereby, the coaxial connector is minimally larger than the diameter of the miniature coaxial cable and the center conductor cannot be shifted laterally sufficiently to be short-circuited to the conductive case.

5. A combination miniature transducer housing and coaxial cable connector, comprising in combination,

(a) a hollow electrically conductive case having case walls, a thin-walled electrically conductive shell having a cylindrical bore defined by a bore wall which is threaded inward from one end for at least a portion of its length toward the opposite end, at least a portion of a wall of said shell being common with at least a portion of a wall of said case, and the common wall between said case and shell being apertured proximate to the said bore opposite end to provide an opening between said bore and the case interior,

(b) an electrical insulator part and an electrically conductive contact carried thereby disposed in said bore

proximate to said opening into said case, said contact being insulated from said conductive shell and disposed in axial alignment with the bore axis, and

(c) a thin walled cylindrical conductive sleeve having an outside surface and an inside surface, said outside surface being externally threaded along at least a portion of its length so as to be axially projected into said shell bore by threaded engagement with said bore walls, the open internal cross section of said conductive sleeve being just sufficient to permit passage therethrough of a coaxial cable of desired size with an outer conductive shield braid of the cable in electrical contact with the inside surface of said sleeve,

whereby, a coaxial cable may be projected through said conductive sleeve with the cable outer shield braid electrically and mechanically secured to said sleeve and with a free end portion of the cable center conductor exposed by removal of the surrounding dielectric material and shielding and extending beyond the end of the threaded conductive sleeve so that the threading of the sleeve into the bore of the said conductive shell axially advances the cable center conductor into engagement with the aforesaid conductive contact carried by the electrical insulator part disposed within the bore and electrically connects the cable shield braid to the electrically conductive shell and case, such a cable and said conductive sleeve being thereby nonintegrally fixedly securable to the transducer housing and removable therefrom for replacement of a cable as desired by unthreading said conductive sleeve from the bore of said conductive shell, and whereby a multiterminal electrical device disposable within said conductive case may have one terminal electrically connected to the coaxial cable shield braid through the conductive case and may have another terminal electrically connected to the cable center conductor by connection of its said another terminal through said bore side opening to the said conductive contact.

6. A combination miniature transducer housing and coaxial cable connector, comprising in combination,

(a) a hollow transducer case having case walls, a shell having a bore therein defined by an electrically conductive bore wall threaded inward from one end for at least a portion of its length toward the opposite end, at least a portion of a wall of said shell being common with at least a portion of a wall of said case, and the common wall between said case and shell being apertured proximate to the said bore opposite end to provide an opening between said bore and the case interior,

(b) an electrical insulator part and an electrically conductive contact carried thereby disposed in said bore proximate to said opening into said case, said contact being electrically insulated from said bore wall and disposed in axial alignment with the bore axis,

(c) electrically conductive means connected to said electrically conductive bore wall and extending therefrom to the interior of said hollow case, and

(d) a conductive sleeve having an outside surface and an inside surface, said outside surface being externally along at least a portion of its length so as to be axially projected into said shell bore by threaded engagement with said bore wall, the open internal cross section of said conductive sleeve being sufficient to permit passage therethrough of a coaxial cable of desired size with an outer conductive shield braid of the cable in electrical contact with the inside surface of said sleeve,

whereby, a coaxial cable may be projected through said conductive sleeve with the cable outer shield braid electrically and mechanically secured to said sleeve and with a free end portion of the cable center conductor exposed by removal of the surrounding dielectric material and shielding and extending beyond the end of the threaded conductive sleeve so that the threading of the sleeve into the bore of the said conductive shell axially advances the cable center conductor into engagement with the aforesaid conductive contact carried by the electrical insulator part disposed within the bore and electrically connects the cable shield braid through the electrically conductive bore wall and conductive means extending therefrom to the said case interior, such a cable and said conductive sleeve being thereby non-integrally fixedly securable to the transducer housing and removable therefrom for replacement of a cable as desired by unthreading said conductive sleeve from the bore of said shell, and whereby a multiterminal electrical device disposable within said hollow case may have one terminal electrically connected to the coaxial cable shield braid through the said conductive means extending from the conductive bore wall to the case interior and may have another terminal electrically connected to the cable center conductor by connection of said another terminal to the said conductive contact through the said opening between said bore and the case interior.

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