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[54] **TIGHT ANGLE MULTI-CONTACT ELECTRICAL CONNECTOR**

[75] Inventors: **Edward J. Pierce**, Melrose, Mass.; **Daniel R. Doucet**, Newton, Mass.

[73] Assignee: **General Connector**, Newton, Mass.

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[52] **U.S. Cl.**.....**339/90 R**, 174/86, 285/363, 339/94 M, 339/218 M

[51] **Int. Cl.** **H01r 13/54**

[58] **Field of Search**.....339/89, 90, 92, 94, 218; 285/184, 363, 368; 174/86

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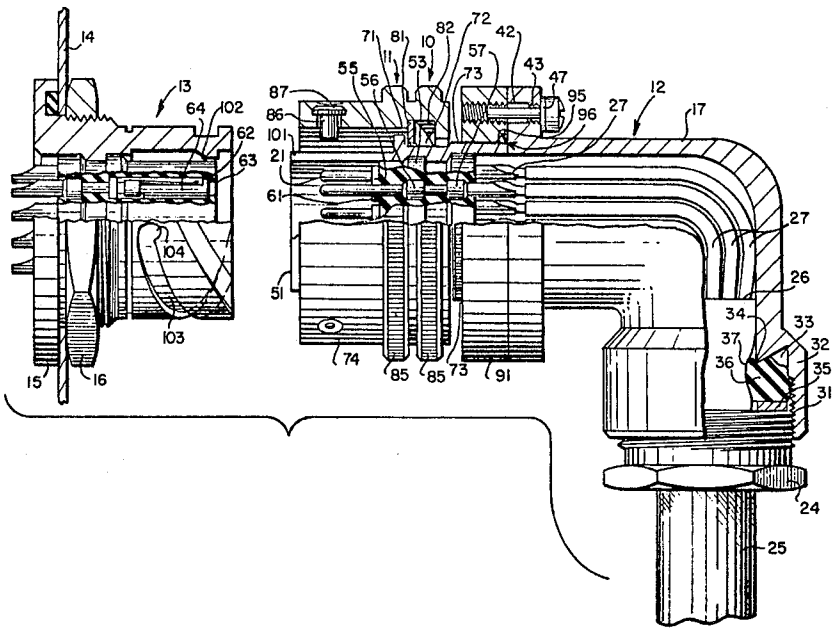
Primary Examiner—Joseph H. McGlynn

Attorney—Weingarten, Maxham & Schurgin

[57] **ABSTRACT**

A multi-contact right angle connector is adapted to permit cable entry at any one of a large plurality of discrete angular orientations with highly reliable hermetic seals to maintain a stable dry environment in the critical internal region.

4 Claims, 3 Drawing Figures



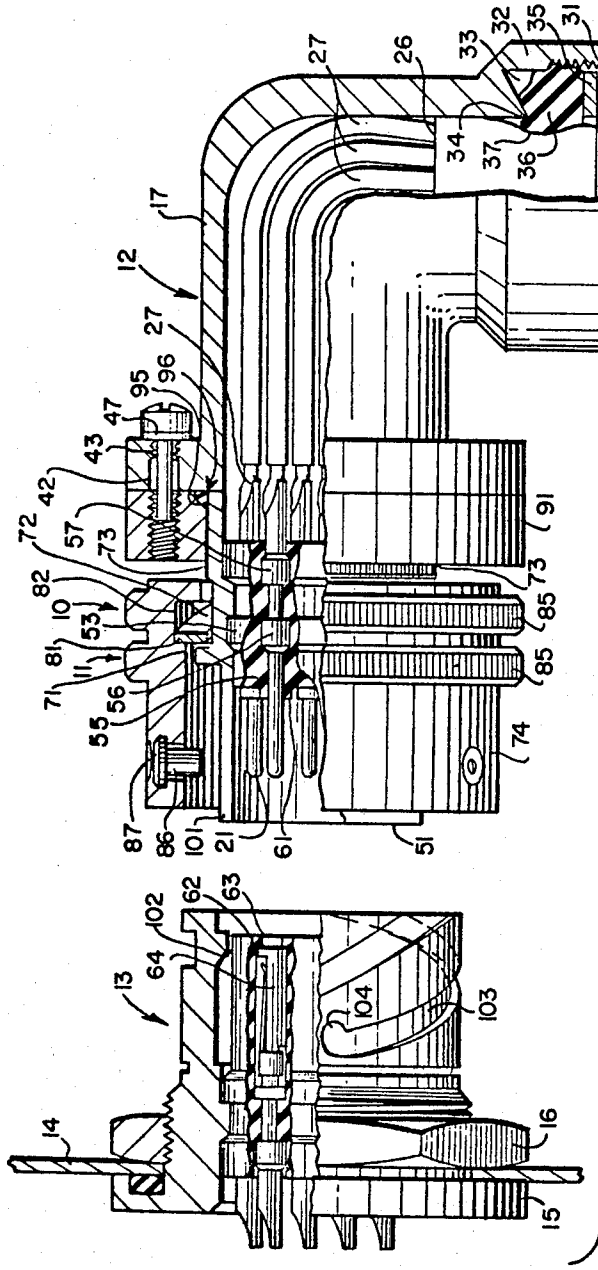


FIG. 1

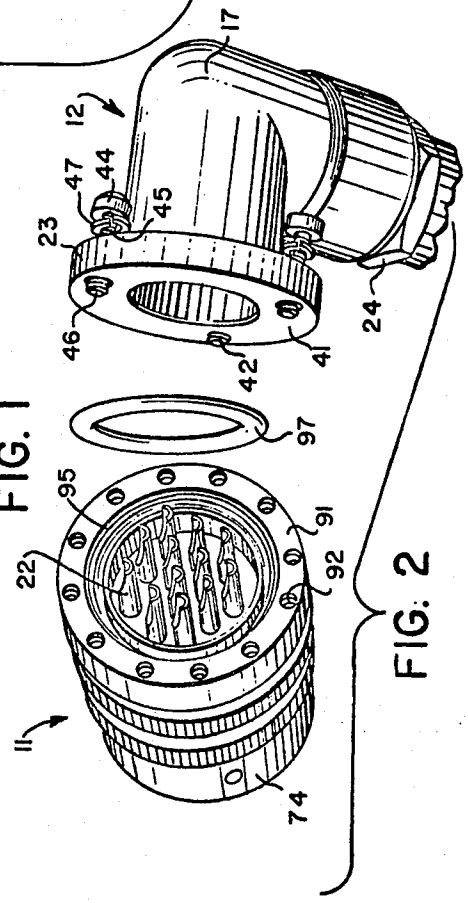


FIG. 2

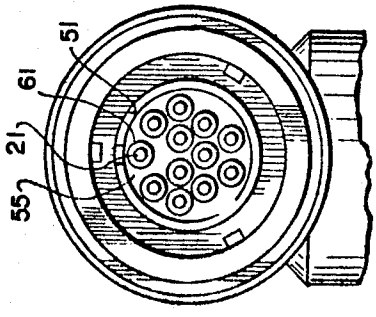


FIG. 3

TIGHT ANGLE MULTI-CONTACT ELECTRICAL CONNECTOR

FIELD OF THE INVENTION

The present invention relates in general to the field of multi-contact electrical connectors of exceedingly high reliability and more particularly concerns an electrical connector of this general classification which is specially adapted to accept a multi-conductor jacketed electrical cable at right angles to the axis defined by pin motion when engaging a mating element. The term "right angle connector" is used in this art to designate a connector which receives its cable substantially at right angles to the axis of pin motion during connect and disconnect operations, and is thus distinguished from straight connectors wherein the cable lies parallel to the pins. Right angle connectors are in themselves well known and have broad application wherever an installation requires an abrupt ninety degree change in cable direction.

BACKGROUND OF THE INVENTION

As noted above, right angle connectors have a well established place in the art and numerous types are presently available to meet most of the needs of product designers. Characteristically, a prior art right angle connector may utilize a tubular shell which extends straight from the region of the connector pins for some predetermined distance and then abruptly changes direction by ninety degrees. In high reliability applications extreme care must be taken in the design, manufacture and assembly of the connector components to achieve a stable waterproof environment within the connector itself to preclude corrosion and other causes of faulty electrical operation. Thus the region of the interior of the connector assembly between the contact pins or pin sockets and the point where the cable enters the connector must remain completely stable and provide dry environment totally resistant to outside moisture. For these reasons the contact pins and pin sockets must be hermetically sealed within the connector assembly and provision must be made to seal the entry of the cable jacket to preclude leakage of moisture.

In some arrangements the desired hermetic seal has been achieved by integrally molding the region between pins and cables in solid rubber, in others the hermetic seal has been achieved within an integral outer shell. In some applications it is desirable to permit changes in the angular orientation of the outwardly extending cable with respect to the disposition of the pins, that is, to provide for adjustment of the angle at which the cable emanates from the connector when the connector is plugged into its mate. In right angle connectors utilizing two sections which are attached to each other by mating threads, the exact orientation of the cable is uncertain and will depend on the extent to which the threads are tightened. Of course, a complete set of connectors having different fixed angles may be made available, but this is unsatisfactory if changes are to be effected in the field. To be serviceable and economical, the angular adjustment capability must be built into the connector itself, but the technique must allow ease of angular adjustment together with means permitting hermetic closure after readjustment without tedious or exacting procedures for disassembly and reassembly.

SUMMARY OF THE INVENTION

The present invention contemplates and has as a primary object the provision of a right angle multi-contact electrical connector wherein the outer tubular shell is formed of two sections, separation being in the region between the contacts and the cable entry. More specifically, one of the two sections of the novel connector is formed right angle bend which may be attached to the other with the associated cable disposed at any one of a large plurality of angles by means of confronting flanges having integral means for providing the required hermetic seal. The connector, when assembled, is exceedingly rugged and adaptable to the most severe environmental conditions; yet it may with ease be disassembled for change of the cable angle as needed. The novel arrangement features economy of assembly, enhanced flexibility when the assembled connector is employed in the field, and permits cable angle change by personnel with limited technical skill without damage to the hermetic seal.

DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent from the following specification when read in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation partly in section illustrating a multi-contact right angle connector made in accordance with the principles of this invention in association with a mating straight panel mounted connector;

FIG. 2 is an exploded perspective view of the right angle connector shown in FIG. 1 illustrating the manner in which the connector may be disassembled for cable angle change. The panel mounted connector shown in FIG. 1 has been omitted from FIG. 2; and

FIG. 3 is a pin-end view (on a slightly reduced scale) of the central portion of the right angle connector shown in FIG. 1, and illustrates the array of contact pins and the keying arrangement used to orient the connector when coupled to its mating half.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the drawings, and more particularly to FIGS. 1 and 2, the assembled right angle connector 10 is shown as basically comprised of two principal sections 11 and 12 which are rigidly secured to each other when in use to form a unitary structure. Also shown in FIG. 1 is a mating connector or receptacle 13 of conventional design mounted in an appropriate opening in panel 14 and retained in position between integral flange 15 and a tightened jam nut 16. While mating connector 13 does not constitute an element of the present invention, it has been illustrated to permit a better understanding of the function of certain components of novel right angle connector 10.

As illustrated, the section 11 includes an array of connector pins 21 which terminate at their innermost ends in solder lugs 22. Right hand section 12 of right angle connector 10 is essentially a hollow tubular element 17 which extends from an integral circular connecting flange 23 and turns downwardly at right angles and terminates in a cable nut 24.

As best illustrated in FIG. 1, a rubber or plastic jacketed cable 25 enters the right angle connector through the cable nut 24. The cable jacket is cut clean internally at 26 and the individual leads 27 extend outward, turn 90°, and are soldered at 27 to the array of solder terminals 22.

Turning to the specific details of the construction of the various components of the connector shown in FIGS. 1, 2 and 3, it will be observed that the cable nut 24 has an inside diameter just large enough to smoothly accommodate the passage of jacketed cable 25. Cable nut 24 engages the internal thread 31 of an integral enlarged diameter portion 32 of shell 17. Internally the shell 17 has been machined to provide a circular sharply defined undercut region 33 which terminates in the sharply defined circular edge 34. A ferrule or washer 35 having an internal opening slightly larger than the cable diameter bears against the inner surface of cable nut 24, which in turn bears upon an annular rubber grommet 36 which in unstressed condition normally will have a generally rectangular cross section. As the cable nut 24 is tightened within threads 31, the advancing ferrule 35 compresses and distorts grommet 36 in the manner shown in FIG. 1, and in so doing drives the grommet 36 into hermetically sealing engagement with the sharp circular edge 34 and simultaneously forces the grommet radially inward at the region 37 into hermetically sealing, compressive engagement with the cable jacket 37.

As shown in FIG. 1, the cable when fully assembled is hermetically sealed and correspondingly the outer lower end of right angle connector 10 is also hermetically sealed. More specifically, moisture seeping along the cable jacket through the cable nut will be barred from entering the internal region of shell 17 by the engagement of grommet 36 against the cable at 37 and also by the engagement between grommet 36 and ferrule 35. Moisture which may penetrate through the screw threads between the cable nut and shell 17 will be prevented from entering the internal region by virtue of the compressive force between grommet 36 and sharp circular edge 34.

As noted earlier, the left hand end of connection section 12 terminates in an integral circular flange 23 having a flat, smooth annular engaging surface 41. Flange 23 is provided with three openings 42 which are spaced precisely 120° apart. As best shown in FIG. 1, each of the three openings 42 includes a short smooth bore followed by an internally threaded portion 43. Bolts 44, each of which has a smooth shaft portion 45 followed by a threaded portion 46, are threaded through the respective openings 42. It may thus be seen that bolts 44 will normally be captured loosely in the respective openings as shown in FIG. 2, but that they may, however, be removed by drawing them backward and unscrewing them through the threaded portion 43. Lock washers 47 are provided on each of bolts 44 and are retained without chance of loss by virtue of the arrangement described immediately above.

Turning at this time to left hand section 11 of right angle connector 10, an inner hollow cylindrical machined shell 51 encloses the array of contact pins 21 at one end and the corresponding solder lugs 22 at the other end thereof. More specifically, the inner surface of shell 51 is formed with a cylindrical protrusion 52 and a cylindrical recess 53 to more rigidly secure solid rubber contact pin insulator 55, which during the customary integral bonding process forms an adherent hermetic seal with the interior of shell 51. Cylindrical protrusions 56 and 57 on each of the pins provide enhanced hermetic sealing between the pins and the rubber 55 and also more securely seat the respective pins and preclude axial movement thereof during normal connection and disconnection from the mating connector.

As illustrated best in FIGS. 1 and 3, the forward open face of the rubber insulator 55 has been molded to provide an integral small annular boss 61 around each of pins 21. These bosses are arranged to engage the forward face of rubber insulator 62 at respective areas 63 in the open end of mating connector 13 to achieve an interfacial seal which precludes the flow of moisture radially into the contact area between each pin 21 and its mating pin socket 64 in panel connector 13.

The outer surface of shell 51 of connector section 11 is provided with a machined flange 71 and a recessed annular region 72. Cylindrical surface 73 of lesser diameter than flange 71 is knurled (for reasons to be described below).

A coaxial outer cylindrical coupling 74 surrounds virtually the entire left hand half of inner shell 51 and is normally urged to the right as viewed in FIG. 1 by means of a circular wave-washer (split spring washer) 81 which is captured within the annular recess 82 of outer shell 74. A pair of knurled raised flanges 84 and 85 provide the means by which coupling 74 may be gripped manually, drawn axially to the right, and rotated as desired. When released, the coupling 74 springs back to the position shown.

Three small steel pins 86, spaced at equal angles about coupling shell 74, are retained firmly in position by the metal 87 peened over the respective pin heads. Each pin extends inwardly between coupling 74 and inner shell 51 and provides means for locking the right angle connector 10 to the panel connector 13, as will be described more fully below.

In assembly of connector section 11, coupling 74 is slipped over the inner shell 51 with the wave washer 81 in the position shown. Thereafter, a circular adapter flange 91 is press-fitted in the position shown upon the knurled surface 73 for rigid attachment to inner shell 51. After flange 91 is attached, outer shell 74 is "captured" on the connector since its motion to the right is limited by flange 91 and to the left by flange 71. Coupling 74, however, may be rotated angularly about its axis.

As best illustrated in FIG. 2, flange 91 is formed with a circular array of threaded openings 92 spaced precisely at 30° intervals. The three bolts 44 may thus be engaged in respective openings of flange 91 in any one of 12 discrete angular orientations, each spaced 30° from the preceding one. As is now apparent, the number of discrete positions available for attachment may be altered by changing the number of openings 92 appropriately.

The right hand surface of flange 91 is smooth and flat and thus fits tightly against the confronting surface of flange 23 as illustrated in FIG. 1. As shown in FIGS. 1 and 2, a small continuous circular bevel 95 is provided at the innermost edge of flange 91 which cooperates

with the right hand edge of shell **51** to provide a small annular recess **96** adapted to receive a resilient O-ring gasket **97**. As shown in FIG. **1**, when flanges **23** and **91** are drawn tightly together by bolts **44**, O-ring **97** is compressed to provide a hermetic seal to bar the flow of moisture which may seep between abutting flanges **23** and **91** from the interior of the right angle connector **10**.

When right angle connector **10** is inserted into panel connector **13**, slot **101** in inner shell **51** is aligned with key **102** to bring contact pins **21** into appropriate alignment with pin sockets **64**. Coupling **74** is positioned so that pins **86** are engaged in three equiangularly spaced curved slots **103**; thereafter coupling **74** is rotated to draw the mating halves of the connector together. Continued rotation of coupling shell **74** ultimately results in compression of wave washer **81** and finally the slight relief thereof as the pins **86** snap into slot detents **104**. As previously noted, when the connector halves are so engaged the two molded rubber elements **55** and **62** develop an interfacial seal which precludes moisture seepage into the pin and mating socket contact region.

Connector components **17**, **51** and **74** are preferably formed of a durable non-corrosive aluminum alloy. The various parts which were noted as being made of rubber may of course be made of synthetic Neoprene, or the like. During fabrication, cable **25** and its free leads **27** are first inserted through cable nut **24** which is initially loose to permit free passage with the grommet **36** in uncompressed condition. Also at the time of assembly, the two connector halves **11** and **12** are separated as shown in FIG. **2**, and cable **25** may be pushed through shell **17** to an extent which enables soldering of the leads **27** to solder lugs **22** to be performed with ease; the O-ring **97** having first been placed over leads **27**. As sections **11** and **12** are brought together for final assembly, cable **25** may be withdrawn as required and upon tightening of bolts **44**, cable nut **24** is tightened to complete the seal.

Whenever required, the three bolts **44** may be withdrawn from flange **91** to slightly separate sections **11** and **12** for rotation one with respect to the other in steps of 30° to position the cable at any desired one of the twelve possible discrete orientations. Separation and reassembly requires nothing more than a screw driver for the bolts shown and, although the seal provided by O-ring **97** is broken when the two sections are separated, the seal is readily re-established since the O-ring may conveniently be dropped back into recess **96** for reassembly. Since O-ring **97** surrounds the cable wires **27**, its inadvertent loss is prevented. Thus, with minimum effort, the hermetic seal integrity of the assembled connector is assured.

It will thus be apparent that the novel right angle connector constitutes the present invention. It is exceedingly flexible, both from the standpoint of manufacture and final use in the field. Structurally, the arrangement shown ensures moisture-free environment in the critical internal portion of the connector notwithstanding the most adverse external conditions.

Certain modifications of the novel connector will now become apparent to those skilled in the art; for example, the contact pins may be replaced with pin sockets if desired and may also, as required, be adapted for panel mounting. Accordingly, the scope of the present invention should be deemed limited only by the appended claims.

What is claimed is:

1. A multi-contact right angle electrical connector for a jacketed multi-conductor electrical cable comprising in combination:

a first generally cylindrical tubular shell enclosing an electrical insulator; an array of electrical contacts supported within and extending through said insulator; said insulator being bonded to said contacts and to the interior surface of said shell to provide hermetic seals with said contacts and shell;

a second tubular shell formed with a substantially right angle bend, and adapted to enclose a multi-conductor jacketed electrical cable;

confronting attachment means provided on adjacent ends of said first and second tubular shells and arranged to permit rigid attachment of said first and second tubular shells at any one of a plurality of discrete angular orientations; the attachment means on said first tubular shell and the outer surface of said first shell being formed and arranged together to define an annular recess;

a gasket disposed within said annular recess and compressed therein by said confronting attachment means when said first and second shells are rigidly attached to provide a hermetic seal between said shells; and

means on said second tubular shell at the end opposite said attachment means for providing a hermetic seal between said second shell and the jacket of a multi-conductor electrical cable.

2. A multi-contact right angle electrical connector in accordance with claim **1** wherein said confronting attachment means comprises:

first and second confronting flanges rigidly secured to adjacent ends of said first and second tubular shells, respectively; one of said flanges having a plurality of equiangular spaced openings, the other of said flanges having a substantially larger plurality of equiangular spaced openings, selective ones of said larger plurality being adapted for alignment with each of said openings in said first flange in a substantial number of discrete angular orientations;

detachable means for rigidly securing together said first and second flanges through said aligned openings; the inner edge of said first flange at the junction with said first shell being formed with a bevel to define said annular recess; said recess having a generally triangular cross-section;

said gasket comprising an O-ring adapted to fit within said recess and to be compressed by said first and second flanges when rigidly secured to each other.

3. A multi-contact right angle electrical connector as in claim **2** and including:

a hollow cylindrical coupling surrounding said first tubular shell;

an annular ridge formed on the outer surface of said first shell;

said coupling being captured by said first flange and said annular ridge and arranged for limited motion therebetween; and

resilient means within said coupling normally urging said coupling toward said first flange.

4. A multi-contact right angle electrical connector as in claim 3 wherein said means on said second tubular shell for providing a hermetic seal between said second shell and said cable jacket comprises:

a cable nut threaded into said second tubular shell at the end remote from said second flange;

a cable nut gasket positioned internally of said second shell and adjacent said cable nut; said gasket being arranged to provide, when said cable nut is tightened, a hermetic seal around a jacket of a cable entering said connector through said cable nut.

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