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Carter et al.

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[54] **LATCHABLE INTEGRALLY MOLDED ELECTRICAL CONNECTOR**

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[73] Assignee: **Hughes Aircraft Company**, Culver City, Calif.

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[52] **U.S. Cl.** **339/42**, 339/59, 339/91, 339/217

[51] **Int. Cl.** **H01r 13/42**, H01r 13/44

[58] **Field of Search** ..... 339/17 L, 42, 36, 339/45, 75, 91, 176, 217, 34, 59–62, 206

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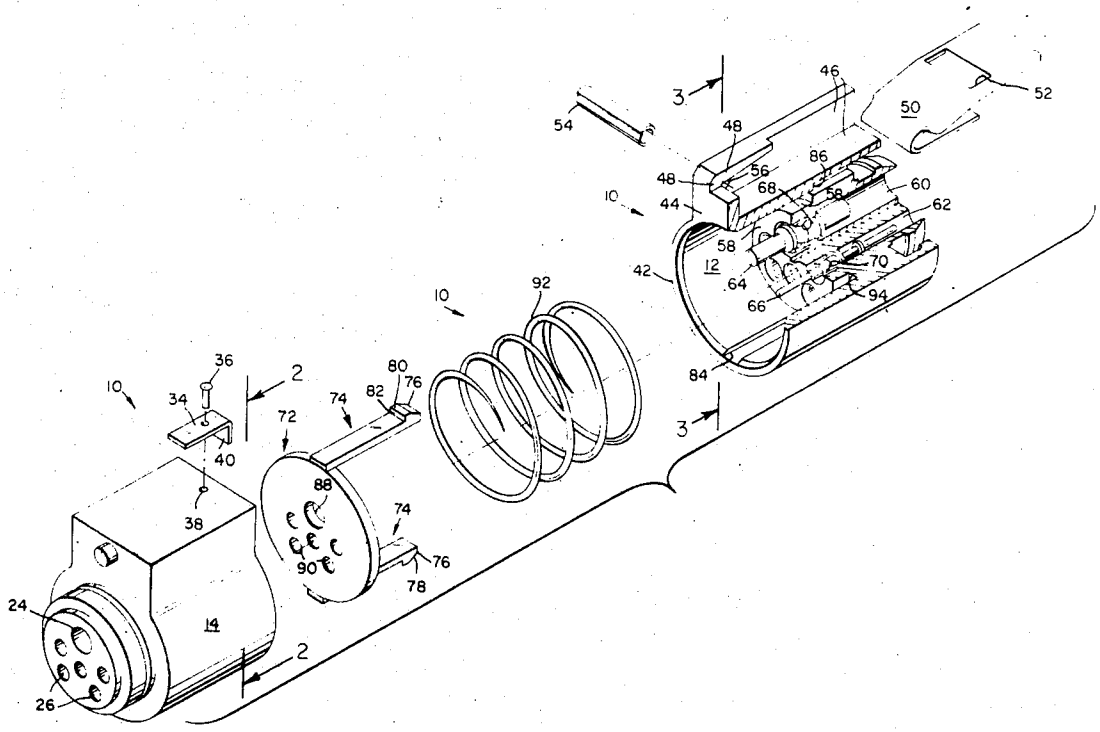
Assistant Examiner—Terrell P. Lewis
Attorney—W. H. MacAllister, Jr. et al.

[57] **ABSTRACT**

An electrical connector is disclosed comprising two axially joined and latched insulating connector bodies. Each body is formed with a plurality of electric contact bores. Along a portion of each contact bore is disposed an integrally molded contact retaining mechanism having a pair of deflectable fingers, shaped and sized such that when each contact is inserted into its respective bore, an enlarged portion of the contact expands the diametric spacing of inwardly projecting buttress portions of those fingers. This diametric spacing then contracts to a relaxed position with the buttress portions restraining the inserted contact from axial motion. The front portion of each retaining mechanism finger is inwardly tapered to facilitate contact removal.

8 Claims, 7 Drawing Figures



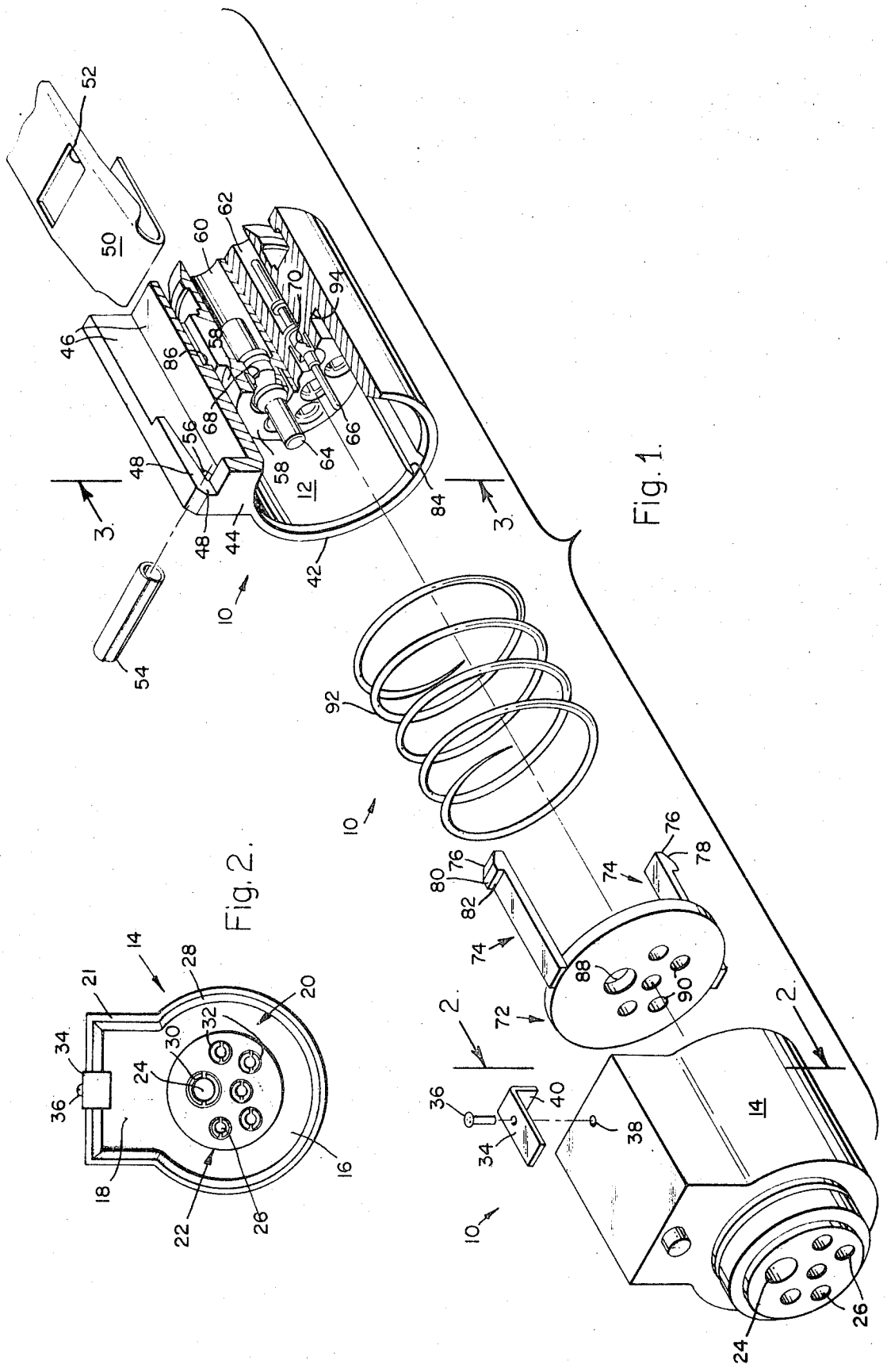

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Fig. 1.

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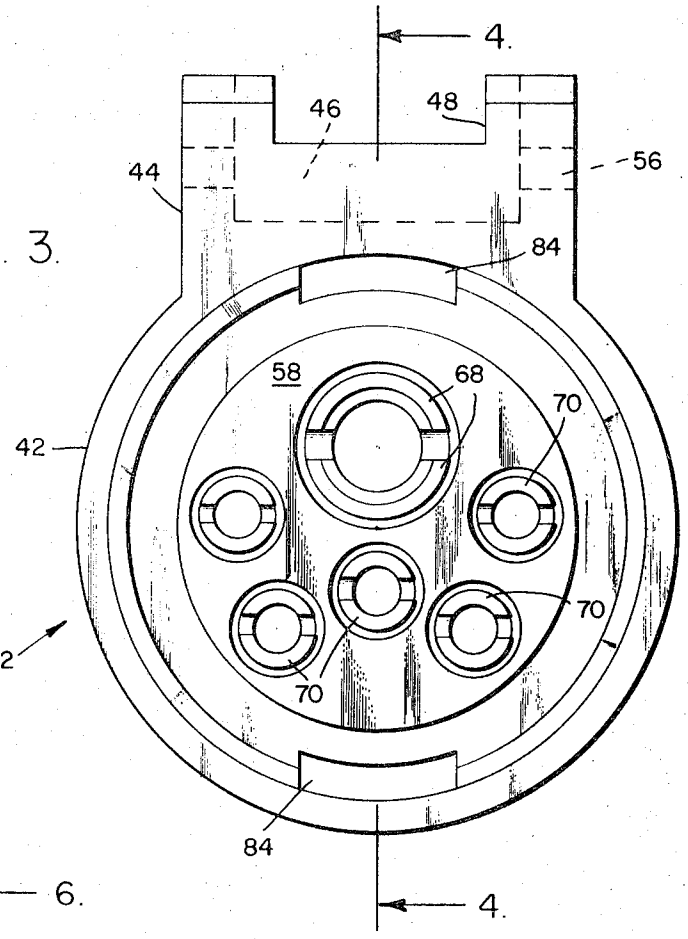
Fig. 2.

Fig. 3.



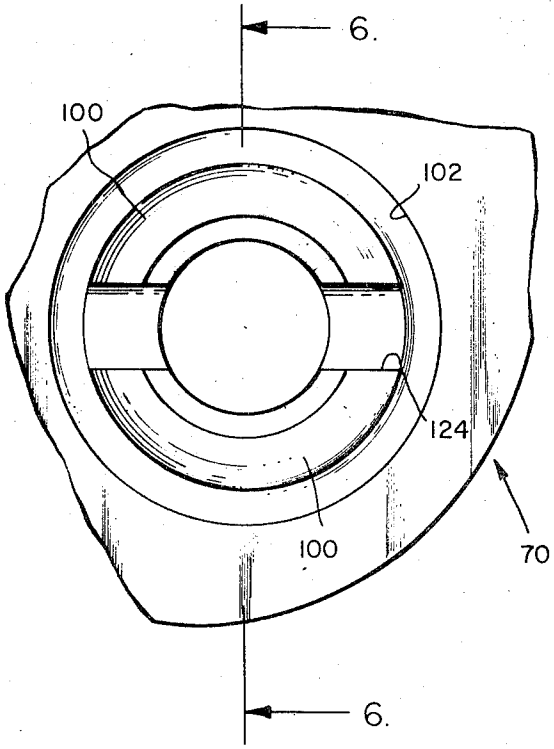


Fig. 5.

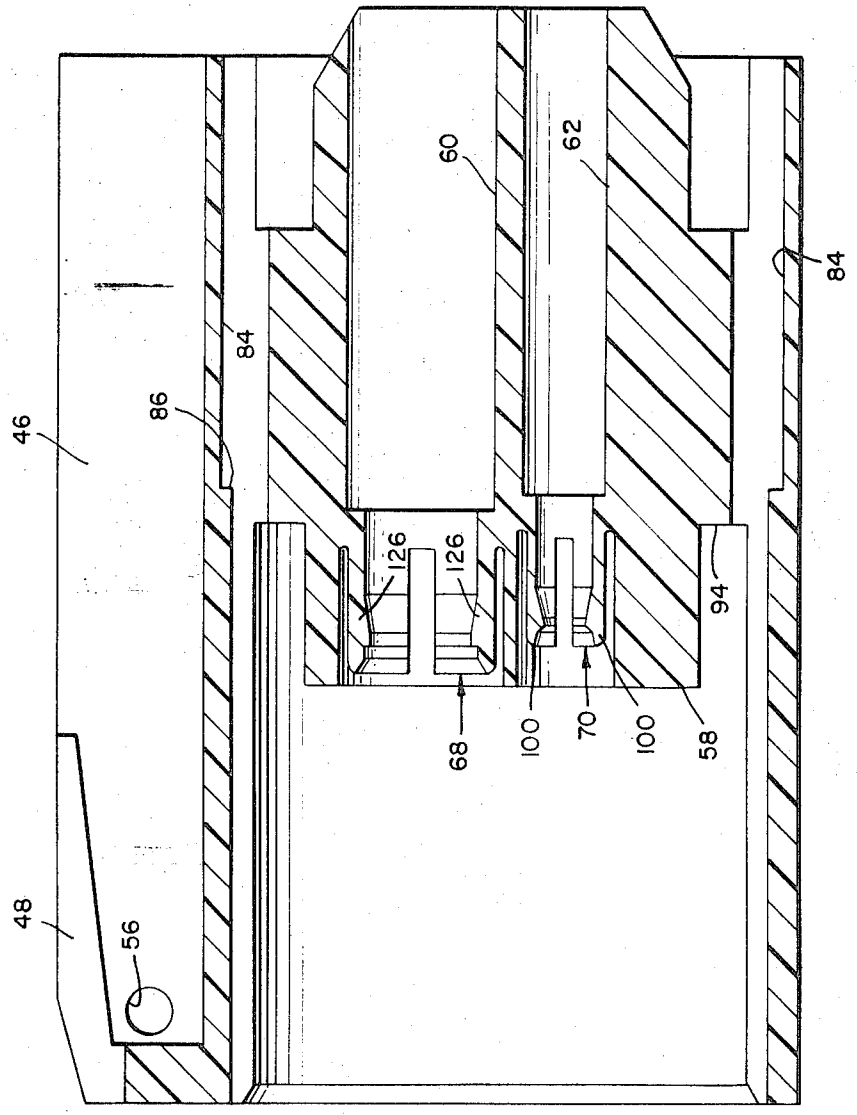
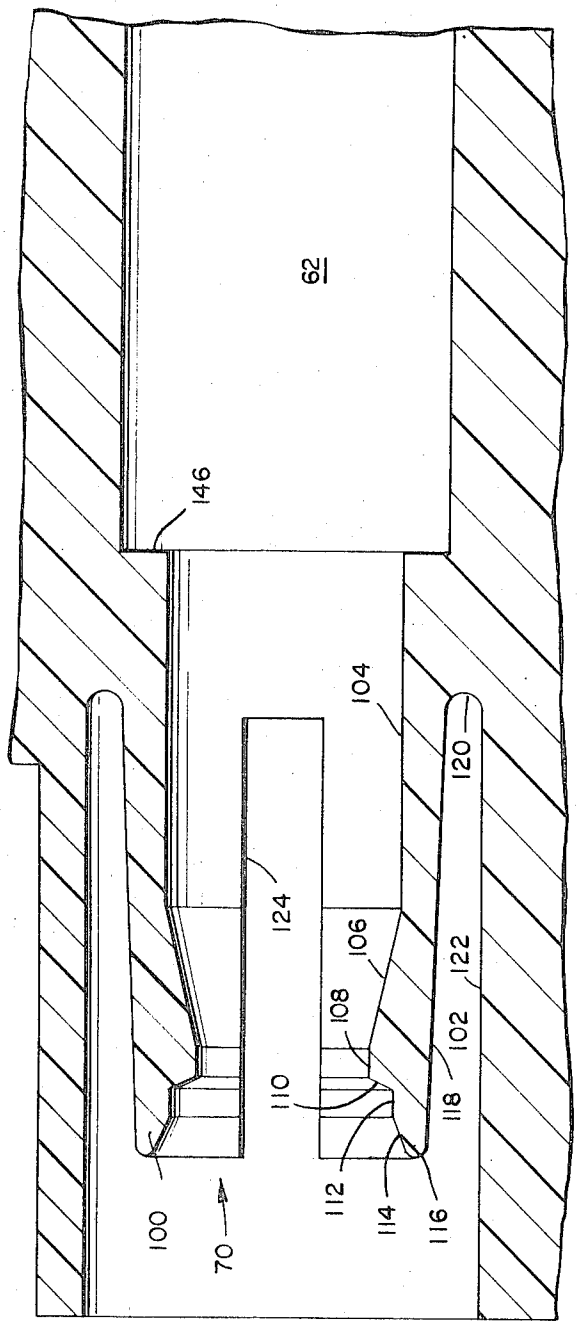


Fig. 4.


62
146
104
120
124
106
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110
118
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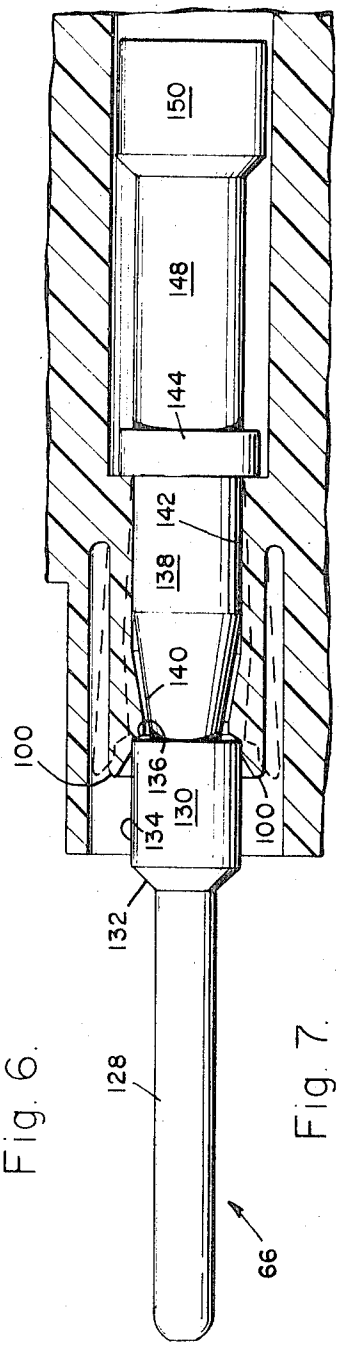
100
70

Fig. 6.


150
148
144
142
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130
100
132
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Fig. 7.

LATCHABLE INTEGRALLY MOLDED ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to electrical connectors. More particularly, the invention relates to an electrical connector comprising a connector body which incorporates an integral electrical contact retention system having improved electrical and mechanical characteristics, economy of fabrication, and ease of assembly and disassembly.

2. Description of the Prior Art

In some prior art electrical connectors, electrical contact retention was achieved by a separate spring member disposed in a bore provided in the connector body. The spring member defined an inclined portion of resilient metal which, when in contact was moved past, blocked axial shifting. Cooperating contact and spring stop members blocked shifting in opposite directions. A clearance space was provided to enable insertion of a tool to deflect the spring so that the contact could be withdrawn. The aforementioned spring members were difficult to insert into the associated bores and were sometimes destroyed or damaged during insertion. Moreover, the required degree of resiliency was difficult to maintain in production. In addition, the connectors were expensive to manufacutre and assemble, required close tolerances be maintained, and required accurate heat treating of the individual spring members. The damage or destruction of an individual spring insert often made it necessary for the entire connector to be discarded or caused trouble in operation of a critical connector element.

Other retention mechanisms of the prior art comprised individual clip members which were separately assembled into position on the electrical contact themselves. Upon assembly of an individual clip member upon its associated electrical contact, the assembled contact and clip could be installed in the connector body. During the installation operation, the clip is compressed by a special tool. The tool is then removed and the clip expands into a precise dimensioned annular groove provided in the connector body, thereby retaining the electrical contact in position. In comparison with the present invention, those devices were also expensive and difficult to manufacture and the clip members required delicate assembly operations, complex machinery and careful material control. Removal of the electrical contact with the clip contained thereon required another special tool for compressing the clips should the contact assembly have to be removed. The individual clips were also vulnerable to destruction, and when destroyed, rendered the electrical connectors useless. Close manufacturing tolerances had to be maintained for several dimensions in the connector body, the retaining clip member, the contact and the connector. These limitations caused delays, expense, and difficulty of assembly.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a connector body capable of retaining electrical contacts and/or coaxial cable plugs therein, which is of improved reliability, has improved electrical characteristics, and at the same time enables decreases in cost, number of parts and assembly time.

It is a further object of the invention to provide an electrical connector which may be assembled by a relatively inexperienced operator with less chance of damage to the connector.

Another object of the present invention is to provide a contact retention electrical connector with an integral quick release connector body latching and polarizing arrangement.

In accordance with the above objectives, the inventive connector comprises male and female connector bodies at least one of which is integrally formed of resilient insulating material and incorporating an integrally molded contact retaining mechanism for each contact. A polarizing portion may also be integrally molded in one connector body for aligning the body with respect to a corresponding polarization portion in the other connector body.

The integral retention mechanism includes at least two inwardly projecting buttress portions which cooperate in an abutting relationship with an enlarged shoulder portion of the contact, thereby retaining the installed contact within its respective bore. Each buttress portion is an integral part of a flexible finger thereby permitting the buttress portion of the finger to be deflected away from the enlarged shoulder portion of the contact during the insertion operation. Once contact has been fully inserted, the finger returns to its normal relaxed position with its buttress portion abutting the contact shoulder.

A connector constructed according to the teachings of the present invention dispenses with the need for external shells, internal dielectric inserts, and/or separate contact retaining clips.

The foregoing and other objects, advantages, features and uses of the devices embodying the principles of the invention will become more apparent to those skilled in the art upon reference to the following detailed description when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an exploded view illustrating an electrical connector according to a preferred embodiment of the present invention;

FIG. 2 is an elevational view taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged elevational view taken along line 3—3 of FIG. 1 prior to installation of any electrical contacts;

FIG. 4 is a view partly in section taken along line 4—4 of FIG. 3;

FIG. 5 is an enlarged fragmentary view illustrating the portion of the electrical contact retention arrangement shown in FIG. 4;

FIG. 6 is a view partly in section taken along line 6—6 of FIG. 5; and

FIG. 7 is a reduced size sectional view similar to FIG. 6 but with an electrical contact pin inserted in the connector body.

DETAILED DESCRIPTION

Description of a Preferred Embodiment

Referring to FIG. 1, electrical connector assembly 10 includes a plug or male connector body 12 and a socket

or female connector body **14**. Connector bodies **12** and **14** define a variety of flanges, recesses, apertures, grooves and projections which are described in detail below. The bodies **12** and **14** may be molded from a polycarbonate plastic (such as that marketed by General Electric under the name "LEXAN") which is flexible, resilient and resistant to work hardening. By use of such a plastic, it is possible to mold each connector body as a single unit having the structure described below.

Referring to FIG. **2** as well as to FIG. **1**, the female connector body **14** comprises an essentially cylindrical male connector body receiving portion **16** and a rectangular polarizing latch receiving section **18**. The internal portion of connector body **14** has a rear wall **20** and a forwardly extending substantially cylindrically shaped electrical contact retaining boss **22**. A coaxial cable socket retaining bore **24** and a plurality of electrical longitudinally through boss **22** and rear wall **20**. Bores **24** and **26** are disposed parallel to the axis of boss **22**.

The cylindrically shaped electrical contact retaining boss **22** extends forwardly about **70%** of the distance between the rear wall **20** and a front face **21** of connector body **14**. An internal bevel or chamfer **28** extends rearwardly with respect to the front face **21** of connector body **14**. A coaxial socket retaining mechanism **30** is provided in the coaxial cable socket bore **24**. In each of the electircal contact bores **26** is provided an electrical socket contact retaining mechanism **32**. Mechanisms **26** and **32** are similar to retaining mechanisms **68** and **70**, respectively, described below for the male electrical connector body **12**.

A ribbon-shaped latch dog **34** made of a wear resistant material such as stainless steel, is attached by a rivet **36** to a hole **38** provided in the top front portion of latch receiving section **18**. At the front face **21** of female connector body **14**, the latch dog **34** is bent downwardly to form a depending locking finger **40**.

Male connector body **12** is preferably of unitary construction and is of general shape similar to, but somewhat smaller than, that of the female connector body **14**. Specifically, connector body **12** comprises a cylindrical outer shell portion **42** and a polarizing flange **44** which is generally of lengthened rectangular cross-sectional configuration so that it may fit within similarly shaped latch receiving section **18** of female body **14**. However, within polarizing flange **44** is a wedge-shaped groove **46** which extends for most of the length of the connector body **12**, opening to the rear and top faces of flange **44**. A U-shaped groove **48** (FIG. **3**) is provided to accept latching dog **34**. A U-shaped latching spring **50**, made of material such as stainless steel, is adapted for insertion into the groove **46** with its front bight urged against the front wall of the groove **46** in the connector body **12**. The upper surface of latching spring **50** defines a rectangular aperture **52** to receive the depending end **40** of latch dog **34**. A pin **54** adapted for insertion through a hole **56** provided in the side walls of the flange **44** maintains the latch spring **50** in place within the groove **46**, but at the same time enables downward movement of the top portion of the spring **50**.

In the male connector body **12** there is a cylindrical boss **58** which is of approximately the same diameter as the boss **22** in female body **14**. The boss **58** has coaxial cable plug and electric contact pin bores **60** and **62**, respectively, aligned with the respective bores **24** and **26** of the body **14**. Disposed respectively in the coaxial plug bore **60** and in the contact pin bores **62** are coaxial connector plug **64** and contact pins **66**. Coaxial connector plug **64** is held in the bore **60** by a retention mechanism **68** and pins **66** are held in respective bores **62** by retention mechanisms **70**. Retention mechanisms **68** and **70** will be described in more detail below with respect to FIGS. **3**, **4** and **6**. It should be understood that a retention system according to the invention is utilizable for either or both socket and pin contacts, the pin contact insertion being shown in FIG. **1** (and in more detail in FIG. **7**) merely by way of illustration of one of the two types of contacts which may be inserted into retention mechanism **70**.

A disc-shaped member **72** (hereinafter referred to as a "dead-face") is provided with a pair of dead-face securing latch fingers **74** depending from two opposed points along its periphery and extending in the direction toward the male connector body **12**. The fingers **74** are each elongated to facilitate resiliency and are rectangular in cross-section. Each latch finger **74** terminates with a buttress-shaped locking projection **76** comprising an outwardly angled portion **78**, a relatively straight portion **80** and a surface **82** perpendicular to the outer face of dead-face securing fingers **74**. Each finger **74** fits slidably within a corresponding groove **84** in the male body **12**, the surface **82** being restrained from excessive forward movement by a ledge **86** in the body **12**. A dead-face coaxial plug aperture **88** and a plurality of dead-face electrical contact apertures **90**, which are aligned with the corresponding bores **60** and **62** of the connector body **12**, are provided in dead-face member **72**. Disposed between the dead-face **72** and the connector body **12** is a dead-face coil spring **92**. Coil spring **90** is of a diameter to fit within the space between the dead-face securing latches **74**. The ends of spring **92** are retained between the adjacent surface of dead-face member **72** and a counterbore **94** defined in the connector body **12**.

The contact retaining mechanism **70** is shown in detail in FIGS. **4** and **6** and comprises two opposing deflectable projecting fingers **100**. Between projecting fingers **100** and the surrounding connector body insulating material is provided a recess **102** to enable the fingers **100** to be radially deflected during the contact insertion or removal operation. Projecting fingers **100** is provided at its inner circumferential portion with a first straight surface **104**, an inwardly angled ramp surface **106**, a second straight surface **108**, a sharply angled buttress surface **110**, a third straight surface **112**, a tapered surface **114** (having a taper of approximately 30° from contact bore axis) and a front surface **116**. An outer projecting member surface **118** may be tapered angularly outward about 2° from the front surface **116** toward the rear face of the connector body. Curved surface **120** connects the projecting member outer surface **118** with insulating body surface **122**. Each pair of projecting fingers **100** are separated by a pair of slot portions **124** (FIGS. **5** and **6**). Retaining mechanism **68** for coaxial plug **64** is similar to retaining mechanisms **70** and defines a pair of opposing projecting fingers **126** similar to projecting fingers **100**. The functional relationship of the various portions of the fingers **100** will be discussed later under "Assembly and Use."

FIG. **7** illustrates a pin contact **66** mounted in a portion of the male connector body **12** and also illustrates the deflection of the projecting fingers **100** while the

contact 66 is being installed or removed from the connector body 12. The pin 66, as illustrated, comprises a socket engaging pin section 128, an enlarged section 130 having a beveled portion 132 and a straight enlarged front retention collar 134 which terminates in a beveled rear buttress surface 136. The contact pin 66 further comprises a section 138 which is bounded by outside tapered circumferential surface 140 and an enlarged straight surface portion 142. The pin 66 terminates in an enlarged rear collar 144 which abuts against a ledge 146 defined on the connector contact bore 62. To the rear of enlarged collar portion 144 is provided an additional reduced section of solid material having a counterbored wire crimp barrel 148. The wire crimp barrel 148 terminates in a wire insulation support tubular portion 150 of larger diameter and having a larger counterbore therein than the crimp barrel 148 in order to support insulation. The enlarged tubular portion 150 is gradually merged into the reduced diameter wire crimp barrel 148. The contact pin 66 is normally made of solid conductive material, for example, beryllium copper.

ASSEMBLY AND USE

The plug or male connector body 12 and the socket or female connector body 14 are integrally molded from a polycarbonate plastic using conventional techniques. The molding process results in a connector body made to very close tolerances and having an acceptable finish. Consequently, no special machining operations are required for these bodies other than possibly the drilling of holes 38 and 56 for the latching mechanism. Prior to delivery to the user, the latching mechanism is installed. Latch spring 50 is inserted into the groove 46 of the male body 12, after which rollpin 54 is pressed through the hole 56 permanently securing the latch spring 50 in place. Latch dog 34 is attached to female connector body 14 by means of rivet 36 through hole 38.

The user is thus supplied with a package containing a male and a female connector body with latching mechanism already assembled, a supply of contacts, as well as a dead-face member 72 and a dead-face spring 92. The user need only attach the contacts to the ends of his wiring harness, insert the attached contacts into the relevant bores of the connector body, and install the dead-face member and its spring. Alternatively, the dead-face member 72 can be pre-assembled onto the connector body prior to delivery to the user.

Refer now to FIG. 7 in conjunction with FIG. 6. FIG. 7 shows a connector pin contact 66 already installed in a connector body bore. The installation process may be simplified by the use of a PULL-THRU tool, such as described in U.S. Pat. No. 3,614,824 assigned to the assignee of the present invention. As the connector is inserted, beveled portion 132 of contact enlarged section 130 wedges against retaining mechanism finger ramp surface 106. As the contact is further inserted into the connector body, the wedging force exerted by beveled portion 132 on ramp surface 106 acts to deflect fingers 100 radially outward to an offset position in the recess area 102 such that the inner diameterical spacing between buttress surfaces 110 is equal to the outer transverse dimension of enlarged section 130 of contact pin 66. The dashed lines in FIG. 7 illustrate the deflected position assumed by fingers 100 just before the contact 66 is fully inserted. The contact insertion operation is completed when the forward face of contact rear collar 144 contacts the ledge 146 defined on the bore 62. Since the axial distance between ledge 146 and buttress surface 110 is essentially equal to the distance between the forward face of contact collar 144 and the beveled rear face 136, projecting fingers 100 are free to return to their relaxed position once the contact has assumed its installed position as illustrated, and the contact is retained within its bore and prevented from accidental removal by the abutting relationship between retaining mechanism buttress surface 110 and beveled rear face 136 of the contact 66.

Should it be necessary to remove the contact, as for example for repair or reconfiguration of an electrical connection, an appropriately shaped tool may be inserted into the tapered recess defined by contact straight surface 134 and retaining mechanism tapered surface 114 defined on the front end of the fingers 100. Insertion of such a tool will tend to deflect the fingers 100 into the position shown in dashed lines in FIG. 7 (with the retaining mechanism buttress surface 110 no longer restraining the contact enlarged portion 130), so that the contact may be readily removed.

Refer back to FIG. 1. Once the contacts have been installed, dead-face member 72 is inserted into connector body 12 as follows. Coil spring 92 is placed in the counterbore 94 of the connector body 12. Latch fingers 74 are inwardly compressed such that they can be inserted into latch grooves 84, and the dead-face member 72 is pushed into the connector body 12 until the buttress portions 82 are free to expand into the enlarged rear portion of the groove 84. The right angle segment 82 of the finger 74 springs outwardly to engage the ledge 86 thereby restraining the dead-face 72 from excessive movement. The dead-face member 72 serves to protect the pin contacts from accidental bending or electrical shorting when the connector is disconnected.

When the two connector bodies are latched together, connector body 14 has its forward boss 22 in contacting relationship with the front face of the dead-face member 72, maintaining the dead-face member 72 in a rearward position against the pressure of the spring 92. The latch dog 34 extends into the aperture 52 of the latch spring 50 at approximately right angles, thereby holding the two connector bodies 12 and 14 in a connecting relationship against the pressure of the dead-face member and its associated spring.

Unlatching is conveniently and quickly performed by depressing the latch spring 50 a distance greater than the penetration of the latch dog 34 into the aperture 52, thus causing the male connector body 12 to be ejected from the female connector body 14 by the action of the dead-face spring 92. Latching is performed by inserting the male body 12 into the female body 14 using sufficient pressure to counteract the force of the dead-face spring 92. Projecting latch dog 34 sliding over the forward portion of the U-shaped spring 50 depresses the spring until the latch dog enters the latch aperture 52, at which time the two connector bodies are securely latched, one to another.

Thus, it can be readily seen that a connector according to the present invention not only is adapted for low cost manufacture and assembly, but also is very convenient to use.

While salient features have been illustrated and described with respect to particular embodiments, it

should be readily apparent that modifications can be made within the spirit and scope of the invention, and it is therefore not desired to limit the invention to the exact details shown and described.

What is claimed is:

1. In a multiple conductor electrical connector having a plug assembly and a socket assembly each comprising a connector body formed of insulating material and a plurality of electrical contacts respectively insertable into a plurality of contact bores defined in the connector body:

a plurality of contact retaining mechanisms integrally formed in each of said connector bodies coaxially with the respective contact bores, each contact retaining mechanism defining a plurality of opposing deflectable longitudinal fingers each having a laterally inwardly projecting buttress portion, the diametric spacing between opposing buttress portions when said fingers are in a relaxed position being less than the outer transverse dimension of an enlarged shoulder portion of the contact to be inserted into the contact retaining mechanism such that said opposing buttress portions abut said shoulder portion and retain said contact after it has been inserted, each said finger being deflected to an offset position during the insertion of said contact into said contact retaining mechanism such that the diametric spacing between said opposing buttress portions is at least equal to said outer transverse dimension of said shoulder portion; and

means integrally formed in said connector bodies for polarizing said plug assembly with respect to said socket assembly, the portion of said means formed in the plug assembly connector body being of a generally rectangular external cross-section and having attached thereto a U-shaped latching spring having a latch aperture, the portion of said means formed in the socket assembly connector body being of a generally rectangular internal cross-section slightly larger than said external cross-section and having attached thereto a latch dog insertable into said latch aperture when said plug and socket assemblies are connected together.

2. An electrical connector according to claim 1 wherein:

each said retaining mechanism defines an inwardly tapered surface at the respective ends of said projecting fingers, whereby removal of said contact from said retaining mechanism is facilitated.

3. An electrical connector according to claim 1 wherein:

each said connector body is formed of polycarbonate plastic.

4. An electrical connector according to claim 1 further including:

a dead-face member slideably retained in one of said connector bodies, said member having a plurality of apertures aligned with the contact bores in said body;

the other of said connector bodies defining a surface parallel to a face of said dead-face member; and

a dead-face spring disposed between said dead-face member and a surface of said one connector body for urging said dead-face member against said surface of said other connector body.

5. An electrical connector according to claim 4 wherein:

said dead-face member is formed of polycarbonate plastic and has a plurality of flexible latch fingers projecting therefrom; and

said one of said bodies has a plurality of integrally formed grooves for receiving said latch fingers.

6. An electrical connector plug assembly comprising:

a body portion formed of insulating material and having a plurality of contact bores defined therein, said body portion having an outer shell portion of generally circular cross-section;

a plurality of opposing deflectable contact retaining fingers associated with each of said contact bores and integrally formed in said body portion;

a plurality of electrical contacts removably insertable into said contact bores and retainable therein by said deflectable fingers;

a polarizing flange having a generally rectangular external cross-section integrally formed with said body portion, said polarizing flange having an outwardly opening channel formed therein; and

a latching spring insertable in said channel.

7. The plug assembly of claim 6 further comprising:

a deadface member slidably retainable in said connector body, said member having a plurality of apertures aligned with the respective contact bores of said body; and

a deadface spring disposed between said deadface member and said connector body.

8. An electrical connector socket assembly comprising:

a body portion formed of insulating material and having a plurality of contact bores defined therein, said body portion having a receiving internal portion of generally circular internal cross-section;

a plurality of opposing deflectable contact retaining fingers associated with each of said contact bores and integrally formed in said body portion;

a plurality of electrical contacts removably insertable into said contact bores and retainable therein by said deflectable fingers;

a polarizing latch receiving section having a generally rectangular internal cross-section integrally formed with said body portion; and

a latch dog attached to said section.

* * * * *