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(54) Separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members.

(57) Separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members, said one connector member including at least one socket contact (10) comprising a contact sleeve (12) of resilient metal having a mating end (18) and a wire receiving end (20), the wall of said contact sleeve (12) defining three slots extending axially from the mating end (18) and being circumferentially equally spaced thereby providing a set of three equally spaced contact fingers each extending as a cantilever beam from the ends of the slots and terminating at the mating end (18), so that said contact fingers provide the necessary contact force as well as a centering action upon entry of a cooperating contact pin (24).

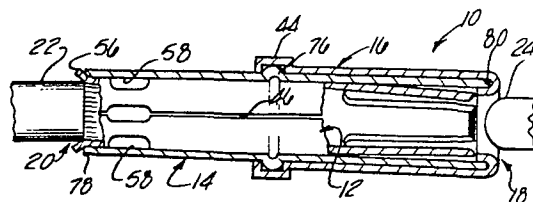


Fig-1

Separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members

This invention relates to a separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members, wherein: each of the connector members includes
5 a dielectric insert; at least one socket contact is mounted in the insert of one of the connector members with the socket contact comprising a sleeve of resilient metal having a mating end and a wire receiving end and with the wall of the sleeve defining slots extending axially from the mating end
10 thereby providing contact fingers each extending as a cantilever beam from the ends of the slots and terminating at a free end; and a pin contact corresponding to the socket contact is mounted in the insert of the other of the connector members and adapted for telescopic engagement with the mating
15 end of the socket contact when the connector members are in mated relationship.

Electrical connectors of the plug and receptacle type are used in many applications for connecting multiple pairs of corresponding conductors. Such connectors are widely
20 ly used in the aerospace field in complex electronic systems in which a single connector may interconnect hundreds of pairs of wires. In such systems, the connectors must be miniaturized to minimize the weight and size. The wires at the receptacle are connected to individual terminals and the
25 wires at the plug are connected to corresponding terminals. Each of the terminals on one of the connector members is a socket contact and each of the terminals on the other member is a pin contact which is adapted to telescopically engage the corresponding socket contact when the plug and receptacle
30 are in mated relationship. In order to miniaturize the connector, the pin and socket contacts need to be very small; for example, the socket contact may be less than 2.5 mm in diameter and less than 13 mm in length.

Connectors of the type described must be capable

of quick and easy connection and disconnection without undue force. Yet each set of contacts must provide excellent electrical conductivity and be capable of repeated connection and disconnection without damage or significant deterioration.

5 When miniature contacts were first introduced, they were manufactured by machining from metal stock since that was the only feasible way to hold the tolerances required for the mating contacts. However, machined contacts are relatively costly. In recent years such contacts have been made from
10 sheet metal by forming and rolling to produce "a formed" contact.

Formed socket contacts have been developed which comprise an assembly of a contact sleeve or liner of spring metal having plural contact fingers at the mating end and a
15 supporting sleeve thereon. The wire receiving end is provided with plural openings and has a supporting sleeve thereon and is crimped into engagement with the wire. Additionally, a mounting flange is provided in the midsection of the contact sleeve. In this construction, the inner sleeve has an open
20 seam from one end to the other, i.e. the abutting edges of the rolled sleeve are not welded or brazed together. A socket contact of this construction and method of making it are described in U.S. Patent No. 4,072,394. Formed contacts with welded or brazed seams are disclosed in the following patents:
25 U.S. Patent No. 3,286,223 , U.S. Patent No. 3,317,887 , and U.S. Patent No. 3,721,943.

In a socket contact of the type described, the contact fingers constitute cantilever beams deflected in a radial direction by the insertion of the mating pin contact. Each of
30 the contact fingers is supported only at its root in the contact sleeve. In order to insure a good electrical connection between the socket contact and the pin contact, it is necessary to have each finger exerting an appropriate resisting force to radial deflection. If the resisting force is too great the
35 insertion force required for the pin contact is excessive; if the insertion force for the pin contact is too small, the electrical connection between the pin and socket contacts may be defective.

The present invention overcomes the limitations and

disadvantages of the prior art arrangements by providing a separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members, wherein: each of the connector members includes a dielectric insert; at least one socket contact is mounted in the insert of one of the connector members with the socket contact comprising a sleeve of resilient metal having a mating end and a wire receiving end and with the wall of the sleeve defining three slots extending axially from the mating end and being circumferentially equally spaced thereby providing a set of three equally spaced contact fingers each extending as a cantilever beam from the ends of the slots and terminating at a free end; and a pin contact corresponding to the socket contact is mounted in the insert of the other of the connector members and adapted for telescopic engagement with the mating end of the socket contact when the connector members are in mated relationship.

Accordingly therefore to the invention, a socket contact is provided which exhibits a desired contact force and a centering action upon entry of a cooperating contact pin.

One way of carrying out the invention is described in detail below with reference to the drawings which illustrate one specific embodiment of this invention, in which:

FIGURE 1 shows the socket contact assembly in elevation with certain parts broken away;

FIGURE 2 shows detail of construction of the wire receiving end of the socket contact;

FIGURE 3 shows the socket contact of this invention in an electrical connector;

FIGURE 4 shows a contact blank which has been stamped from sheet metal to form the contact sleeve;

FIGURE 5 is an elevation view with parts broken away of the contact sleeve of the socket contact of this invention;

FIGURE 6 is an end view of the sleeve of FIGURE 5;

FIGURE 7 is a sectional view of the supporting sleeve for the socket contact of this invention;

FIGURE 8 is a sectional view of an outer sleeve of

the socket contact; and

FIGURE 9 shows a detail of construction.

Referring now to the drawings, there is shown an illustrative embodiment of the invention in a socket contact 5 especially adapted for use in separable electrical connectors. The socket contact comprises a contact liner of the formed type, i.e. it is fabricated from thin sheet metal by stamping and rolling. The contact is adapted for mounting in a dielectric insert of an electrical connector member and for 10 telescopic engagement with a pin contact mounted on a mating connector member.

The socket contact, with the parts assembled, is shown in FIGURE 1. In general, the socket contact 10 comprises a contact liner or sleeve 12 disposed in telescopic relationship within a supporting sleeve 14 which extends substantially the full length of the contact sleeve. An outer sleeve or front hood 16 is disposed in telescopic relation over the supporting sleeve 14 and extends from the pin receiving or mating end 18 to a point near the midsection of the contact sleeve 12. The back end of the contact 10 terminates in 20 a wire receiving opening 20 which receives a conductor or wire 22. The mating end 18 at the front of the contact is adapted to receive a pin contact 24. Before proceeding with the detailed description of the socket contact 10, it will 25 be helpful to consider the mounting of the socket contact in an electrical connector member.

FIGURE 3 shows a fragmentary view of an electrical connector of the type of which the socket contact of this invention may be used. The electrical connector comprises a receptacle 30 which contains a dielectric insert 32 in 30 which are mounted a plurality of socket contacts 10. The electrical connector also includes a plug 34 which contains a dielectric insert 36 in which are mounted a plurality of pin contacts 24. The receptacle 30 and the plug 34 are adapted to be oriented and drawn together in a mated relationship (by means not shown) so that the pin contact 24 is telescopically inserted into the socket contact 10 to provide an electrical connection therebetween. In this illustration, the insert 32 defines a recess 35 which contains a retention 35

device 40. The socket contact 10 is mounted in the insert 32 by the contact retention device 40 which includes plural deflectable spring fingers 42 which engage a rearward shoulder 44 on the socket contact 10. The socket contact 10 is inserted from the rear of the insert through the retention device and the spring fingers 42 deflect to allow the hood 16 to pass by and then the fingers seat against the rear shoulder 44. Accordingly, the socket contact 10 is maintained in a fixed position within the insert.

10 Referring now, especially to FIGURES 2,5 and 6, the contact sleeve 12 will be described in greater detail. The contact sleeve 12 is formed from a resilient sheet metal, preferably a beryllium copper alloy, by a stamping and rolling process. The process of forming the sleeve 12 is suitably that described in the above cited U.S. Patent No.
15 4,072,394. A contact blank 12' which has been stamped from sheet metal for forming contact sleeve 12 is shown in FIGURE 4. The contact sleeve 12 comprises a cylindrical portion 50 having an open seam 46 which is formed by the abutting or
20 closely spaced, longitudinally extending edges 52 and 54 of the portion 50. The contact sleeve 12 is provided with an oblique flange 56 at the rearward or wire receiving end 20 to serve as a stop or locating shoulder for the supporting sleeve 14. Adjacent the wire receiving end 20 of the contact
25 sleeve 12 the wall thereof defines a set of five elongated openings 58 which are equally spaced circumferentially of the sleeve with one of the openings 58 being centered on the open seam 46. At a position forward of the openings 58 the contact sleeve 12 is provided with a plurality of annu-
30 lar inwardly directed ribs 60. As shown in FIGURE 2. the wire receiving end 20 of the contact sleeve 12 receives the end of the wire 22. An inwardly directed stop tab 62 is provided by lancing a portion of the walls of the supporting sleeve 14 and the contact sleeve 12. Preferably the tab 62
35 is located diametrically opposite from the open seam 46. The wire 22 is stripped of insulation at its end and the bare conductor is inserted into the contact sleeve 12 and seated against the stop tab 62. When the socket contact is to be installed on the wire 22 for use in a connector, the double

wall thickness of the contact sleeve 12 and the supporting sleeve 14 is crimped inwardly at four equally spaced locations to provide indentations 64, as shown in FIGURE 9, wherein the contact sleeve 12 is crushed inwardly against the bare wire to provide a good electrical and mechanical connection.

Reverting back to FIGURES 4 and 5, contact sleeve 12 is provided with a set of three equally spaced tines or contact fingers 66 at the forward or mating end 18 of the sleeve 12. The contact fingers 66 are formed by punching three equally spaced slots 68 into the sheet metal of the contact sleeve 12 while it is in a flat condition. The slots 68 extend from the pin mating end 18 of the contact sleeve 12 to a location adjacent midsection of this sleeve and each slot 68 terminates in an arcuate configuration at the root of the contact fingers 66. The contact sleeve 12 in that portion extending from the root of the fingers 66 to the free ends of the fingers is tapered to a smaller diameter at the mating end 18. In other words, each of the contact fingers 66 extends radially inwardly at its free end. After the forming operation, the contact sleeve 12 is heat treated so that the contact fingers 66 are stress-relieved in the tapered position illustrated. Additionally, the free ends of the fingers 66 are coined to provide bevelled ends 70 to facilitate entry of the pin contact 24 into the contact sleeve 12.

The supporting sleeve 14 as shown in FIGURES 1 and 7 is a cylindrical metal tube. The sleeve 14 is preferably constructed of stainless steel and is formed by deep drawing to provide a tube having a relatively thin wall of a few hundredths of a millimeter in thickness. The supporting sleeve 14 is provided with an annular, outwardly extending flange 76. The supporting sleeve 14 is disposed externally of the contact sleeve 12 and, as shown in FIGURE 1, the rearward end 78 thereof is in abutting engagement with the stop shoulder 56 on the contact sleeve 12. The forward end 80 of the supporting sleeve 14 extends slightly beyond the ends of the contact fingers 66. It is noted that the forward end of the supporting sleeve 14 is radially spaced from the contact fingers 66 leaving room for radial deflection of the

fingers upon the entrance of the pin contact 24. The annular flange 76 on the supporting sleeve 14 is axially located near the midsection of the contact sleeve 12 and serves to secure the mounting flange 44 which is formed on the outer sleeve or hood 16. The supporting sleeve 14, as shown in FIGURE 2, is interlocked with the contact sleeve 12 by means of the tab 62 and it serves as a support structure for the contact sleeve 12 in the formation of the crimped indentations 64.

The outer sleeve or hood 16, as shown in FIGURES 1 and 8 is a cylindrical tube disposed in external telescopic relation with the supporting sleeve 14. The hood 16 is preferably made of stainless steel by a deep drawing operation and has a wall thickness of a few hundredths of a millimeter. The forward end of the hood 16 is provided with an inwardly turned annular bight 86 which forms an annular channel 88 adapted to receive the forward end 80 of the supporting sleeve 14. The rearward end of the hood 16 has an enlarged diameter to form a bell mouth 44' which is adapted to fit over the annular flange 76 on the supporting sleeve 14. With the hood 16 positioned on the supporting sleeve 14, the bell mouth 44' thereof is rolled over the flange 76 to provide the annular retention flange 44, as shown in FIGURE 1. At the forward end of the hood 16 the annular bight 86 provides a socket entrance adapted to guide the mating contact pin 24 into centered relationship with the contact fingers 66. For this purpose, the inside diameter of the annular bight 86 is substantially the same as the outside diameter of the bevelled surfaces 70 and there is a small axial spacing between the end of the bight 86 and the ends of the fingers.

As described above, the socket contact 10, as shown in FIGURE 1, is connected with a wire 22 and is mounted in a connector as shown in FIGURE 3. In this example, the socket contact 10 is positioned in the insert parts 33 and 35 with the fingers 42 of the retaining device 40 seated against the rearward face of the flange 44. In use of the connector, the pin contact 24 on the plug 34 is axially aligned with the socket contact 10 and when the plug and receptacle are drawn together the pin contact 24 is telescopically inserted into the socket contact 10. As the pin contact 24

enters the socket contact, the contact fingers 66 are first engaged by the pin at the bevelled surfaces 70 which facilitate entrance of the pin contact and minimize the axial loading on the contact fingers. The contact fingers are radially deflected as the pin contact enters the socket contact. The three contact fingers 66 exert equal radial forces on the pin contact and due to the equal angular spacing thereof, the pin and socket contacts tend to remain on center with each other. Each of the three contact fingers exerts a normal force against the pin contact due to the resiliency of the fingers and maintains a good electrical contact therewith. The normal force exerted by the three contact fingers, and hence the axial resisting force against the pin contact, is less than that provided in a socket contact of the same materials and dimensions but having two contact fingers instead of three; additionally the third contact finger enhances the electrical contact. The contact sleeve 12 of this invention having three contact fingers is especially well adapted to fabrication by stamping and rolling as compared to socket contacts with two or four contact fingers, especially where the open seam 46 is disposed diametrically opposite one of the contact fingers.

Claims:

1. Separable electrical connector of the type including first and second connector members with improved contact members for one of the connector members, wherein: each of the connector members (30,34) includes a dielectric insert (32;36); at least one socket contact (10) is mounted in the insert (32) of one of the connector members (30,34) with the socket contact (10) comprising a sleeve (12) of resilient metal having a mating end (18) and a wire receiving end (20) and with the wall of the sleeve (12) defining slots (68) extending axially from the mating end (18) thereby providing contact fingers (66) each extending as a cantilever beam from the ends of the slots (68) and terminating at a free end; and a pin contact (24) corresponding to the socket contact (10) is mounted in the insert (36) of the other of the connector members (30,34) and adapted for telescopic engagement with the mating end (18) of the socket contact (10) when the connector members (30,34) are in mated relationship; characterized in that the slots (68) are three in number and circumferentially equally spaced thereby providing a set of three equally spaced contact fingers (66).

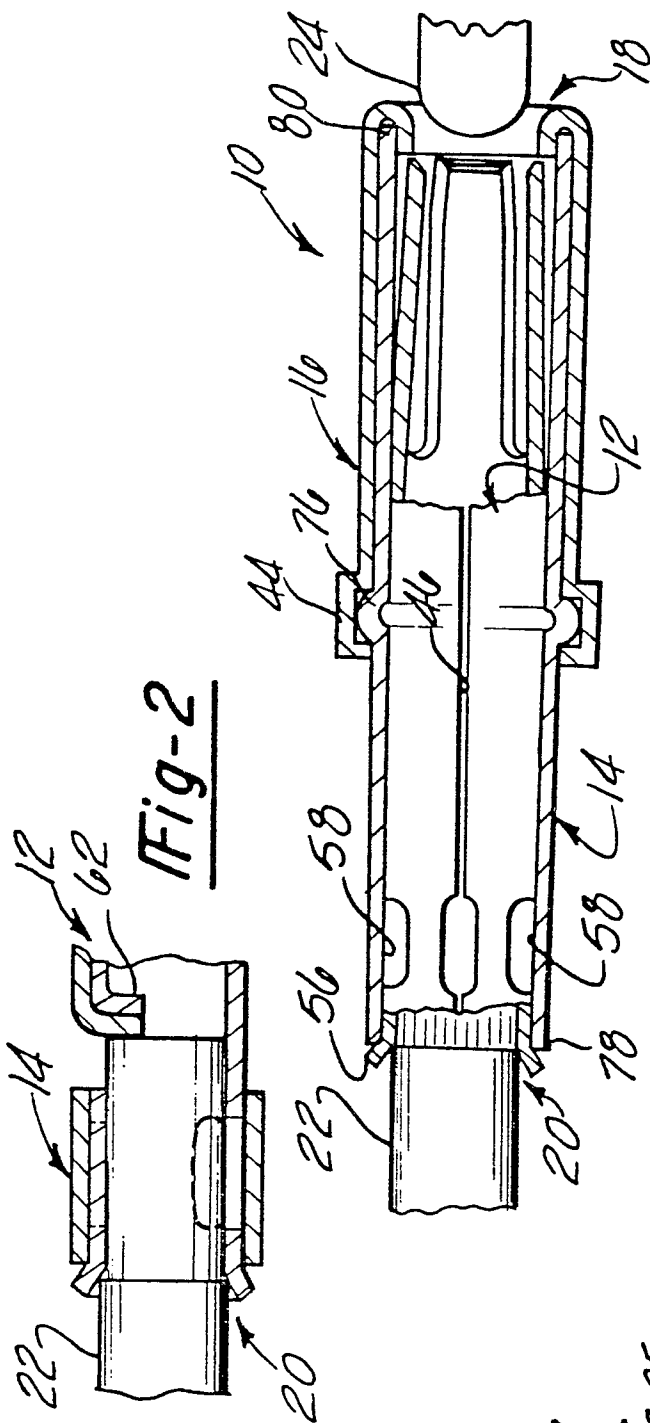
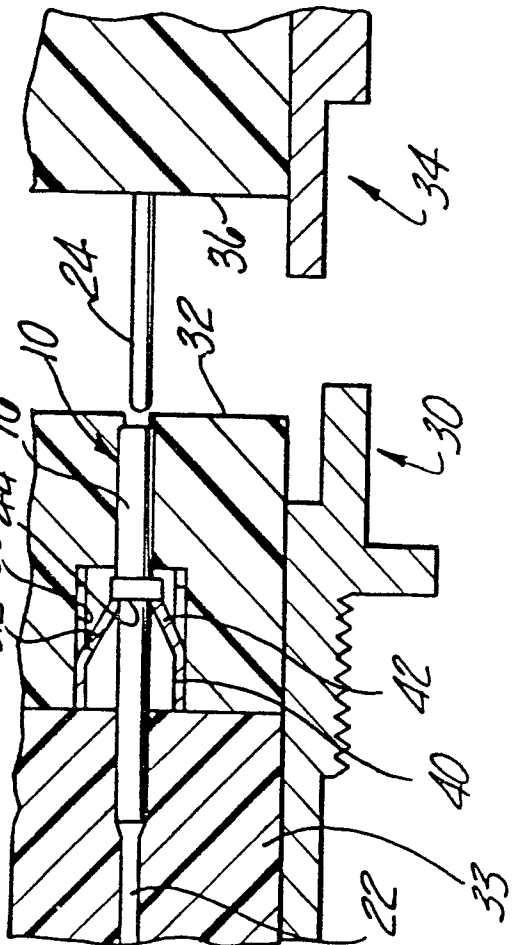
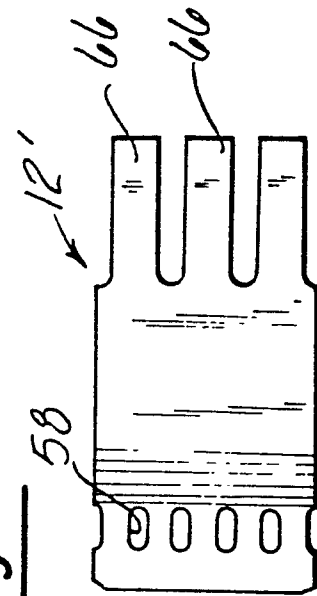
2. Separable electrical connector as claimed in claim 1, characterized in that the contact sleeve (12) has an open seam (46) extending from end to end and one of the slots (68) is in alignment with the seam (46).

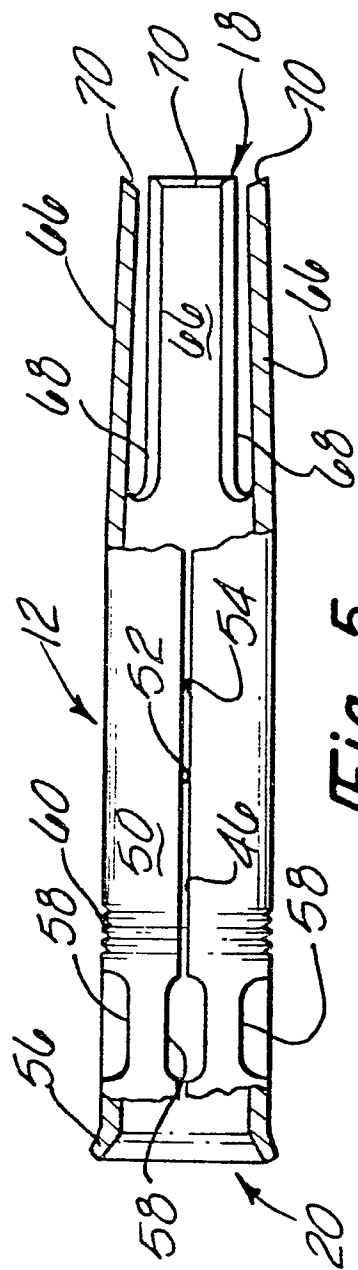
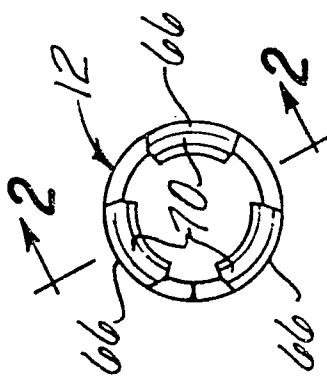
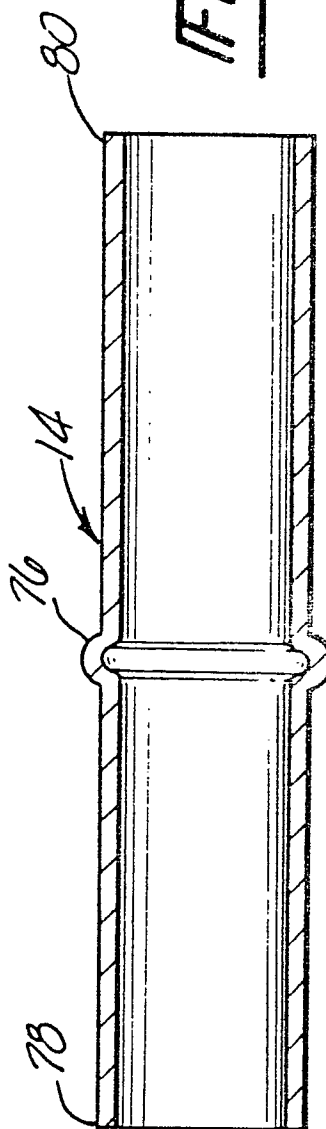
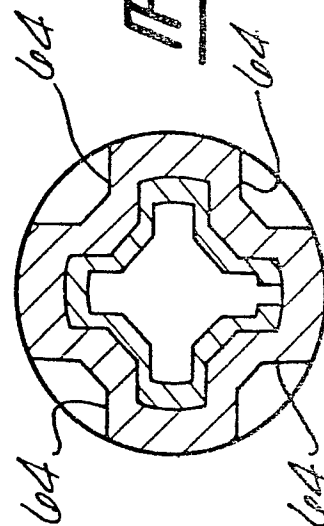
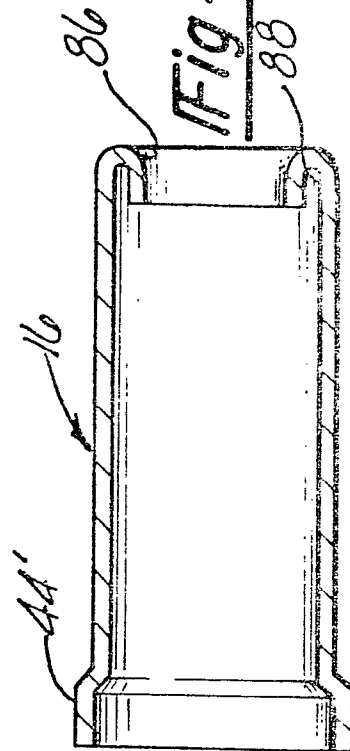
3. Separable electrical connector as claimed in claim 1 or 2, characterized in that there are provided a supporting sleeve (14) in external telescopic relation with the contact sleeve (12), and an outer sleeve (16) in external telescopic relation with the supporting sleeve (14), said outer sleeve (16) including, on the one hand, an inwardly directed bight at the mating end (18) of the contact sleeve (12) in axial alignment therewith and, on the other hand, means (44) for mounting it on the supporting sleeve (14).

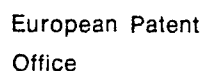
4. Separable electrical connector as claimed in claim 3, characterized in that the supporting sleeve (14) extends from the mating end (18) to the wire receiving end (20), and in that there is provided means (62) for securing
5 the supporting sleeve (14) to the contact sleeve (12) including a finger extending into the contact sleeve (12) adjacent the wire receiving end (20) thereof.

5. Separable electrical connector as claimed in claim 4, characterized in that the contact sleeve (12) terminates in an obliquely extending flange (56) at the wire
10 receiving end (20) and the supporting sleeve (14) is positioned against said obliquely extending flange (56).

6. Separable electrical connector as claimed in claim 5, characterized in that the contact sleeve (12) defines plural openings (58) in the wall thereof adjacent the
15 wire receiving end (20), said openings (58) being spaced circumferentially around the contact sleeve (12) with one opening in alignment with the seam (46) whereby the wall of the supporting sleeve (14) and the wall of the contact
20 sleeve (12) between the openings (58) may be crimped inwardly against a wire (22) disposed in the wire receiving end (20).

Fig-1Fig-2Fig-3Fig-4

Fig-5Fig-6Fig-7Fig-9Fig-8



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