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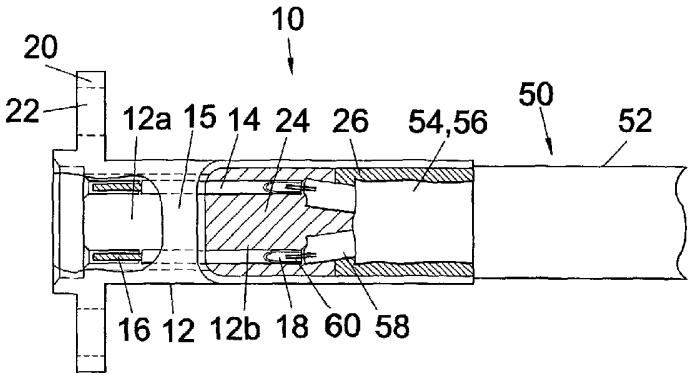
(54) Title: CABLE CONNECTOR




(57) Abstract: A data transmission cable connector (10) for connection to a twinaxial cable (50) includes a pair of terminal connector pins (14) separated by a dielectric (15). The dielectric is dimensioned and has a dielectric constant such that the impedance of the connector matches the impedance of the cable. The connector (10) further includes a conductive potting material (26) which secures the cable (50) in position and connects the shield (56) of the cable to the walls of the connector. An insulating potting material (24) is used to secure the pins (14) and cable in position.

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# CABLE CONNECTOR

The present invention relates to a cable connector, and to a data transmission cable incorporating such a connector. Certain embodiments of the invention relate particularly to cables and connectors for use in transmission of large volumes of data at high speeds.

Modern control and monitoring systems such as those used on aircraft and on spacecraft require the transmission and flow of large volumes of data at high speeds between component parts of the systems. Generally data transmission will take place over data transmission cables connecting the various parts of the relevant systems.

High speed data transmission is greatly improved if the impedance of the cables and the cable end connectors is matched. This is not however always straightforward to achieve; in particular, impedance matching may be restricted by connector space limitations.

A further restriction on data transmission cables when used on aircraft and spacecraft is the requirement for a robust, secure connection within a limited space.

One common construction of data transmission cable is coaxial cable. However, typical uses will require paired coaxial cables, each of which must be separately secured and connected to a component of the relevant system, thereby increasing the minimum footprint of the relevant connections. Such connections are also relatively difficult

to install and access. Further, it can be complex to produce coaxial cable pairs with a desired impedance matching.

Alternative forms of data transmission cable are known, in particular the so-called 'twinaxial' or 'twinax' construction. These arrangements allow for smaller connector sizes to be used; however, available twinax cables are not of sufficiently robust construction to provide a secure connection capable of resisting vibration and other forces which may be experienced on aircraft and spacecraft. These cables and their connectors are therefore generally not suitable for use in these fields.

It is among the objects of embodiments of the present invention to obviate or alleviate these and other disadvantages of existing data transmission cable connectors. It is further among the objects of selected embodiments of the present invention to provide an impedance-matched cable and connector of restricted footprint size which nonetheless allows a secure, robust connection to be made.

According to a first aspect of the present invention, there is provided a cable connector comprising a casing housing two terminal contacts, each terminal contact including a cable contact portion for coupling to a respective data transmission member of a twinax data transmission cable, and a socket contact portion, the

casing further comprising securing means for securing the connector to a corresponding receiving socket, and wherein the terminal contacts are held at a predetermined separation within a dielectric material to provide a predetermined impedance.

Preferably the cable contact portions are adapted for soldering to a respective data transmission member, although in other embodiments alternative coupling arrangements may be utilised.

Preferably the dielectric material is a polymeric material; conveniently the dielectric material is a liquid crystal polymer.

Preferably the impedance between the terminal contacts is between 100 and 200 ohms; more preferably the impedance is around 150 ohms. This impedance is selected to provide the same impedance as standard twinax data transmission cables; however, this impedance has previously proved difficult to obtain in a connector suitable for air and space use.

Preferably the terminal contacts are disposed substantially within the casing; that is, they do not protrude from the casing. Preferably the terminal contacts are in the form of pins; more preferably the terminal contacts are in the form of twisted wire pins, for example, those sold under the trade mark of TwistPins by Glenair, Inc (RTM) of Glendale, California.

Preferably the casing is divided into two compartments, with the socket contact portions and the cable contact portions of the terminal contacts being disposed in respective compartments. Conveniently the casing is divided by means of the dielectric material which serves to hold the terminal contacts in position, and through which the terminal contacts pass.

The connector may further comprise a twinax data transmission cable potted within the casing. Conveniently the potting comprises a conductive potting portion and a non-conductive potting portion. Preferably the non-conductive portion is disposed adjacent the cable contact portion of the terminal contacts, and serves to isolate the cable contacts from the conductive potting portion, with the conductive portion being disposed away from the solder contact portion. Conveniently the non-conductive portion comprises a flexible epoxy compound; for example, the non-conductive portion may comprise Raychem (RTM) S1125 epoxy compound. Preferably the conductive potting portion is in contact with the casing and a shielding member of the cable; this allows electrical contact to be made without the need to solder the shielding to the casing. Preferably the conductive potting portion does not contact the cable contact portion of the terminal contacts; hence there is no risk of short circuits or the like between these parts of the assembly. Conveniently the conductive potting portion

is of conductive silver loaded epoxy compound; for example, Raychem (RTM) S1184 compound may be used.

Preferably the casing comprises a removable cover or plate for allowing access to the interior of the casing. This allows access to the terminal contacts for soldering or for potting of the cable. The removable plate may be aligned at 180° or at 90° to the remainder of the casing, such that the connector may be a straight connector or a right angled connector.

Preferably the securing means for securing the connector to a corresponding receiving socket comprises screws or the like.

Conveniently the terminal contacts are laterally spaced by around 4-8 mm, preferably by around 6 mm. It has been found that this allows a relatively small footprint to be provided, while still retaining sufficient impedance matching of the two terminal contacts for satisfactory high-speed data transmission.

Preferably the spacing of the terminal contacts is substantially identical to the spacing of the data transmission members of the cable; this allows the cable to be connected to the connector with no change in spacing and hence no significant change in impedance from the cable to the contacts.

Preferably the cable and connector are provided in combination with a receiving socket portion, for engaging

with the cable connector. The receiving socket portion conveniently comprises a pair of sockets for receiving terminal connector pins of the cable connector. In use, the receiving socket portion may be coupled to a printed circuit board (PCB), or the like component of an electronic system. Preferably the receiving socket portion comprises means for securing to the securing means of the cable connector; for example, a threaded recess for receiving a screw or the like.

Preferably the connector is provided in combination with a data transmission cable comprising two data transmission members, each member being surrounded by a dielectric, the members being enclosed in a jacket, wherein the dielectric is selected to provide a desired impedance between the members.

Preferably the cable is a twinax cable.

Preferably the impedance between the members is between 100 and 200 ohms; more preferably the impedance is approximately 150 ohms.

Preferably the dielectric is a polymeric material; more preferably a fluoropolymer; most preferably the dielectric is expanded polytetrafluoroethylene (ePTFE). ePTFE has been found to provide the desired level of impedance for high speed data transmission. Preferably the dielectric is wrapped around each member; conveniently the dielectric is in sheet or tape form and comprises a

plurality of windings around each member.

Preferably the members are metallic. Each member may comprise a plurality of strands.

Preferably the jacket is of a polymeric material. Preferably the jacket is extruded polymeric material. Conveniently the jacket comprises a fluoropolymer; preferably fluorinated ethylene propylene, alternatively ethylene tetrafluoroethylene copolymer may be used.

Preferably the cable further comprises a shielding member, for restricting the absorption / emission of electromagnetic radiation to or from the cable. The shielding member is conveniently disposed beneath the jacket. Preferably the shielding member comprises an aluminium-polyester film laminate material. Alternatively, or in addition, the shielding material may comprise a metal serve or braid disposed beneath the jacket. In certain embodiments of the invention, shielding members in the form of an aluminium-polyester film laminate material and a metal serve or braid may both be present, as each shield material offers different shielding ranges. Where both shielding members are present, the serve or braid is preferably disposed over the aluminium-polyester film laminate.

These and other aspects of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figures 1 to 3 show plan, side, and end views of a cable connector in accordance with a first embodiment of the present invention;

Figures 4 and 5 show plan and side views of a cable connector in accordance with a second embodiment of the present invention;

Figures 6 and 7 show plan and end views of a receiving socket for use with the cable connectors of Figures 1 to 5; and

Figure 8 shows a cross-sectional view of a data transmission cable suitable for use with the connector of the present invention.

Referring first of all to Figures 1 to 3, these show plan, side, and end views of a cable connector in accordance with a first embodiment of the present invention. The cable connector 10 comprises a casing 12 made of aluminium alloy / nickel plate within which are mounted a pair of terminal connector pins 14. The terminal pins 14 are held by a dielectric 15, such as a liquid crystal polymer material, and spaced 6 mm apart; it has been found that this provides an appropriate level of impedance for use in high data transmission applications. The dielectric 15 also serves to partition the casing 12 into front and rear portions. Each of the terminal pins 14 is a TwistPin connector as produced by Glenair Inc (RTM), of Glendale, California, and includes a socket contact

portion 16 in the form of a twisted bundle of wires, and a hollow solder contact portion 18. The casing 12 further includes a removable cover 13, which allows access to the solder contact portions 18 of the terminal pins 14.

The front portion of the casing 12 adjacent the socket contact portions 16 of the terminal pins 14 includes a pair of outwardly extending flanges 20 having within them a pair of openings 22, for use in securing the connector 10 to a socket by means of screws.

Figure 1 also shows the end of a data transmission cable 50 mounted within the connector 10. The cable 50 is a twinax cable, having two adjacent conducting elements, and is of the type sold by W.L. Gore, Inc (RTM) as Fiberchannel cable. The cable 50 is illustrated in more detail in Figure 8.

The cable 50 comprises an outer jacket 52 of fluorinated ethylene propylene, or ethylene-tetrafluoroethylene copolymer, which surrounds a metallic serve 54. Within the serve 54 is an aluminium polyester film laminate shield 56, which restricts electromagnetic emissions from the cable 50 and surrounds a pair of silver plated copper conductor bundles 60, each of which is insulated by a wrapping 58 of ePTFE tape. For high data transmission rates, the size of the copper conductors 60 and the thickness of the ePTFE wrapping 58 are selected to provide an impedance between the bundles of 150 ohms.

To mount the cable 50 to the connector 10, the fluorinated ethylene propylene jacket 52 is stripped from the cable 50 to expose the serve 54 and shield 56, and to expose the insulated copper conductors 60. Each of the insulated copper conductors 60 is further stripped to remove the insulation therefrom. The exposed portion of the copper conductors 60 is then soldered to the solder contact portion 18 of a respective pin 14. The cable 50 is then potted within the casing 12 to secure the cable in position. The casing 12 of the connector 10 is divided into two separate volumes 12a, 12b, by the dielectric 15 to prevent potting material from entering one volume from the other, with the connector pins 14 extending through both volumes. The cable 50 and solder portions of the pins 14 are in the rearmost volume 12b. A first volume of insulating flexible epoxy compound (Raychem (RTM) S1125) 24 is used to pot the cable 50 in position and surround the pins 14 and the exposed portions of the copper conductors 60; this is followed by a second potting using a volume of conductive silver loaded epoxy compound (Raychem (RTM) S1184) 26 to secure the serve 54 and the shield 56 of the cable 50 to the walls of the casing 12, and to earth the shield. The removable panel of the casing is then secured in position to close the cable connector 10. If desired, a polymeric jacket may be heat shrunk onto the junction between the cable 50 and the connector 10 to further seal,

secure, and give added strain relief to the assembly.

A modified form of cable connector 110 is illustrated in Figures 4 and 5. This is generally similar to the connector 10 illustrated in Figures 1 to 3, with the exception that the removable cover 113 of the connector 110 is angled at 90 degrees to the body of the connector. This allows the cable 50 to enter the connector 110 at a 90 degree angle, so allowing the connector 110 to be used in more restricted spaces than the connector 10 of Figures 1 to 3. Connection of the cable 50 to the pins 14 and potting of the cable 50 within the casing is carried out in the same manner as described above. The cable 50 may be passed through the cover 113 before soldering and potting with the insulating potting; thereafter the cover 113 may be placed on the connector 110 and the conductive silver loaded potting compound added. Assembly of the connector 110 in this manner allows access to the cable connector pins through an opening on the connector without having to access through the cover 113.

Figures 6 and 7 illustrate a receiving socket 70 for use with the connectors 10, 110 of Figures 1 to 5. The socket 70 comprises a body portion 72 including a pair of sockets 74 for receiving the connector pins 14 of the cable connectors 10, 110. The sockets 74 are separated by a dielectric 75 of liquid crystal polymer. The sockets 74 connect to contact pins 76, which in use are connected to

terminals of a printed circuit board or the like, to receive data transmitted by the data transmission cable 50. The body portion 72 of the socket 70 includes a pair of flanges 78, each of which includes a threaded aperture 80 for securing to the corresponding apertures 22 of the cable connector 10, 110 via a screw or the like.

The present invention thus provides a secure and robust cable connector assembly which allows data transmission cables to be connected to relevant systems with a limited size of footprint. The construction of the data transmission cable herein described also allows a high impedance cable to be produced of restricted size, thereby allowing high rates of data transmission with smaller cables and connectors than previously possible.

**CLAIMS**

1. A cable connector comprising a casing housing two terminal contacts, each terminal contact including a cable contact portion for coupling to a respective data transmission member of a twinax data transmission cable, and a socket contact portion, the casing further comprising securing means for securing the connector to a corresponding receiving socket, and wherein the terminal contacts are held at a predetermined separation within a dielectric material to provide a predetermined impedance.

2. The cable connector of claim 1, wherein the cable contact portions are adapted for soldering to a respective data transmission member.

3. The cable connector of claim 1 or claim 2, wherein the dielectric material is a polymeric material.

4. The cable connector of claim 3, wherein the dielectric material is a liquid crystal polymeric material.

5. The cable connector of any preceding claim, wherein the impedance between the terminal contacts is between 100 and 200 ohms.

6. The cable connector of claim 5, wherein the impedance is around 150 ohms.

7. The cable connector of any preceding claim, wherein the terminal contacts are disposed substantially within the casing.

8. The cable connector of any preceding claim, wherein the terminal contacts are in the form of pins.

9. The cable connector of claim 8, wherein the terminal contacts are in the form of twisted wire pins.

10. The cable connector of any preceding claim, wherein the casing is divided into two compartments, with the socket contact portions and the cable contact portions of the terminal contacts being disposed in respective compartments.

11. The cable connector of claim 10, wherein the casing is divided by means of the dielectric material which serves to hold the terminal contacts in position, and through which the terminal contacts pass.

12. The cable connector of any preceding claim, further comprising a twinax data transmission cable potted

within the casing.

13. The cable connector of claim 12, wherein the potting comprises a conductive potting portion and a non-conductive potting portion.

14. The cable connector of claim 13, wherein the conductive potting portion comprises a silver loaded epoxy compound.

15. The cable connector of claim 13 or 14, wherein the non-conductive potting portion comprises a flexible epoxy compound.

16. The cable connector of claims 13, 14, or 15, wherein the non-conductive portion is disposed adjacent the cable contact portion of the terminal contacts, with the conductive portion being disposed away from the solder contact portion.

17. The cable connector of claim 15 or 16, wherein the conductive potting portion is in contact with the casing and a shielding member of the cable.

18. The cable connector of any preceding claim, wherein the casing comprises a removable cover or plate for

allowing access to the interior of the casing.

19. The cable connector of any preceding claim, wherein the securing means comprises screws or the like.

20. The cable connector of any preceding claim, wherein the terminal contacts are laterally spaced by around 4-8 mm.

21. The cable connector of claim 20, wherein the terminal contacts are laterally spaced by around 6 mm.

22. The cable connector of any preceding claim, provided in combination with a receiving socket portion, for engaging with the cable connector.

23. The cable connector of any preceding claim, provided in combination with a data transmission cable comprising two data transmission members, each member being surrounded by a dielectric, the members being enclosed in a jacket, wherein the dielectric is selected to provide a desired impedance between the members.

24. The cable connector of claim 23, wherein the cable is a twinax cable.

25. The cable connector of claim 23 or 24, wherein the cable further comprises a shielding member, for restricting the absorption / emission of electromagnetic radiation to or from the cable.

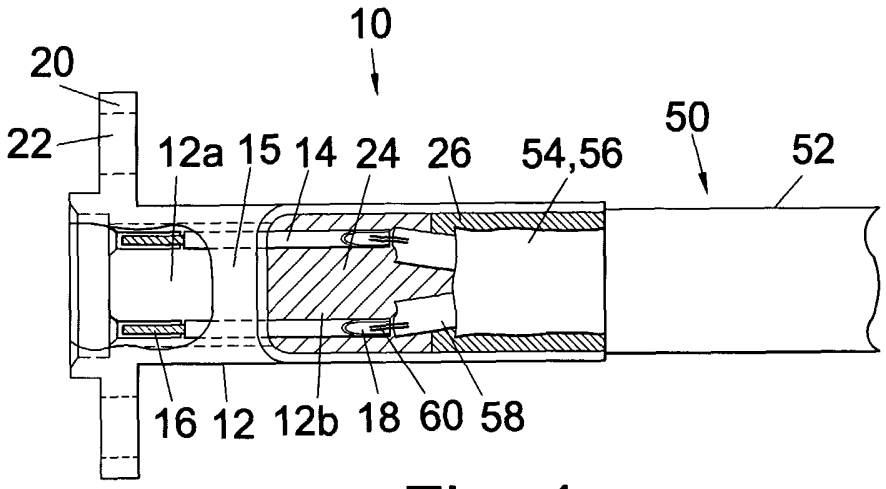



Fig. 1

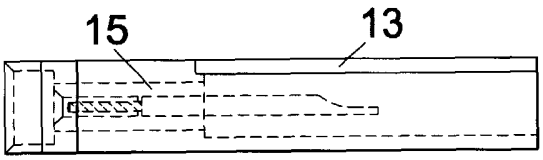



Fig. 2

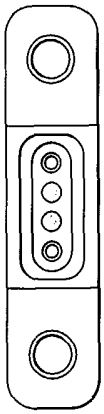


Fig. 3

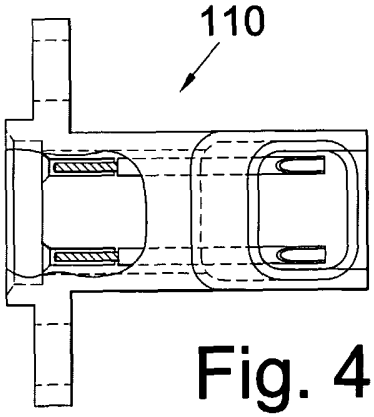
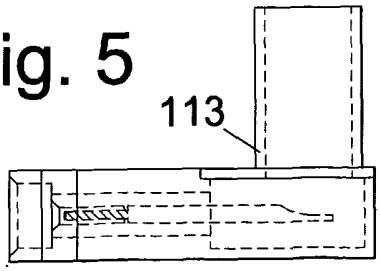



Fig. 4

Fig. 5



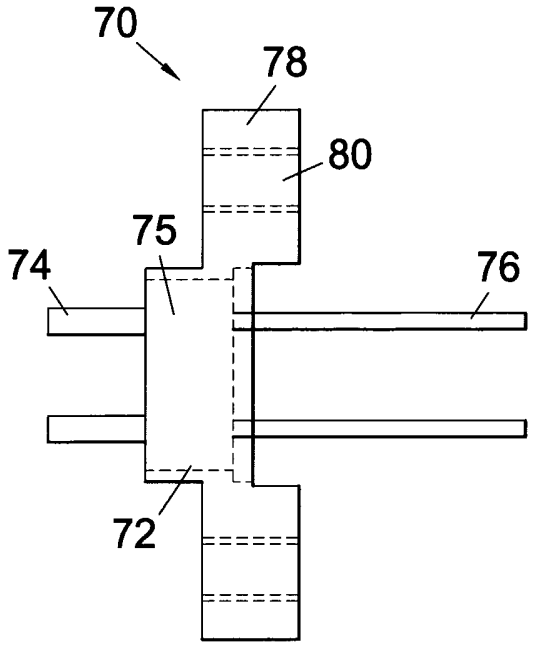



Fig. 6

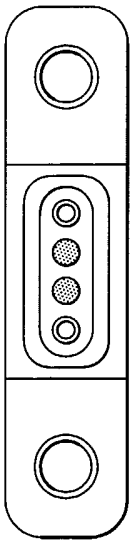


Fig. 7

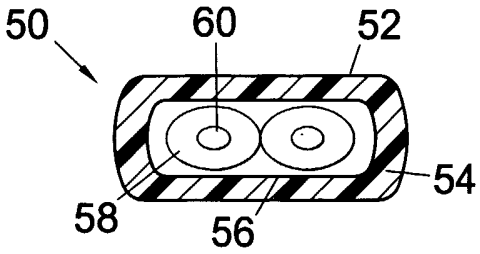



Fig. 8

# INTERNATIONAL SEARCH REPORT

Internat plication No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01R13/405 H01R13/658

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 6 273 753 B1 (KO DAVID TSO-CHIN) 14 August 2001 (2001-08-14) | 1,7,8, 10,11, 22-25 |
| Y | column 2, line 35 -column 4, line 4 | 2-4, 12-17 |
| Y | US 5 768 771 A (DAWIEDCZYK DANIEL L ET AL) 23 June 1998 (1998-06-23) column 6, line 6 - line 17 | 2 |
| Y | DE 198 28 982 A (WHITAKER CORP) 7 January 1999 (1999-01-07) column 1, line 62 - line 67 | 3,4 |
| Y | US 3 322 885 A (MAY JAMES J ET AL) 30 May 1967 (1967-05-30) column 1, line 42 -column 2, line 29 | 2-4, 12-17 |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 4 February 2003 | 11/02/2003 |

| Name and mailing address of the ISA | Authorized officer |
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Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

Internati ...plication No
PCT/GB 02/05874

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 6273753 B1 | 14-08-2001 | CN 2462570 U | 28-11-2001 |
| | | TW 467406 Y | 01-12-2001 |
| US 5768771 A | 23-06-1998 | CN 1168553 A ,B | 24-12-1997 |
| | | JP 3015945 B2 | 06-03-2000 |
| | | JP 10189149 A | 21-07-1998 |
| | | KR 256928 B1 | 15-05-2000 |
| DE 19828982 A | 07-01-1999 | DE 19828982 A1 | 07-01-1999 |
| US 3322885 A | 30-05-1967 | NONE | |