July 7, 1970 H. J. PROW, JR., ET AL 3,519,975

ELECTRICAL CONNECTOR

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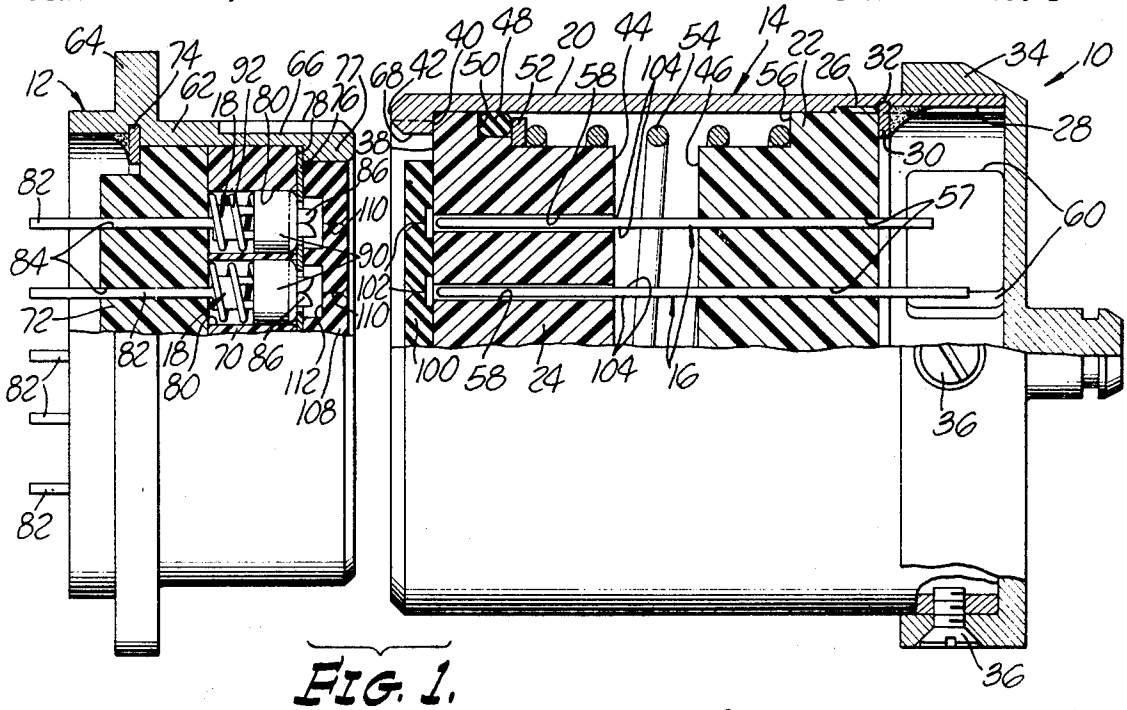

FIG. 1.

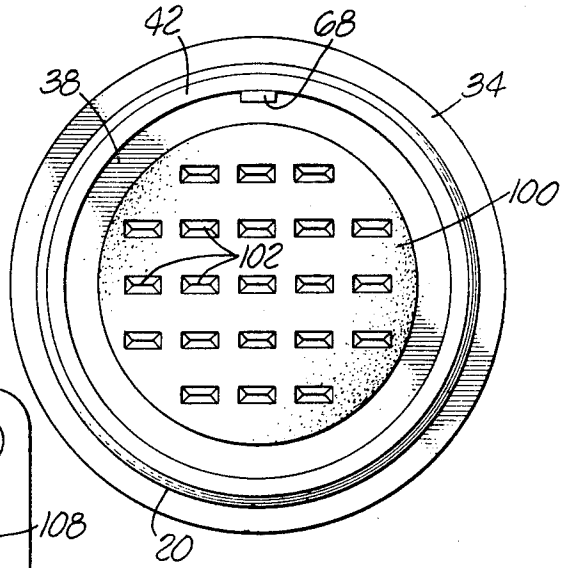

FIG. 2.

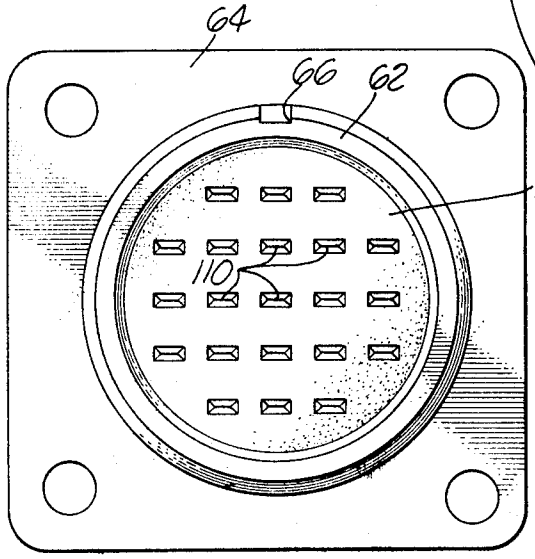

FIG. 3.

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FIG. 4.

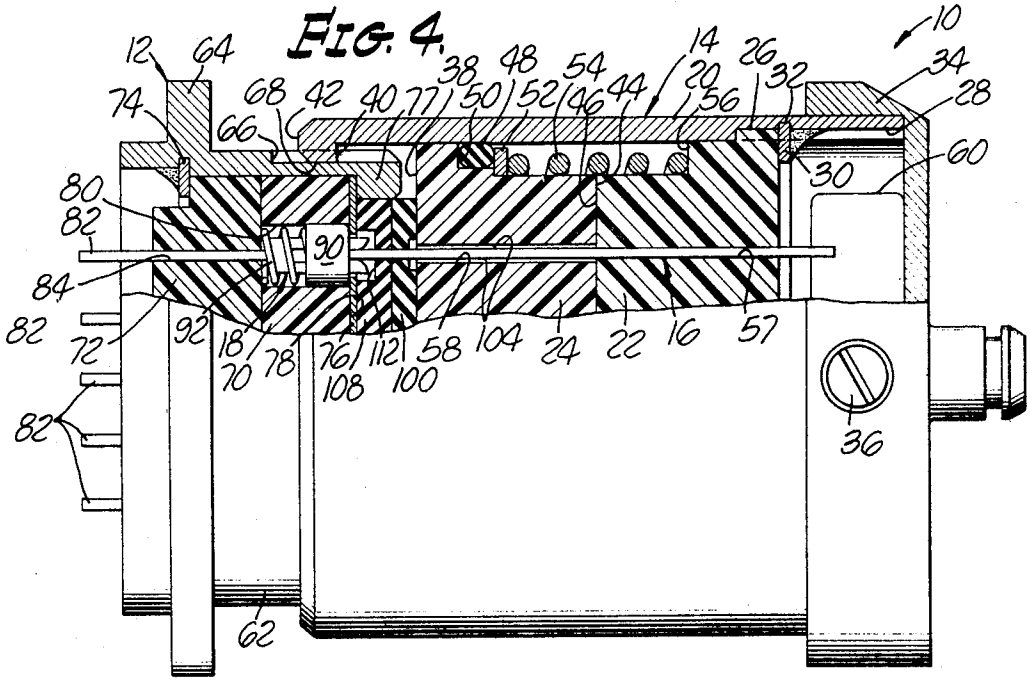
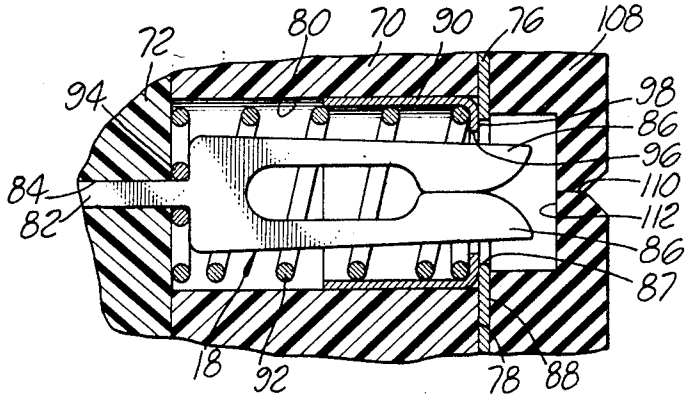


FIG. 5.



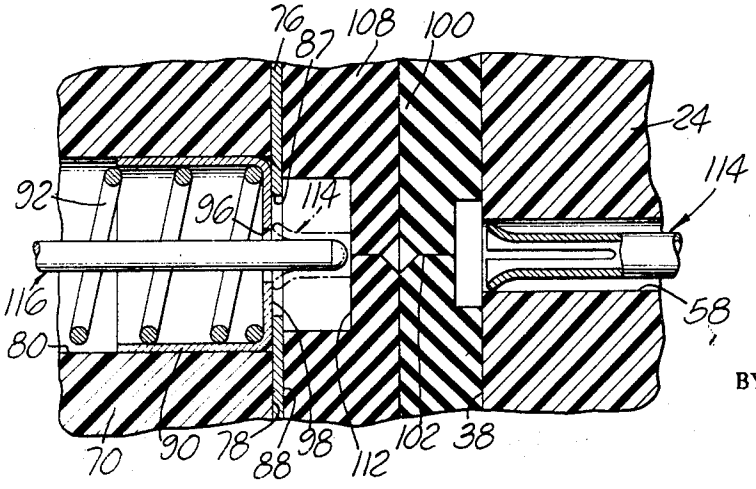


FIG. 8.

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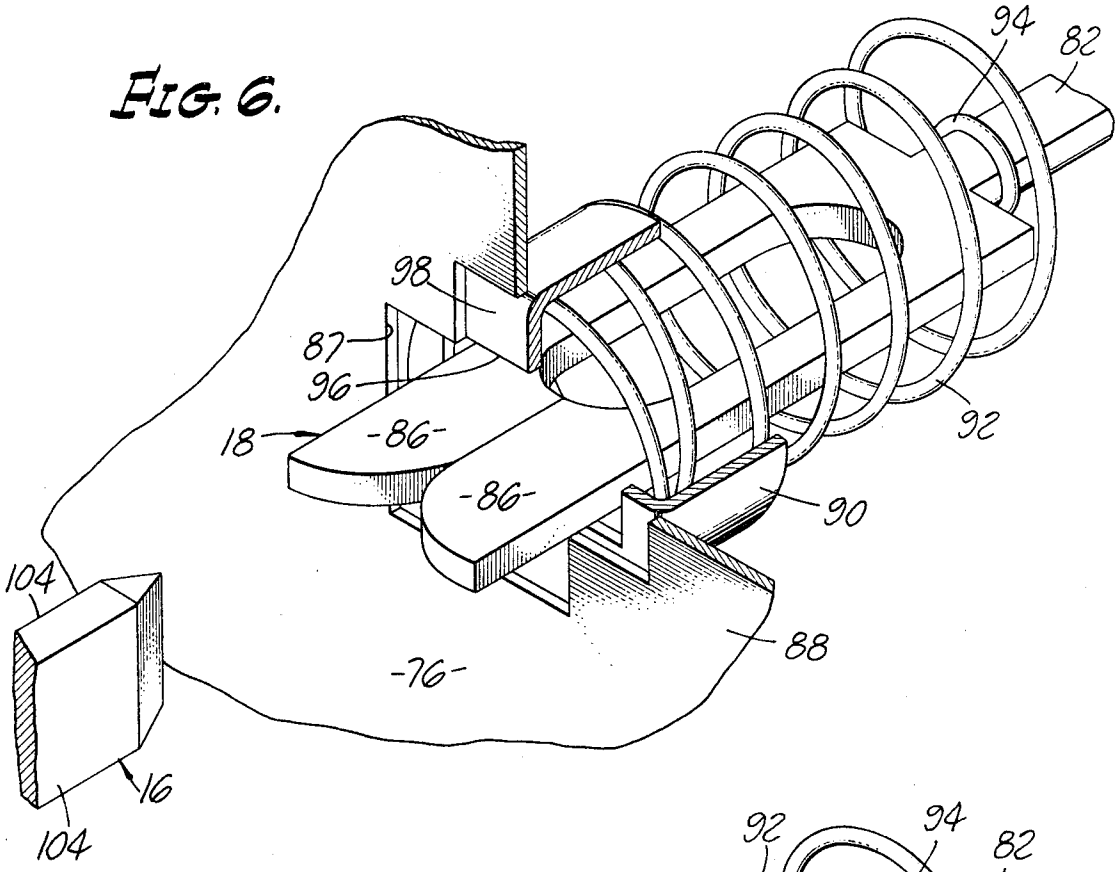
FIG. 6.



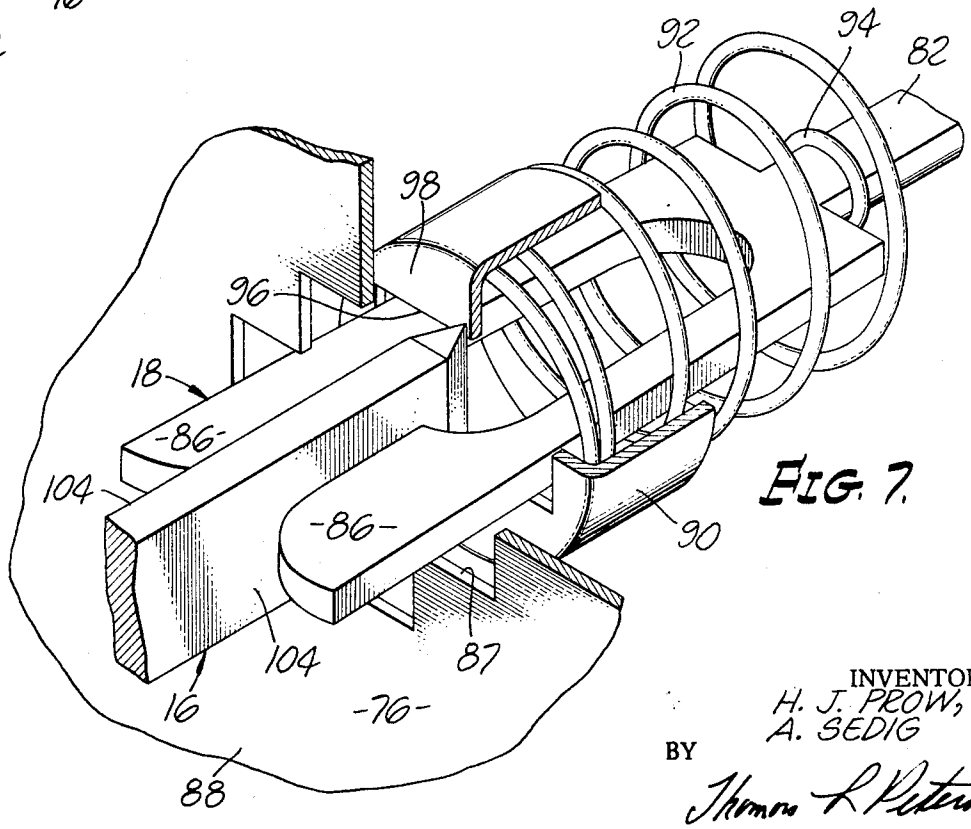


FIG. 7.

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United States Patent Office 3,519,975 Patented July 7, 1970

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ELECTRICAL CONNECTOR

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Int. Cl. H01r 3/06
U.S. Cl. 339—14 10 Claims

ABSTRACT OF THE DISCLOSURE

An electrical connector comprising interengageable receptacle and plug members carrying a plurality of axially aligned contact elements which complete a series of electrical circuits through the connector when the members are interengaged. Means are provided for automatically unshorting the receptacle contact elements when the connector members are interengaged and for automatically grounding or shorting said elements when the connector members are disengaged. In addition, means are provided for completely sealing the forward faces of both of the connector members when the latter are disengaged to prevent contamination of the interior of the connector members by moisture, dust, etc., in the atmosphere.

Background of the invention

This invention relates to an electrical connector and, more particularly, to an umbilical electrical connector that includes a plug member engageable with a receptacle member to complete a plurality of electrical circuits through the connector.

Umbilical electrical connectors have a number of uses and one of the most prominent is the use of such connectors with remotely controlled large aircraft including missiles, rockets, airplanes, target drones, and the like. Also, umbilical electrical connectors are employed with artillery type rockets, helicopter launched rockets, as well as with ground captive vehicles such as land sleds, etc. It is an important requirement in the use of these umbilical electrical connectors for the aforementioned applications that the receptacle contact elements be grounded when the connector members are disengaged and that the receptacle contact elements be unshorted when the receptacle members are interengaged. This function has been accomplished in the past by the deflection of a peripheral flat spring in the receptacle connector member upon interengagement therewith of the plug connector member, with the deflection of the spring causing depression of a common central shorting member for the receptacle contact elements. In these connectors, normally only peripheral seals are provided at the forward face of the connector members for preventing the interior of the connector members from being contaminated by moisture, dust, or other constituents of the environment in which the connector is employed. These connectors have had the disadvantage that their receptacle contact elements are easily exposed and unshorted when the connector members are disengaged thus creating a possible hazard to operators utilizing the connectors. Also, since the receptacle contact elments are shorted or unshorted through a common central shorting member, on occasion not every one of the receptacle contact elements is completely and positively shorted or unshorted upon disengagement and interengagement, respectively, of the connector members. Furthermore, since the connector members are merely sealed by peripheral sealing rings, the interior of the connector members have been subject to contamination by moisture and dust. Thus, what is needed and constitutes the principal object of the present invention is to provide an umbilical type electrical connector which employs means for positively and reliably shorting and unshorting of the receptacle contact elements upon disengagement and interengagement, respectively, of the connector members and which is provided with sealing means that effectively prevents contamination of the connector members by moisture and dust both when the connector members are engaged and disengaged.

Summary of the invention

According to a principal aspect of the present invention, there is provided an electrical connector comprising interengageable receptacle and plug members carrying axially aligned contact elements which complete an electrical circuit through the connector when the members are interengaged. A grounding plate having an aperture axially aligned with the contact elements is mounted on a forwardly facing portion of the receptacle member. A movable grounding device electrically connected to the receptacle contact member is normally urged into engagement with the grounding plate so that the contact element is grounded or shorted when the connector members are disengaged. Engaging motion of the plug connector member toward the receptacle connector member causes the plug contact element to extend through the aperture in the grounding plate and engage the grounding device, thereby pushing the latter away from the grounding plate and unshorting the receptacle contact element. Thus, when the connector members are fully mated, an electrical circuit is completed through the connector with the receptacle contact element positively and reliably unshorted due to the displacement of the shorting device by the plug contact element. When the connector members are disengaged, the grounding device re-engages the grounding plate, thereby automatically grounding the receptacle contact element.

According to another aspect of the invention, elastomeric facial seals are provided on the forward faces of the receptacle and plug members of an electrical connector constructed in such a manner that the contact elements in the connector members are positioned behind the respective seals when the members are disengaged. These facial seals are provided with slits which are axially aligned with the contact elements in the two connector members. The elasticity of the facial seals causes the slits to be closed, thereby preventing moisture, dust, or other contaminants from entering the interior of the connector members when the latter are disengaged. Upon engaging motion of the plug member toward the receptacle member, the contact element in the plug member extends through the slits in the facial seals to engage the contact element in the receptacle member. At this time, the walls of the slits seal against the surface of the plug contact element. Thus, the faces of the connector members are automatically and completely sealed when the two members are disengaged, and the facial seals provide effective sealing of the faces of the two connector members when the latter are disengaged.

Brief description of the drawings

FIG. 1 is an exploded partial longitudinal section of the connector of the present invention, showing the receptacle connector member and plug connector member disengaged from each other;

FIG. 2 is an elevational view of the front end of the plug connector member;

FIG. 3 is an elevational view of the front end of the receptacle connector member;

FIG. 4 is a partial longitudinal section of the connector, showing the receptacle and plug connector members interengaged;

FIG. 5 is an enlarged, fragmentary, partial longitudinal section illustrating the details of construction of the self-

shorting and unshorting arrangement for the receptacle contact element used in the connector illustrated in FIGS. 1–4;

FIG. 6 is an enlarged, exploded perspective view of the contact elements employed in the connector illustrated in FIGS. 1–5, with a portion of the grounding plate broken away to show the construction of the self-shorting and unshorting arrangement for the receptacle contact element and with the elastomeric seal being removed for clarity, the contact elements being shown in disengaged position;

FIG. 7 is an enlarged perspective view similar to FIG. 6 but showing the contact elements in interengaged position; and

FIG. 8 is an enlarged, fragmentary, partial longitudinal section through a modified form of an electrical connector, showing in detail the construction of the contact elements therein and their relationship to the shorting elements and facial seals therefor.

Description of the preferred embodiments

Referring now to the drawings in detail, and first, particularly to FIG. 1, there is shown an electrical connector, generally designated **10** including a receptacle member **12** and plug member **14**.

The plug member contains a plurality of blade contact elements or terminals **16** and the receptacle member contains a corresponding number of tuning fork contacts or terminals **18**, the connector members being so designed that when joined together, the contact elements of the plug member will mate with the respective tuning fork contacts of the receptacle member to provide a multiplicity of independent electrical circuits. It is to be understood, of course, that contact elements of other forms may be employed as will become apparent later in the description.

The plug connector member comprises a shell **20** having a rear insulation body **22** and a front insulation body **24**. The rear insulation body **22** is provided with an outwardly extending polarizing key **26** which engages in an axially extending keyway **28** in the inner surface of the shell **20** for properly angularly positioning the body **22** in the shell. Rearward movement of the body **22** in the shell is prevented by a retainer ring **30** fixedly secured in an annular groove **32** in the inner surface of the shell. The rear end of the shell is closed by a suitable cap **34** which is fixed to the shell by means of a plurality of screws **36**.

The front insulator body **24** is slidable axially in the shell **20** between the position shown in FIG. 1, wherein the forward face **38** of the body engages the rear surface **40** of an inwardly extending annular flange **42** at the forward end of the shell **20**, to a position shown in FIG. 4 in which the rear surface **44** of the front insulation body **24** engages the front surface **46** of the rear insulation body **22**. An elastomeric O-ring **48** is positioned in an annular recess **50** in the outer surface of the insulation body **24** providing a seal between the body and the inner surface of the shell **20**. The O-ring **48** is retained in the recess by means of a retaining ring **52**. The front insulation body **24** is normally urged forwardly into the position illustrated in FIG. 1 by means of a coil spring **54** interposed between a forwardly facing shoulder **56** on the rear insulation body **22** and the retaining ring **52** on the front insulation body.

The blade contacts **16** are fixedly mounted in axially extending passages **57** in the rear insulation body **22** while the forward contacting portion of the blade contacts **16** extend through axially extending passages **58** in the front insulation body **24**; the passages **58** are aligned with the passages **56** in the rear insulation body. There is sufficient clearance between the contact elements **16** and the passages **58** in the front insulation body to permit sliding movement of the body with respect to the contact elements. The rear portion of the contacts **16** are connected to terminals **60**, to which are connected the conductors of an electrical cable, not shown, or other support to receive the plug member. A polarizing keyway **66** is formed in the outer forward surface of the shell **62**. This keyway is engaged by a complementary key **68** formed in the inner surface of the flange **42** on the shell **20** to inusre proper orientation of the two connector members upon interengagement.

A front insulation body **70** and rear insulation body **72** are mounted in the shell **62** of the receptacle. Rearward movement of the two bodies is prevented by a retainer ring **74**. A metallic grounding plate **76** is positioned adjacent to the forward face **78** of the front insulation body **70** and is electrically bonded at its outer periphery to an inwardly extending annular flange **77** on the forward end of the shell **62**.

The tuning fork contacts **18** in the receptacle are positioned in axially extending cylindrical cavities **80** in the front insulation body **70**. The bases **82** of the tuning fork contacts are fixedly mounted in apertures **84** in the rear insulation body **72**. The forward bifurcated ends **86** of the tuning fork contacts extend forwardly through cross-shaped clearance holes **87** in the grounding plate **76** and beyond the forward surface **88** of the plate, as best seen in FIGS. 5–7. A metallic grounding cup **90** is positioned in each cavity **80** and is biased into engagement with the grounding plate **76** by means of a coil spring **92**. The coil spring surrounds the tuning fork contact and is electrically connected to the base **82** thereof by a rear coil convolution **94** as best seen in FIG. 5. A generally rectangular aperture **96** is formed in the bottom or base **98** of the grounding cup **90** through which the forward portion **86** of the tuning fork contact extends. The dimensions of the aperture **96** are such that when a blade contact **16** engages in the bifurcated end **86** of a tuning fork contact, the end of the blade contact will engage the bottom **98** of the cup, as best seen in FIG. 7, to effect displacement of the cup away from the grounding plate **76**.

The front face **38** of the front insulation body **24** of the plug is covered with an elastomeric seal **100**, which may be bonded to the insulation body by a suitable epoxy or cement. Preferably the seal is formed of silicone rubber, it being understood of course that other elastomeric sealing material may be employed. The seal is formed with a plurality of parallel generally elongated slits **102** which are in axial alignment with the blade contacts **16** and are arranged so that the upper and lower surfaces **104** of the blade contacts will engage the opposed walls of the slits upon rearward movement of the front insulation body **24** in the shell **20**.

A second elastomeric facial seal **108** is bonded to the front face of the grounding plate **76**. This seal is also formed with a plurality of slits **110** which are positioned in a pattern identical to the slits **102** in the facial seal **100** and are of the same configuration. Recesses **112** are formed in the rear portion of the elastomeric seal **108** in axial alignment with the tuning fork contacts **18**. The forward ends **86** of the tuning forks extend into these recesses as best seen in FIG. 5.

When the plug and receptacle connector members are disengaged, the walls of the slits **102** and **110** in the elastomeric facial seals **100** and **108**, respectively, are closed in sealing relationship due to the elasticity of the seals. When the connector members are interengaged, the walls of the slits **102** and **110** seal against the flat upper and lower surfaces **104** of the blade contacts. Thus, whether the connector members are interengaged or disengaged, the facial seals prevent moisture, dust, and other elements in the surrounding environment from contaminating the interior of the connector members.

When it is desired to connect the plug connector member **14** to the receptacle connector member **12**, the plug member is positioned against the receptacle member with the key **68** on the plug engaging the polarizing keyway

66 of the receptacle and the environmental facial seals 100 and 108 are brought into contact. Engaging motion of the plug member toward the receptacle member causes the forward insulation body 24 in the plug member to shift rearwardly against the force of spring 54, causing the blade contacts 16 to extend through the slits 102 and 110 of the facial seals 100 and 108, respectively, the walls of the slits remaining in sealing relationship with the surfaces of the blade contacts. After the blade contacts pass through the interfacial seals, they make electrical contact with the mating tuning fork contacts, as best seen in FIG. 7. As each blade contact passes through its respective clearance hole 87 in the grounding plate and encounters the grounding cup 98, it pushes the grounding cup away from the plate to automatically unshort the tuning fork contacts in the receptacle connector member. When the connector members are fully mated, all blade contacts are electrically mated to the respective tuning fork contacts with all circuits ungrounded due to the displacement of the grounding cups 90 by the blade contacts. The connector members are retained in their fully interengaged position by a suitable locking mechanism, not shown.

When the mating pressure on the plug member is released, the spring loaded front insulation body 24 will force the plug member out of engagement with the receptacle member, thereby withdrawing the blade contacts from the tuning fork contacts and breaking the electrical circuit through the connector. As the blade contacts are withdrawn from the receptacle, the grounding springs 92 bias the grounding cups back into contact with the grounding plate 76 to ground all the receptacle contact elements. With the connector members fully disengaged, the resilient walls of the slits in the facial seals 100 and 108 return to their closed seals relationship to thereby provide a complete sealing face for the electrical contacts in each of the connector members.

Thus, it is seen that by the present invention there is provided means for self-sealing of the faces of the two connector members and for automatically and positively unshorting each receptacle contact element individually as the connector members are interengaged and for shorting or grounding each receptacle contact element after the connector members are disengaged.

While it is preferred that the contact elements employed in the connector of the present invention have the configuration shown in FIGS. 1 and 4–7, namely, as tuning fork and blade contacts, since the blade contacts cause a minimum displacement of the facial seals thus minimizing the stresses of the sealing material, it is understood that the contact elements may take other forms. For example, as seen in FIG. 8, the plug contact elements 114 may be female members having a generally cylindrical configuration while the receptacle contact elements 116 may be male members in the form of cylindrical rods which are slidable within the cylindrical plug contact elements upon interengagement of the connector members. In this embodiment of the invention, it is necessary that the diameter of the plug contact elements be smaller than the apertures 96 in the grounding plate 76 but sufficiently large so as to contact the bottom of the grounding cup 98 upon interengagement of the connector members so that the grounding cup will be displaced rearwardly from the grounding plate when the connector members are interengaged.

It will be noted that in the connector of the present invention, as seen by the two embodiments illustrated in the drawings, the contact elements in the plug and receptacle members may be of either male or female configuration. Hence, the terms "plug contact element" and "receptacle contact element" are intended to designate either a male or female contact employed in the plug member and receptacle member, respectively.

Although we have herein shown and described our invention in what is conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of our invention, which is not to be limited to the details disclosed herein.

What is claimed is:

1. An electrical connector comprising: interengageable receptacle and plug members, each member having an insulation body; a pair of complementary axially aligned contact elements mounted in the bodies respectively and adapted to complete an electrical circuit throught the connector when one contact element is connected to the other by interengagement of said members; a grounding plate on the forward face of the body of said receptacle member, said plate having an aperture therein axially aligned with said contact elements; movable grounding means electrically connected to the contact element in said body of said receptacle member and engaging the rear surface of said grounding plate; said grounding means being displaced from said grounding plate by the contact element in the plug member upon interengagement of said members, and said grounding means reengaging said grounding plate upon disengagement of said members.

2. An electrical connector as set forth in claim 1 including elastomeric seals on the forward face of said grounding plate and on the forward face of the body of said plug member; slits formed in said seals axially aligned with said contact elements, the plug contact element extending through said slits upon interengagement of said members, and the walls of said slits closing in sealing relationship when said members are disengaged.

3. An electrical connector as set forth in claim 1 in which there are provided a plurality of said pairs of contact elements in said bodies, and said movable grounding means comprising a plurality of individual grounding devices connected to respective contact elements in said body of said receptacle member.

4. An electrical connector as set forth in claim 1 wherein said grounding means includes means biasing a portion of said grounding means into engagement with said grounding plate.

5. An electrical connector as set forth in claim 1 wherein said grounding means comprises a movable grounding element and spring means; and spring means being connected to said receptacle contact element and urging said grounding element into engagement with said grounding plate; and said grounding element being spaced from said receptacle contact element and including a forward wall dimensioned as to be engaged and thereby retracted from said grounding plate by the plug contact element upon interengagement of said members.

6. An electrical connector as set forth in claim 1 wherein said grounding means comprises a cup and a coil spring, said cup having its base adjacent to said grounding plate, said base having an opening therein through which said receptacle contact element extends; said coil spring having one end attached to said receptacle contact element and its other end extending into said cup to abut against the base thereof thereby biasing said cup base into engagement with said grounding plate; and the walls of said base adjacent to said opening therein being spaced from said receptacle contact element but said opening being sufficiently small so that said walls will be engaged by the plug contact element upon interengagement of said members.

7. An electrical connector as set forth in claim 6 wherein said receptacle contact element extends forwardly beyond the forward face of said grounding plate so as to be engaged by the plug contact element prior to engagement of said latter contact element with said cup base.

8. An electrical connector as set forth in claim 3 wherein said insulation body of said plug member includes a fixed portion and a movable portion, means biasing said movable portion away from said fixed portion and toward the forward end of the plug member; said contact

elements in said plug member being fixedly mounted in said fixed portion and extending into axially extending passages in said movable portion in sliding relationship therewith; elastomeric seals on the forward faces of said grounding plate and said movable portion of said plug insulation body; the forward ends of the contact elements in each of said members being disposed behind the forward faces of said seals when said members are disengaged; slits formed in said seals axially aligned with respective pairs of said contact elements; and said movable portion being shifted rearwardly to extend the forward ends of said plug contact elements through said slits in said seals to effect engagement thereof with the respective receptacle contact elements upon interengagement of said members, and the walls of said slits closing in sealing relationship when said members are disengaged.

9. An electrical connector as set forth in claim **8** wherein said insulation body of said receptacle member is formed with a plurality of axially extending cavities each receiving a receptacle contact element therein, said cavities extending to said grounding plate; each individual grounding device comprising a movable grounding element and spring means positioned in a respective cavity; said spring means being connected to the receptacle contact element in said cavity and urging said grounding element into engagement with said grounding plate; and said grounding element being spaced from the receptacle contact element in said cavity and including a forward wall dimensioned so as to be engaged and thereby retracted from said grounding plate by the mating contact

element in said plug member upon interengagement of said members.

10. An electrical connector as set forth in claim **9** wherein each grounding element is a cup having its base adjacent to said grounding plate and said spring means is a coil spring surrounding said receptacle contact element in said cavity; said base having an opening therein through which said receptacle contact element extends; said coil spring having one end attached to said receptacle contact element and its other end extending into said cup and abutting against the base thereof biasing said cup base into engagement with said grounding plate; and the walls of said base adjacent to said opening therein being spaced from said receptacle contact element, but said opening being sufficiently small so that said walls will be engaged by the mating contact element in said plug member upon interengagement of said members.

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