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54 **MICROWAVE CONNECTOR.**

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73 Proprietor : **W.L. GORE & ASSOCIATES**
551 Paper Mill Road P.O. Box 9206
Newark, DE 19714 (US)

72 Inventor : **MARTIN, James, Duncan, Shaw**
38 Charleston Drive Dundee
Tayside DD2 2EZ (GB)
Inventor : **ROUNDING, Grant, Thompson**
15 Boniface Road Intergowrie
Tayside DD2 5DW (GB)

74 Representative : **McCallum, William Potter**
Cruikshank & Fairweather 19 Royal Exchange
Square
Glasgow G1 3AE Scotland (GB)

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Description

Background of the Invention

1. Field of the Invention

The present invention relates to a microwave connector for use in providing a microwave connection between two environments separated by a barrier, the connector also functioning as a seal should the connecting systems be breached. The invention will be described with particular reference to an embodiment thereof in which the microwave connector is of a subminiature 'A' type (SMA type) configuration, it being understood that this is in no way intended to limit the scope of the invention.

2. Description of Related Art

The invention originates from a requirement for a microwave connector to operate within a submarine mast environment. Modern submarine mast design dictates the placement of electronic equipment in an electronics pod at the mast head connected by microwave transmission lines to processing equipment in the hull. This arrangement creates the requirement for a connector capable of providing a microwave connection through a pressure boundary without compromising the nature of that boundary, the boundaries concerned being the submarine hull and the mast junction of the electronics pod. Hence, in normal use the connector is required to function in the conventional manner while preventing the penetration of water, pressurized, or otherwise, through the boundaries should the mast head or connecting cable systems be breached.

In the past, microwave connections through boundaries have been facilitated by the use of small lengths of semi-rigid coaxial cable that protrude either side of the interface. In this construction, female SMA "bullets" are soldered to the center conductor, one at each end of the semi-rigid coaxial cable before the cable is housed in a metal sheath. This solder joint forms part of the pressure sealing and is a weak link giving rise to reliability problems during installation and normal service. This problem is further compounded by the need to have two such solder joints within each construction.

French reference FR-A-2 591 040 discloses a through-bulkhead coaxial connector using conventional glass bead sealing techniques. Its main body is a two part construction, one part being the tiered structure ring whose material is selected for its compatibility with glass sealing techniques. Casing is selected as a conventional connector material, typically brass or stainless steel.

The present invention does not rely on this kind of joint to provide the pressure sealing characteristics

of the connector. Moreover, connectors embodying the invention provide enhanced Voltage Standing Wave Ratio (VSWR) performance up to 40 GHz while the design of the connector as a disaster seal enables it to withstand a pressure differential of up to 1000 PSI ($6.89 \times 10^6 \text{ Nm}^{-2}$). A further advantage of such connectors is that it is possible to pre-test the sealing characteristics of each connector before attaching microwave transmission lines or before installation in a particular barrier so that differing bulkhead requirements may be accommodated.

Although the present invention originated from a consideration of the problems of microwave transmission in submarine mast environments, connectors embodying the invention are equally suited to other applications wherein a microwave connection is required between two environments, possibly of differing chemical composition or under different physical conditions, and separated by a barrier or bulkhead.

Summary of the Invention

According to the present invention, there is provided a microwave connector for use in providing a microwave connection between two environments separated by a barrier, the connector also capable of functioning as a seal should the connecting cable systems be breached, the connector comprising a connector body having a central opening extending throughout its length, a central contact located within said central opening and connecting means also located therein to provide a suitable connection for the transmission of microwaves between a transmission line on one side of said barrier and said central contact, and having an insulating sleeve within which said central contact is located and which ensures an interference fit within said central opening between said central contact, said insulating sleeve and said connector body, wherein said connecting means comprises a contact bucket attached to said central contact by means of screw threads and connected to said transmission line by means of solder.

Brief Description of the Drawings

Fig. 1 is a top plan view of the microwave connector according to the invention.

Fig. 2 is a cross-sectional view of the connector of the invention taken along line 2-2 of Fig. 1.

Detailed Description of the Invention and Preferred Embodiments with Reference to the Drawings

The microwave connector, for use in providing a microwave connection between two environments separated by a barrier and also capable of functioning as a seal should the connecting cable systems be breached, is provided with an insulating sleeve locat-

ed within a central opening extending throughout the length of the body of the connector. A central contact is pressed into the insulating sleeve causing the sleeve to expand radially creating a dimensional interference between the central contact, the insulating sleeve and the connector body.

A microwave connector embodying the invention will now be particularly described, by way of example, with reference to the accompanying drawings.

The microwave connector is shown in Figs. 1 and 2 to comprise a connector body 10, situated within an opening 12 in a barrier 14, and held in place by a retaining nut 16, the barrier 14 serving to separate the two environments 18 and 20. The connector body 10 terminates in a standard SMA connector 22 and has a central opening therein which extends throughout the length of the connector body, the diameter of the central opening being such that it slidably receives insulating sleeve 24. Insulating sleeve 24 abuts rear insulator 26 also located within the central opening but in a region of increased internal diameter. The insulating sleeve 24 and the rear insulator 26 are both preferably of polytetrafluoroethylene (PTFE) or a material with similar mechanical and dielectric properties. The mechanical properties of PTFE, together with its low dielectric loss, combine to provide the connector with enhanced pressure sealing properties while maintaining a mode-free operation characteristic at microwave frequencies of up to 40 GHz.

Central contact 28 is rod-shaped and has a diameter that is standard within SMA connector technology and a tip portion 30, of reduced diameter, which forms the central contact within SMA connector 22. The internal diameter of insulating sleeve 24 is tolerated such that an interference fit exists between the central contact and the sleeve. The central contact 28 is pressed, via a support guide, into the central opening of insulating sleeve 24 until the tip portion 30 protrudes from the sleeve forming part of SMA connector 22. This operation radially expands the insulating sleeve causing a dimensional interference between the sleeve and the connector body 10 thus providing the pressure sealing characteristics of the connector. A twofold advantage of the connector described is that these sealing characteristics are not reliant on solder joints or adhesive and may be fully tested before attachment to any existing microwave transmission lines or before installation into a particular barrier so that any bulkhead requirement may be accommodated.

The microwave transmission line to be connected through the boundary is shown in the figures as coaxial cable 32, the central conductor 34 of which is soldered to contact bucket 26. Contact bucket 36 is received within insulator 26 and is attached to central contact 28 by means of screw threads. Both contact bucket 36 and central contact 28 are preferably of the same material, such as gold-plated brass or more pre-

ferably, a hold-plated beryllium-copper alloy. Coaxial cable 32 is held by an SMA hat 38 and SMA retaining nut 40. This retaining means obviates the need to over-tighten the contact bucket 36 on to central contact 28 causing the central conductor 34 of the coaxial cable to twist, the retaining means also immobilizing coaxial cable 32 thus enhancing the reliability of the solder joint between the central conductor 34 and the contact bucket 36.

A further microwave transmission line (not shown) may be attached to SMA connector 22, if provided with suitable connecting means for mating therewith, thus completing the microwave connection between environments 18 and 20 without loss of transmission characteristics and without compromising the nature of the boundary.

The connector will now be further described by reference to particular dimensions, it being understood that any dimensions so given are exemplary and are not intended to limit the scope of the invention in any way.

The central opening within the connector body 10, between SMA connector 22 and rear insulator 26, is preferably of constant diameter and further preferably has a diameter of about 4.06mm (0.160 inch). Central contact 28 has an overall length of approximately 59.74mm (2.352 inches) of which about 2.16mm (0.085 inch) is taken up by the tip portion 30, and about 4.75mm (0.187 inch) by the threaded portion at the opposing end. The decreased diameter of the tip portion is approximately 0.91mm (0.036 inch), while the diameter of the remainder of the central contact is approximately 1.27mm (0.050 inch). The above dimensions dictate much of the size and shape of insulating sleeve 24. In order to achieve a slide fit within the central opening of the connector body, the outer diameter of the sleeve is also approximately 4.06mm (0.160 inch). The internal diameter of sleeve 24 is made approximately 1.17mm (0.046 inch) so that about 0.10mm (0.004 inch) interference exists within said internal diameter. It has been shown that an interference fit of the kind above gives rise to a connector capable of withstanding a pressure differential of up to $6.89 \times 10^6 \text{ Nm}^{-2}$ (1000 PSI) at ambient temperature. It is expected that this pressure differential can be maintained over a temperature range from -40°C to $+70^\circ\text{C}$.

Contact bucket 36 has an overall length of about 11.33mm (0.446 inch). The section of smaller external diameter has a length of about 5.49mm (0.216 inch) and an external diameter of approximately 2.18mm (0.086 inch), this section receiving the threaded portion of central contact 28 and being received by rear insulator 26. The rear insulator has a length of approximately 6.27mm (0.247 inch) and an external diameter of about 6.96mm (0.274 inch) and is located abutting the insulating sleeve within a region of the connector body in which the central opening there-

through has a diameter of approximately 6.99mm (0.275 inch). Central contact 28 passes through a central opening within rear insulator 26 of approximate diameter 1.30mm (0.051 inch) before being received in a threaded opening, about 5.08mm (0.200 inch) in length, within the contact bucket, the contact bucket also being received in a central opening within the rear insulator but of approximate diameter 2.21mm (0.087 inch). The contact bucket and central contact are attached by means of the screw threads which are preferably 12 B.A. type.

The section of contact bucket 36 of larger external diameter is about 5.84mm (0.230 inch) in length and has an external diameter of approximately 3.05mm (0.120 inch). Within this section is a central opening of approximate diameter 2.18mm (0.086 inch) within which coaxial cable 32 is attached to the contact bucket by means of a solder joint.

Although the present invention has been described with reference to a particular embodiment, it will be clear to those skilled in the art that the invention is in no way limited to coaxial connectors of SMA type configuration but is equally applicable to other types of microwave connectors.

While the invention has been disclosed herein in connection with certain embodiments and detailed descriptions, it will be clear to one skilled in the art that modifications or variations of such details can be made without deviating from this gist of this invention, and such modifications or variations are considered to be within the scope of the claims hereinbelow.

Claims

1. A microwave connector for use in providing a microwave connection between two environments (18,20) separated by a barrier (14), the connector also capable of functioning as a seal should the connecting cable systems be breached, the connector comprising a connector body (10) having a central opening extending throughout its length, a central contact (28) located within said central opening and connecting means to provide a suitable connection for the transmission of microwaves between a transmission line (32) on one side of said barrier (14) and said central contact (28), and having an insulating sleeve (24) within which said central contact (28) is located and which ensures an interference fit within said central opening between said central contact (28), said insulating sleeve (24) and said connector body (10), characterized in that said connecting means is also located within said central opening and said connecting means comprises a contact bucket (36) attached to said central contact (28) by means of screw threads and connected to said transmission line (32) by means of sold-

er.

2. A microwave connector according to claim 1 wherein said central contact (28) and said contact bucket (36) are gold-plated brass.
3. A microwave connector according to claim 1 wherein said central contact (28) and said contact bucket (36) are of a gold-plated beryllium-copper alloy.
4. A microwave connector according to claim 1 wherein said insulating sleeve (24) is of polytetrafluoroethylene (PTFE) or a material with similar mechanical and dielectric properties.
5. A microwave connector according to claim 1 wherein said connector body (10) and said central contact (28) terminate in a standard SMA type connector (22).
6. A microwave connector according to claim 1 wherein said interference fit within said central opening between said central contact (28), said insulating sleeve (24) and said connector body (10).
7. A microwave connector according to claim 1 wherein said central opening within said central connector body (10) has a diameter of approximately 4.06 mm (0.160 inch) substantially throughout the length of the portion containing the insulating sleeve (24); and wherein said central contact (28) has a diameter of about 1.27 mm (0.050 inch) substantially throughout its length.
8. A microwave connector according to claim 1 wherein said transmission line (32) on one side of said barrier (14) is held by SMA retaining means.
9. A microwave connector according to claim 1 wherein said transmission line on one side of said barrier (14) is a coaxial cable (32).

Patentansprüche

1. Mikrowellenverbinder zur Verwendung bei der Schaffung einer Mikrowellenverbindung zwischen zwei von einer Barriere (14) getrennten Umgebungen (18, 20), wobei der Verbinder auch in der Lage ist, als Dichtung für den Fall zu fungieren, daß die Verbindungskabelsysteme brechen, wobei der Verbinder einen Verbinderkörper (10) mit einer sich durch ihn in Längsrichtung erstreckenden Mittelöffnung, einen innerhalb der Mittelöffnung angeordneten Mittelkontakt (28)

- und eine Verbindungseinrichtung zur Schaffung einer geeigneten Verbindung zur Übertragung von Mikrowellen zwischen einer Übertragungsleitung (32) auf einer Seite der Barriere (14) und dem Mittelkontakt (28) aufweist und eine Isolierhülse (24) besitzt, innerhalb der der Mittelkontakt (28) angeordnet ist, und die einen Festsitz innerhalb der Mittelöffnung zwischen dem Mittelkontakt (28), der Isolierhülse (24) und dem Verbinderkörper (10) gewährleistet, **dadurch gekennzeichnet**, daß die Verbindungseinrichtung sich ebenfalls in der Mittelöffnung befindet und die Verbindungseinrichtung einen Kontaktbecher (36) aufweist, der an dem Mittelkontakt (28) mittels Schraubverbindungen befestigt ist und an der Übertragungsleitung (32) mittels Lot angeschlossen ist.
2. Mikrowellenverbinder nach Anspruch 1, bei dem der Mittelkontakt (28) und der Kontaktbecher (36) aus vergoldetem Messing bestehen.
3. Mikrowellenverbinder nach Anspruch 1, bei dem der Mittelkontakt (28) und der Kontaktbecher (36) aus einer vergoldeten Beryllium-Kupfer-Legierung bestehen.
4. Mikrowellenverbinder nach Anspruch 1, bei dem die Isolierhülse (24) aus Polytetrafluorethylen (PTFE) oder einem Material, welches ähnliche mechanische und dielektrische Eigenschaften besitzt, besteht.
5. Mikrowellenverbinder nach Anspruch 1, bei dem der Verbinderkörper (10) und der Mittelkontakt (28) in einen Norm-SMA-Verbinder (22) münden.
6. Mikrowellenverbinder nach Anspruch 1, bei dem der Festsitz innerhalb der Mittelöffnung ein etwa 0,010 mm (0,004 Zoll) betragender Festsitz im Inneren der Mittelöffnung zwischen dem Mittelkontakt (28), der Isolierhülse (24) und dem Verbinderkörper (10) ist.
7. Mikrowellenverbinder nach Anspruch 1, bei dem die Mittelöffnung innerhalb des mittleren Verbinderkörpers (10) einen Durchmesser von annähernd 4,06 mm (0,160 Zoll) auf im wesentlichen der Länge des Abschnitts aufweist, der die Isolierhülse (24) enthält, wobei der Mittelkontakt (28) einen Durchmesser von etwa 1,27 mm (0,050 Zoll) über etwa seine Länge hinweg aufweist.
8. Mikrowellenverbinder nach Anspruch 1, bei dem die Übertragungsleitung (32) auf einer Seite der Barriere (14) von einer SMA-Halteeinrichtung gehalten wird.

9. Mikrowellenverbinder nach Anspruch 1, bei dem die Übertragungsleitung auf einer Seite der Barriere (14) ein Koaxialkabel (32) ist.

Revendications

1. Connecteur micro-ondes à utiliser pour fournir une connexion micro-ondes entre deux milieux (18, 20) séparés par une barrière (14), le connecteur étant aussi capable de fonctionner comme un joint étanche au cas où les systèmes de liaison par câbles seraient rompus, le connecteur comprenant un corps de connecteur (10) ayant une ouverture centrale s'étendant sur toute sa longueur, un contact central (28) situé dans ladite ouverture centrale et un moyen de connexion pour fournir une connexion appropriée pour la transmission entre une ligne de transmission micro-ondes (32) sur un côté de ladite barrière (14) et ledit contact central (28) et ayant un manchon isolant (24) dans lequel ledit contact central (28) est situé et qui garantit un ajustage serré dans ladite ouverture centrale entre ledit contact central (28), ledit manchon isolant (24) et ledit corps de connecteur (10) caractérisé en ce que ledit moyen de connexion est aussi situé dans ladite ouverture centrale et ledit moyen de connexion est aussi situé dans ladite ouverture centrale et ledit moyen de connexion comprend une broche de contact (36) fixée audit contact central (28) au moyen de filets de vis et elle est connectée à ladite ligne de transmission (32) au moyen d'une soudure.
2. Connecteur micro-ondes selon la revendication 1 dans lequel ledit contact central (28) et ladite broche de contact (36) sont en laiton plaqué or.
3. Connecteur micro-ondes selon la revendication 1 dans lequel ledit contact central (28) et ladite broche (36) sont un alliage de béryllium-cuivre plaqué or.
4. Connecteur micro-ondes selon la revendication 1 dans lequel ledit manchon isolant (24) est du polytétrafluoroéthylène (PTFE) ou une matière ayant des propriétés mécaniques et diélectriques similaires.
5. Connecteur micro-ondes selon la revendication 1 dans lequel ledit corps de connecteur (10) et ledit contact central (28) se terminent par un connecteur standard du type SMA (22).
6. Connecteur micro-ondes selon la revendication 1 dans lequel ledit ajustage serré dans ladite ouverture centrale a approximativement un ajusta-

ge serré de 0,010 mm (0,004 pouce) dans ladite ouverture centrale entre ledit contact central (28), ledit manchon isolant (28) et ledit corps de connecteur (10).

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7. Connecteur micro-ondes selon la revendication 1 dans lequel ladite ouverture centrale dans ledit corps de connecteur central (10) a approximativement un diamètre de 4,06 mm (0,160 pouce) essentiellement sur toute la longueur de la partie contenant le manchon isolant (24), et dans lequel ledit contact central (28) a un diamètre d'environ 1,27 mm (0,050 pouce) essentiellement sur toute sa longueur.

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8. Connecteur micro-ondes selon la revendication 1 dans lequel ladite ligne de transmission (32) sur un côté de ladite barrière (14) est maintenue par un moyen de fixation SMA.

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9. Connecteur micro-ondes selon la revendication 1 dans lequel ladite ligne de transmission sur un côté de ladite barrière (14) est un câble coaxial (32).

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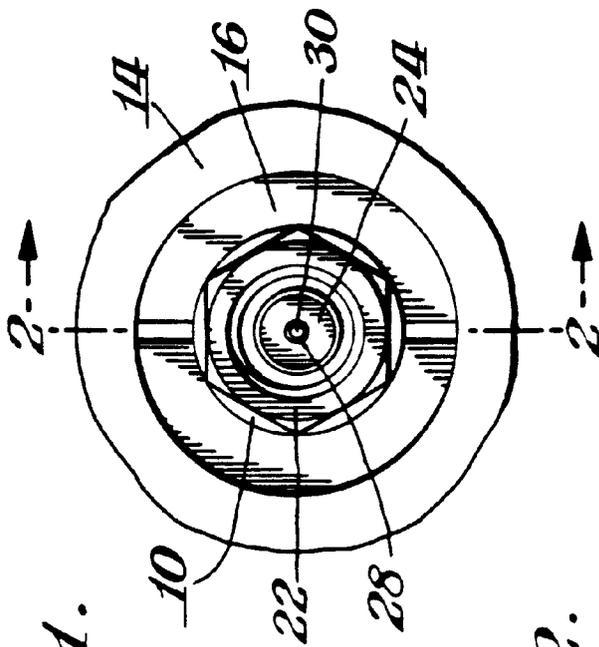


Fig. 1.

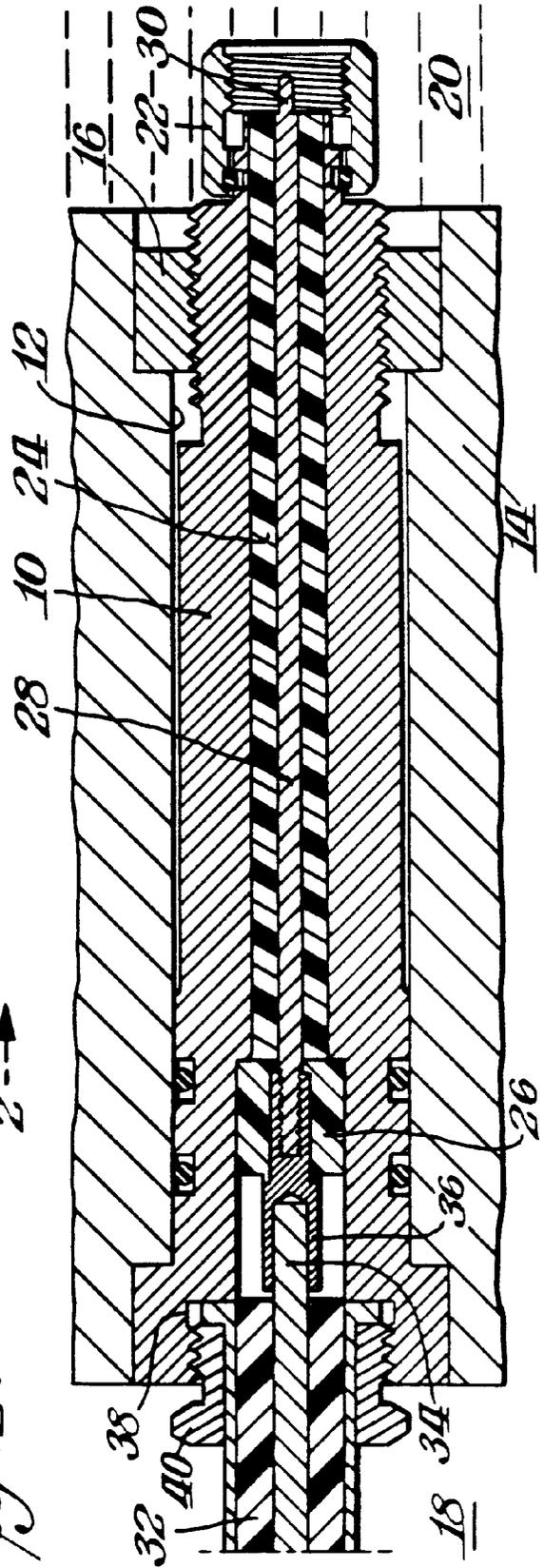


Fig. 2.