Aug. 27, 1968 W. M. MAKI ETAL 3,399,373

ELECTRICAL CONNECTOR

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Fig.1

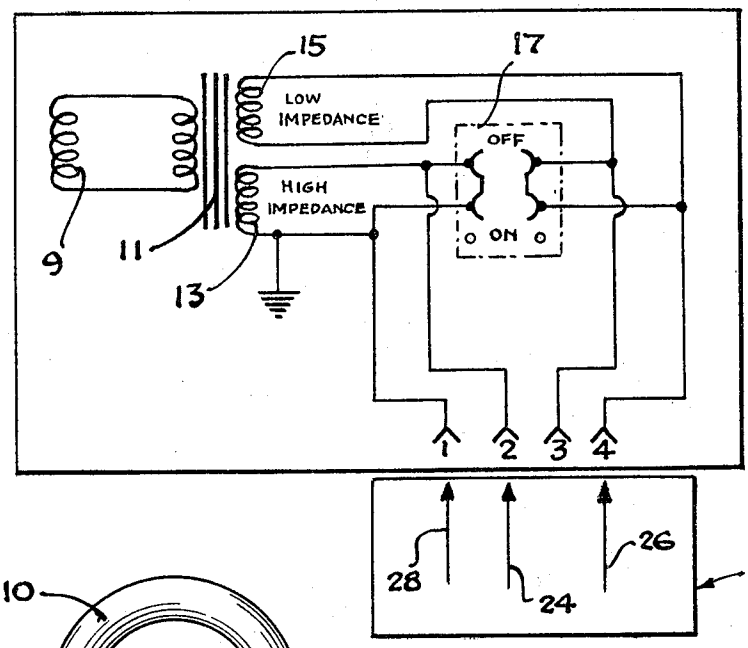
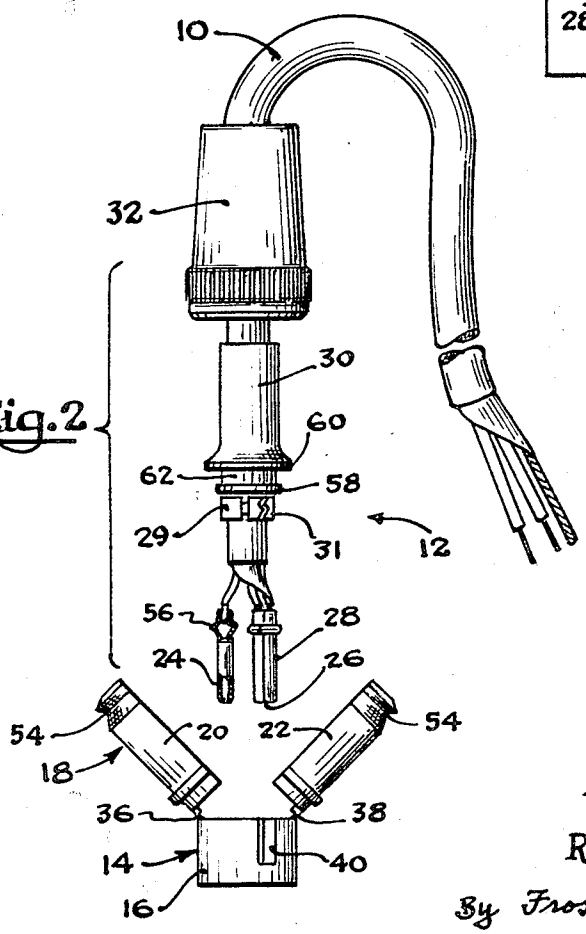


Fig.2



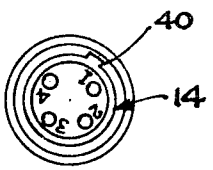


Fig.2A

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ELECTRICAL CONNECTOR

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Fig.3

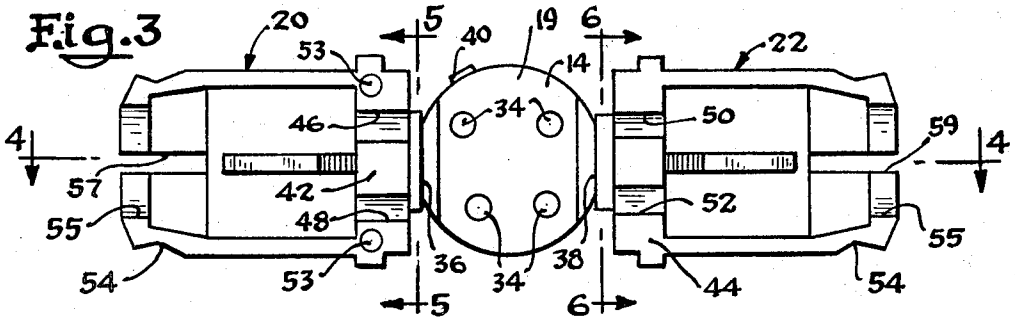


Fig.4

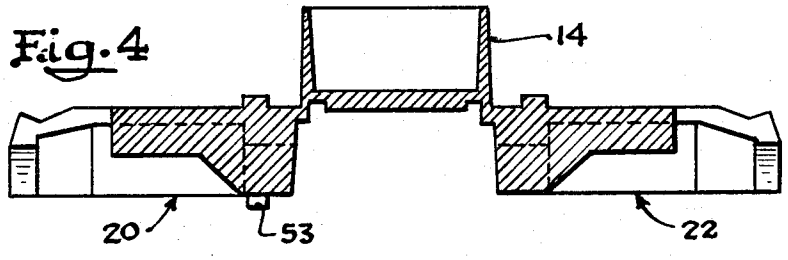


Fig.5

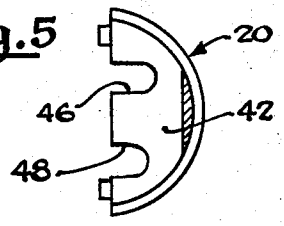


Fig.6

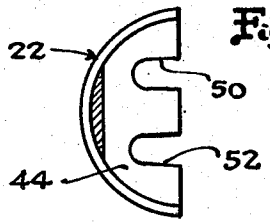


Fig.7

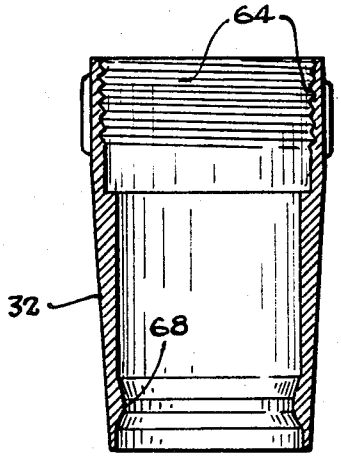


Fig.9

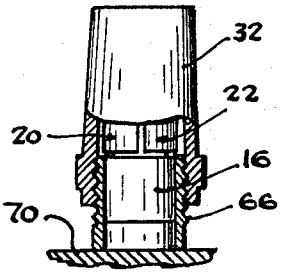
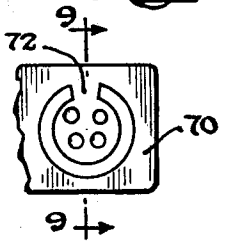


Fig.8



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3,399,373

ELECTRICAL CONNECTOR

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Filed May 17, 1965, Ser. No. 456,428
16 Claims. (Cl. 339—62)

ABSTRACT OF THE DISCLOSURE

This disclosure relates to an electrical cable connector for use on a microphone cable. The connector has an insulating member with a flat portion provided with a plurality of openings for receiving contact elements. The insulating member also has two parts hinged on opposite sides of the flat portion which are adapted to pivot into abutment with each other. A cable extends between and is clamped by the two movable parts, and the wires of the cable are electrically connected to the contact elements. The contact elements are slidable in the openings and are retained in position by means of beads protruding therefrom which are clamped between the flat portion and the two hinged portions of the electrically insulating member.

The present invention relates to an improved electrical cable connector, and particularly to such a connector which is adapted to be used with a microphone.

Most microphones are provided with two electrical outputs, one of the outputs being adapted for coupling to a low impedance input of an amplifier and the other output being adapted to be coupled to a high impedance input of an amplifier. A microphone may be provided with a switch for the purposes of connecting the output terminals of the microphone to either the high impedance output or the low impedance output of the electromechanical transducer, but conventional practice avoids the use of such a switch by simply providing output terminals at a connector on the microphone for both outputs, and the proper output terminals are selected by the cable connector used in association with the microphone connector. A switch is generally not required for selection of the high impedance output terminals or low impedance output terminals because the switch need not and should not be actuated once the microphone has been installed in association with a particular amplifier input, and thus such a switch is costly and undesirable.

Conventially, a microphone is provided with a single connector having four terminals which mates with a cable connector having four terminals. One of the terminals is the ground terminal which is in all cases connected to a shield on the microphone cable, and the ground terminal also serves as one of the high impedance output terminals. The connector has a second terminal which serves as the second high impedance output terminal, and a third and a fourth terminal which serve as the two low impedance output terminals. When the microphone is connected for high impedance output, the shield of the cable is connected to a terminal of a cable connector which will engage the first terminal of the microphone connector when the cable connector and microphone connector are engaged. Also, one of the wires of the cable is connected to a second terminal of the cable connector which engages the second terminal

of the microphone connector, and a third wire of the cable, which need not be connected, is generally electrically connected to a fourth terminal of the cable connector which engages the fourth terminal of the microphone connector. In order to connect the low impedance output of the microphone to the amplifier, the wire of the cable connected to the second terminal of the cable connector is shifted to the third terminal of the cable connector which engages the third terminal of the microphone connector.

Conventional practice for changing the cable connections in order to change the impedance of the microphone impressed upon the input of the amplifier from a high impedance to low impedance is to unsolder the wire in the cable connected to the second terminal of the cable connector and resolder that wire to the third terminal of the cable connector. It is an object of the present invention to provide a cable connector adapted to engage a microphone connector in which one of the wires of the cable may be coupled to either one of two terminals of the microphone connector without disconnecting the terminal of the cable connector from that wire.

It is also an object of the present invention to provide a cable connector which may be assembled on a cable more readily than prior connectors. In accordance with the present invention, a male pin is mechanically attached and electrically connected to each wire of a cable, and the pins are mechanically secured in position within a connector housing, thus avoiding the necessity of soldering or otherwise connecting a plurality of wires to permanently mounted closely spaced terminals of a single connector.

Many electrical connectors are used in environments requiring movement of the cable attached to the connector, and this is particularly true of connectors for microphones. In such applications, the male and female parts of a connector must be mechanically secured in a rigid construction, and a conventional microphone cable connector has an inwardly threaded rotatable housing which engages a protruding outwardly threaded sleeve on a microphone connector. The rotatable housing of a cable connector is an item of substantial cost, since it must be mechanically coupled to the other elements of the cable connector. It is a further object of the present invention to provide a cable connector with a rotatable housing of simpler and less expensive design, particularly such a housing which is mounted on the other elements of the cable connector by a slip fit.

The above and other objects and advantages of the invention will be more readily apparent when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a schematic electrical circuit diagram of a mircophone provided with two different impedance inputs and an electrical connector assembly according to the present invention;

FIGURE 2 is an exploded view of an electrical connector assembly according to the present invention and a portion of a microphone cable attached thereto;

FIGURE 2*a* is an elevational view looking at the contact element end of the electrical connector assembly of FIGURE 2;

FIGURE 3 is an elevational view of the insulating body of the connector of FIGURES 2 and 2*a* in its open position;

FIGURE 4 is a sectional view taken along the line 4—4 of FIGURE 3;

FIGURE 5 is a sectional view taken along the line 5—5 of FIGURE 3;

FIGURE 6 is a sectional view taken along the line 6—6 of FIGURE 3;

FIGURE 7 is a longitudinal sectional view of the connector housing;

FIGURE 8 is a top view of a mating connector unit to which the improved connector unit is adapted to be attached; and

FIGURE 9 is a sectional view taken along the line 9—9 of FIGURE 8, except for the fragment shown in elevation showing the improved electrical connector unit connected to the mating connector of a microphone unit.

The present invention has numerous applications, but it is here described by way of example as a microphone cable connector, an application for which the invention is particularly well suited.

Referring now to the drawings wherein like numerals on the different views identify identical parts, FIGURE 2 shows generally a portion of an electrical cable **10** which is adapted to be attached to a microphone schematically illustrated in FIGURE 1 and an electrical connector unit, designated generally as **12**, at the other end of the electrical cable **10**. The electrical connector **12** is adapted to be connected to a mating connector unit of the microphone, as shown for example in FIGURES 8 and 9.

The microphone schematically illustrated in FIGURE 1 is illustrative and uses a dynamic transducer with a voice coil **9** electrically connected to the primary winding of a matching transformer **11**. The transformer **11** has a high impedance secondary winding **13** and a low impedance secondary winding **15**, windings **13** and **15** being connected to separate output terminals numbered 1, 2, 3 and 4. A switch **17** is also provided to short the secondary windings **13** and **15**.

The electrical connector **12** comprises a member **14** of electrically insulating material which in turn mounts contact elements **24**, **26** and **28**, the contact elements being connected electrically and mechanically to the electrical leads or wires of the cable **10**. The connector **12** also has a strain relief band **29** which is tightly clamped around the cable **10** and a member **30** tightly encompassing the cable **10** but slidable thereon which forms a flex relief for the cable **10**. The connector **12** also is provided with a connector housing **32** into which the body **14** fits in the assembled condition of the connector **12**, as hereinafter described. Strain relief band **29** has a radial tab **31** which is used for a twist relief key.

The electrical connector body **14** preferably is made of a resilient molded plastic material, such as polypropylene. The base **16** of the body **14** as shown in FIGURES 3 and 4, is a cylindrical, cup-like structure having a flat disc shaped end **19** with four cylindrical channels or openings numbered 1, 2, 3 and 4 extending therethrough from a first surface to a second surface parallel thereto for receiving contact elements **24**, **26**, and **28**. These openings are designated as a group by the numeral **34** but are designated individually by numerals 1, 2, 3 and 4 to correspond to the terminals 1, 2, 3 and 4 of the microphone connector of FIGURE 1 and FIGURE 8. The contact elements inserted into openings 1, 2, 3 and 4 are cylindrical pins adapted to make contact with the respective contacts of the female microphone connector to be further described.

The second body portion **18** comprises parts **20** and **22** which are of a substantially semicylindrical tubular shape. Each part **20** and **22** serves as a locking member for a pin and is attached to the first body portion **16** at the outer periphery and on opposite sides of the latter. These attachment points are formed by flexible strips **36** and **38** which effectively form hinges due to the yieldability and flexibility of the plastic molded material used to make the insulating body **14**, thus permitting opening of the parts **20** and **22** to a position as shown in FIGURE 4 and closing them to a position in which the two parts **20** and **22** are substantially a cylindrical tubular extension of the first body portion **16** and in that closed position are adapted to be encompassed by the connector housing **32** in the assembled condition of the connector unit **12**. The first body portion **16** also has a key **40**, integrally molded on the outer periphery thereof, the purpose of which will be hereinafter more fully described.

The parts **20** and **22** of the second body portion are substantially semicylindrical tubular portions respectively having base portions **42** and **44** formed thereon. Base portion **42** of part **20** has slots **46** and **48** formed therein, and the base portion **44** of part **22** has slots **50** and **52** formed therein. These slots are parallel to the axis of revolution of the tubular portions **20** and **22** and adapted to receive a portion of contact elements **24**, **26** and **28** in the assembled condition of the electrical connector unit. One of the parts **20** has formed thereon a pair of spacing studs **53**. Thus when the parts **20** and **22** are folded into their closed position, spaces or gaps are provided between the parts **20** and **22** at the lower end in the vicinity of the studs, and an outward mechanical bias is provided at the oposite ends of the parts **20** and **22** when they are assembled into the connector housing **32**.

The parts **20** and **22** also have a groove **54** formed on the exterior surface at the upper end thereof and a ridge **55** extends radially inwardly from said end, the purpose of which will be hereinafter more fully explained.

It should be particularly noted that the electrical connector insulating body **14**, comprising a first body portion **16** and a second body portion **18**, is preferably an integral molded unit of a yieldable plastic material. It is this insulating body **14** which represents one of the most important features of this invention in that its structure permits the easy insertion of the contact elements **24**, **26** and **28** into the openings **34** of the first body portion **16** and the moving of a particular contact element from one of the openings **34** to another.

Axially extending slots **57** and **59** are formed in the upper ends of the parts **20** and **22** respectively. In the assembled condition of the connector unit **12** on a cable **10** either of these slots is adapted to receive the radially extending projection **31** of the strain relief band **29** which is tightly clamped to the cable. Slots **57** and **59** also allow the lower portion of parts **20** and **22** respectively to move radially inward during assembly into connector housing **32**.

The contact elements **24**, **26** and **28** each have formed thereon a peripheral bead **56** which is slightly larger than the openings **34** in the first body portion **16**. Thus the bead **56** is effective to position the contact elements in the openings **34**.

The flex relief **30** secured about the cable has formed thereon shoulder portions **58** and **60** which define a peripheral groove **62** for receiving the ridge portion **55** on parts **20** and **22** in the assembled condition of the connector unit.

The connector housing **32** is a substantially cylindrical structure which may be made of metal. One end thereof has internal threads formed thereon at **64** for receiving a mating threaded portion **66** (see FIG. 9) of the connector on a microphone unit. At the lower end of the connector housing **32** as viewed in FIG. 7, there is formed a radially inwardly extending bead **68**. In the assembled condition of the connector unit the bead **68** fits into groove **54** on parts **20** and **22**. Thus in the assembly, the insulating body **14** and the cable **10** attached thereto are prevented from relative axial movement with respect to connector housing **32**. In the assembled condition, the connector housing **32** is free to turn on the insulating body in order to secure the connector unit **12** to a mating threaded fitting **66**.

Assembly

In order to assemble the connector unit **12** onto a cable **10**, the connector housing **32** is slipped onto the cable. The

strain relief band **29** is also clamped onto the cable **10** at a prescribed distance from the peripheral beads **56** of the contact elements. The prescribed distance is necessary in order to permit the strain relief band to properly perform its function. The parts **20** and **22** of the insulating body **14** then are unfolded to a position substantially as shown in FIGURE 2, and the contact elements **24**, **26** and **28** are inserted into the proper opening 1, 2, 3 or 4 in the first body portion **16**. A slip fit exists between these openings and the contact elements. The parts **20** and **22** are then folded to a closed position to form in effect a continuous cylindrical structure with the first body portion **16**. In folding the parts **20** and **22**, three of the four slots **46**, **48**, **50** and **52** will closely embrace the three contact elements and the bottom faces of the parts **20** and **22** adjacent to these slots will bear on beads **56** formed on the contact elements. Thus as the parts **20** and **22** are folded to a closed position the contact elements will be respectively pressed through the proper openings **34**. When fully closed the ridge **55** on the parts **20** and **22** will fit into the groove **62** on the flex relief **30**. In addition, the projection **31** on the strain relief band **29** will be fitted into one of the slots **57** or **59** of the part **20** or **22**, or projection **31** can fit within the slot formed between parts **20** and **22**. This connection prevents the cable **10** from twisting with respect to the connector unit. At this time, the connector housing **32**, which was previously placed around the cable, is moved downwardly over the insulating body **14** as viewed in FIGURE 2 until by a hand pull on the cable **10** the ends of the parts **20** and **22** pass over the bead **68** on the inner periphery of the housing **32** to snap the insulating body in place. The bead **68** then fits into the groove **54**. The connector unit **12** is now fully assembled onto the cable **10**.

In the assembled condition, contact element **28**, shown as grounded and connected to shield **11** of the cable **10**, will be in opening 1 of the insulating body **14**; contact element **26** may be inserted into opening 4; and contact element **24** may be inserted into either opening 2 or 3 of the insulating body **14** depending on whether a high or low impedance connection to the microphone is desired.

When the connector unit **12** is plugged into a mating connector unit **70** as shown in FIGURE 9 the key **40** on the first body portion **16** fits into a keyway **72** thus functioning as a polarizing feature to assure the proper connection of the cable leads to the microphone unit.

It will be observed that when the cable has been plugged into the microphone unit that any strain or tension on the cable will be taken by the connector housing through the strain relief band **29** and insulating body **14** which is anchored on the connector housing through the cooperating groove **54** and bead **68** on the connector housing **32** and the strain relief **30**.

As explained at the outset, one of the problems encountered with electrical connectors for microphone cables is that operating conditions experienced in practice require changing the input impedance of the microphone to match the input impedance of the equipment with which the microphone is used. Microphones conventionally provide two electrical outputs of different impedance at the terminals of the microphone, and the connector unit associated with the microphone selects the proper terminals. Heretofore, one of the leads within the electrical connector unit had to be broken from one of the contact elements and resoldered or otherwise connected to another contact element to change the output impedance of the microphone. With the improved electrical connector unit here described, breaking and remaking of soldered connections with all the attendant difficulties is unnecessary. All that is necessary is to disassemble the connector unit by hand without the assistance of any tools, open the insulating body, remove the proper contact element from one opening and place it in another opening, and reassemble. Moving the contact **24** of the connector unit here described from opening 2, as set forth in FIGURE 1, to opening 3, will be effective to change the microphone cable from the high impedance output terminals to the low impedance output terminals of the microphone.

In addition, a connector unit construction has been provided wherein the strain or tension on a cable is all taken by the metal connector housing and not by the cable itself.

While a preferred embodiment of the invention has been specifically disclosed, it is to be understood that the invention is not limited thereto as other variations will be readily apparent to those skilled in the art and the invention is to be given its fullest interpretation within the terms of the following claims.

The invention claimed is:

1. An electrical connector unit for use with an electrical cable having a plurality of electrical leads comprising, in combination: a first insulating body portion adapted to receive a plurality of removable electrical contact elements connected to the leads of an electrical cable; a second insulating body portion comprising a plurality of parts, each part having one end thereof connected to said first body portion and being adapted to assume open and closed positions with respect to each other so that when said parts are in an open position contact elements may be inserted into and removed from said first body portion; contact element retaining means formed on said parts of said second body portion for retaining contact elements in said first body portion when said parts are in a closed position; and a connector housing adapted to telescopically receive said first and second body portions, said connector housing being formed with an inner wall, and cooperating means on said inner wall and the parts of said second body portion for releasably securing said connector housing to said second body portion to prevent relative axial movement therebetween.

2. An electrical connector unit for use with an electrical cable having a plurality of electrical leads comprising the combination of claim **1**, wherein said first body portion is substantially cylindrical in form, and said second body portion comprises a pair of substantially semicylindrical tubular portions which in their closed position substantially form an extension of said first body portion.

3. An electrical connector unit for use with an electrical cable having a plurality of electrical leads comprising the combination of claim **1**, including cable strain relief means attached to the cable and coupled to the connector housing to transfer cable strain to said connector housing.

4. In a cable and electrical connector unit wherein the cable comprises a plurality of electrical leads and contact elements attached thereto the combination comprising:

(a) A cable portion;

(b) An insulating member comprising:

(1) A first insulating body portion adapted to receive a plurality of removable electrical contact elements connected to the leads, and

(2) A second insulating body portion comprising at least two parts, each part having one end thereof connected to said first body portion and adapted to assume open and closed positions with respect to each other so that when said parts are in an open position the contact elements may be easily inserted into and removed from said first body portion;

(c) Contact element retaining means formed on said parts of said second body portion for retaining the contact elements in said first body portion;

(d) Strain relief means secured to said cable, said strain relief means including means engaging said insulating member to prevent twisting of the cable with respect to said insulating member;

(e) Means slidably mounted on said cable for coop-

erating with means on said second body portion for releasably securing the latter two means to each other;

(f) A connector housing for receiving said insulating member and adapted to be attached to a mating connector member;

(g) Means on said connector housing cooperating with means on said second body portion for releasably securing said connector housing and said insulating member to each other.

5. An electrical connector for an electric cable having an electrically conducting wire, said cable connector being adapted to engage a complementary connector unit, comprising, in combination; a base constructed of electrically insulating material having a first and second surface and a channel extending therethrough between the first and second surface; an elongated electrical contact adapted to be mechanically and electrically connected to the wire of the cable having a cross section approximately equal to the cross section of the channel and a protuberance with a cross section greater than the cross section of the channel, said contact being slidably disposed within the channel with the protuberance abutting the first side of the base; a locking member of electrically insulating material disposed adjacent to the first side of the base and mechanically coupled to the base, said locking member being movable relative to the channel of the base and having a surface with a slot extending therein, said slot being aligned with said channel when the locking member is disposed adjacent to the base, said slot having a transverse dimension greater than the cross section of the elongated electrical contact and less than the cross section of the protuberance; and means for anchoring the locking member on the base in a position securing the protuberance between the locking member and the base.

6. An electrical connector for an electric cable having an electrically conducting wire, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 5 wherein the means for anchoring the locking member on the base comprises a rotatable cup-shaped housing disposed about and in abutment with the locking member, said housing being rotatably journaled on the locking members and having a cylindrical mouth disposed on the opposite side of the base from the locking members, the interior surface of the housing having threads extending from the mouth and being adapted to engage the exterior surface of a threaded sleeve of the complementary connector unit.

7. An electrical connector for an electric cable having a plurality of electrically conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising, in combination: a base constructed of electrically insulating material having a plurality of spaced parallel channels extending therethrough from a first surface to a second surface; a separate elongated electrical contact adapted to be mounted on and electrically connected to each of the wires of the cable, each of said contacts having an axis of elongation greater than the length of the channels and a cross section approximately equal to the cross section of the channels, each of said contacts having a protuberance with a cross section greater than the cross section of the channels, each of said contacts being disposed in a channel with the protuberance of the contact abutting the first surface of the base; a locking member of electrically insulating material disposed adjacent to said first surface of the base and mechanically coupled to the base, said locking member having a first surface confronting the axis of a channel and a second surface extending from the first surface and confronting the first surace of the base, said first surface of the locking member being movable relative to said channel of the base, said locking member having a slot in the first surface thereof extending into the second surface thereof and confronting the axis of said channel, said slot extending into the first surface along the axis of movement and said slot having dimensions transverse to the axis of movement greater than the cross section of the connector and less than the cross section of the protuberance; and means for anchoring the locking member on the base in a position securing the protuberance between the locking member and the base.

8. An electrical connector for an electric cable having a plurality of electrically conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 7 wherein the channels are cylindrical and the contacts are straight pins which protrude from the second surface of the base.

9. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 7 wherein at least two locking members are employed, each of said locking members having a first surface confronting a different channel of the base.

10. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 9 wherein the first surface of each locking member is generally normal to the second surface thereof.

11. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 9 wherein each locking member is pivotally mounted on the base by a hinge extending from the second surface of the locking member remote from the first surface of the locking member.

12. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 11 wherein the base and locking members are an integral plastic structure, each locking member being joined to the base by a hinge in the form of a flexible strip.

13. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 12 wherein the locking members collectively form an exterior surface of revolution, said surface having an annular groove on a plane normal to the axis of revolution, and the anchoring means comprises a member defining a ring disposed within the groove.

14. An electrical connector for a cable having a plurality of electrical conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 13 wherein the member defining a ring comprises a housing disposed about the locking means having an inwardly extending circular rib disposed in the groove of the surface of revolution of the locking members, said housing being rotatably journaled on the locking members and having a cylindrical mouth disposed on the opposite side of the base from the locking members, the interior surface of the housing having threads extending from the mouth and being adapted to engage the exterior surface of a threaded sleeve of the mating contact unit.

15. An electrical connector for an electric cable having a plurality of electrically conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 7 wherein the base com-

prises a generally flat disc which is provided with at least one more channel than wires of the cable, whereby the electrical contacts may be moved between channels to change the electrical connections to the complementary connector unit.

16. An electrical connector for an electric cable having a plurality of electrically conducting wires insulated electrically from each other, said cable connector being adapted to engage a complementary connector unit, comprising the combination of claim 7 wherein each of the electrical contacts comprises an elongated cylindrical pin of electrically conducting material and the protuberance on said contact comprises a circular outwardly extending ridge extending about the pin adjacent to one end thereof.

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RICHARD E. MOORE, *Primary Examiner.*