United States Patent [19]

Clark

[11] **3,892,458**

[45] **July 1, 1975**

[54] **COUPLING FOR ELECTRICAL CONNECTOR OR THE LIKE**

[75] Inventor: **Kenneth M. Clark**, Beaumont, Calif.

[73] Assignee: **The Deutsch Company Electronic Components Division**, Banning, Calif.

[22] Filed: **Dec. 26, 1973**

[21] Appl. No.: **427,801**

Related U.S. Application Data

[60] Continuation of Ser. No. 347,821, April 4, 1973, abandoned, which is a division of Ser. No. 167,317, July 29, 1971, Pat. No. 3,727,172, which is a continuation-in-part of Ser. No. 83,782, Oct. 26, 1970, abandoned.

[52] **U.S. Cl.** ..... **339/90 R**; 339/DIG. 2

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

[58] **Field of Search** 339/89, 90, 187, 188, 189, 339/DIG. 2

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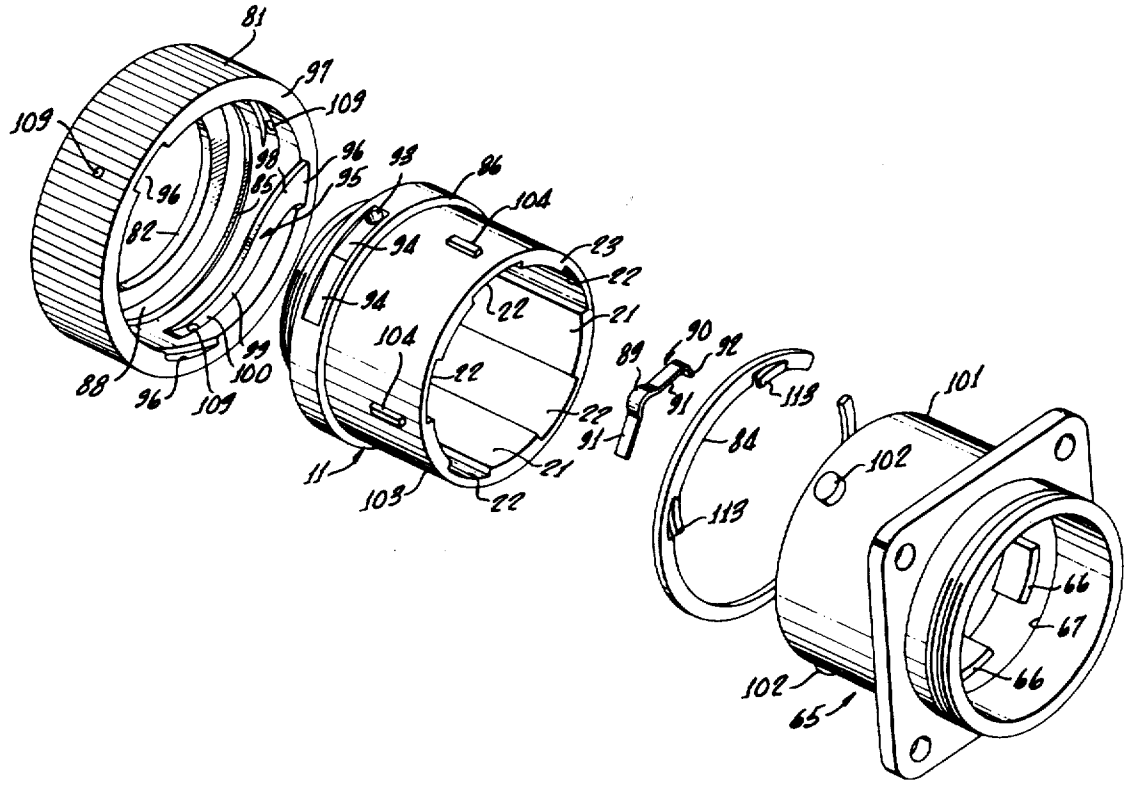
Primary Examiner—Joseph H. McGlynn
Attorney, Agent, or Firm—Gausewitz, Carr & Rothenberg

[57] **ABSTRACT**

An electrical connector that includes a plug and receptacle which are held together by a bayonet coupling that includes pins on the receptacle which enter grooves in a rotatable but axially fixed coupling ring around the plug shell, the bayonet grooves including inner portions that fall within a radial plane and have no forwardly inclined recesses at their inner ends. A detent to prevent inadvertent rotation of the coupling ring after the connector has been mated is provided by a leaf spring which is carried by the plug shell and has an outwardly projecting portion adapted to enter a recess in the inner wall of the coupling ring.

1 Claim, 24 Drawing Figures



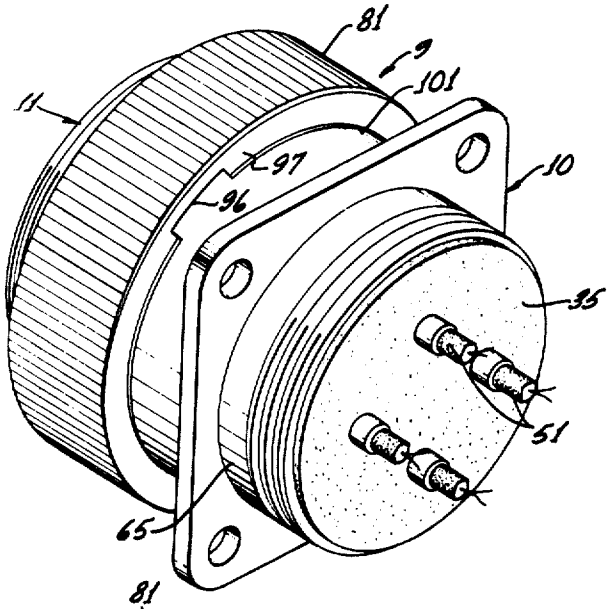

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FIG. 1.

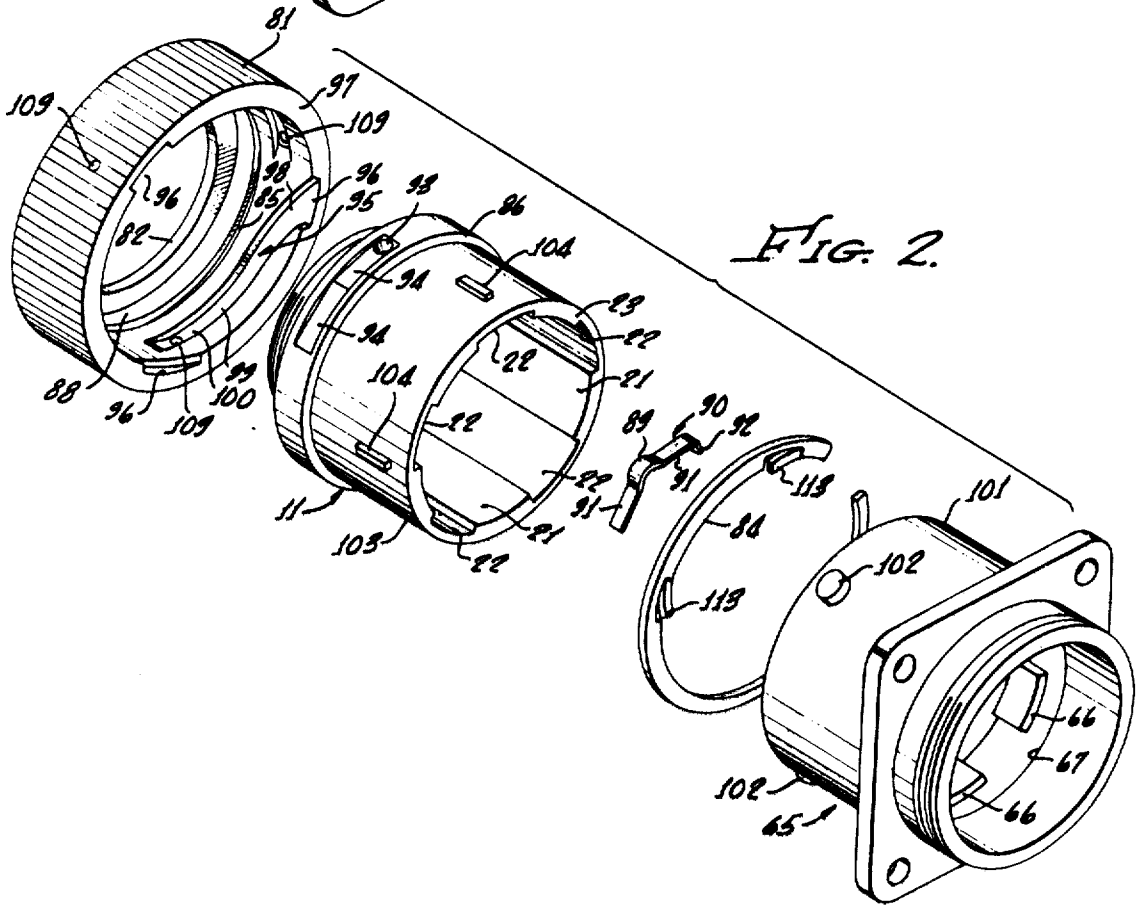
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FIG. 2.

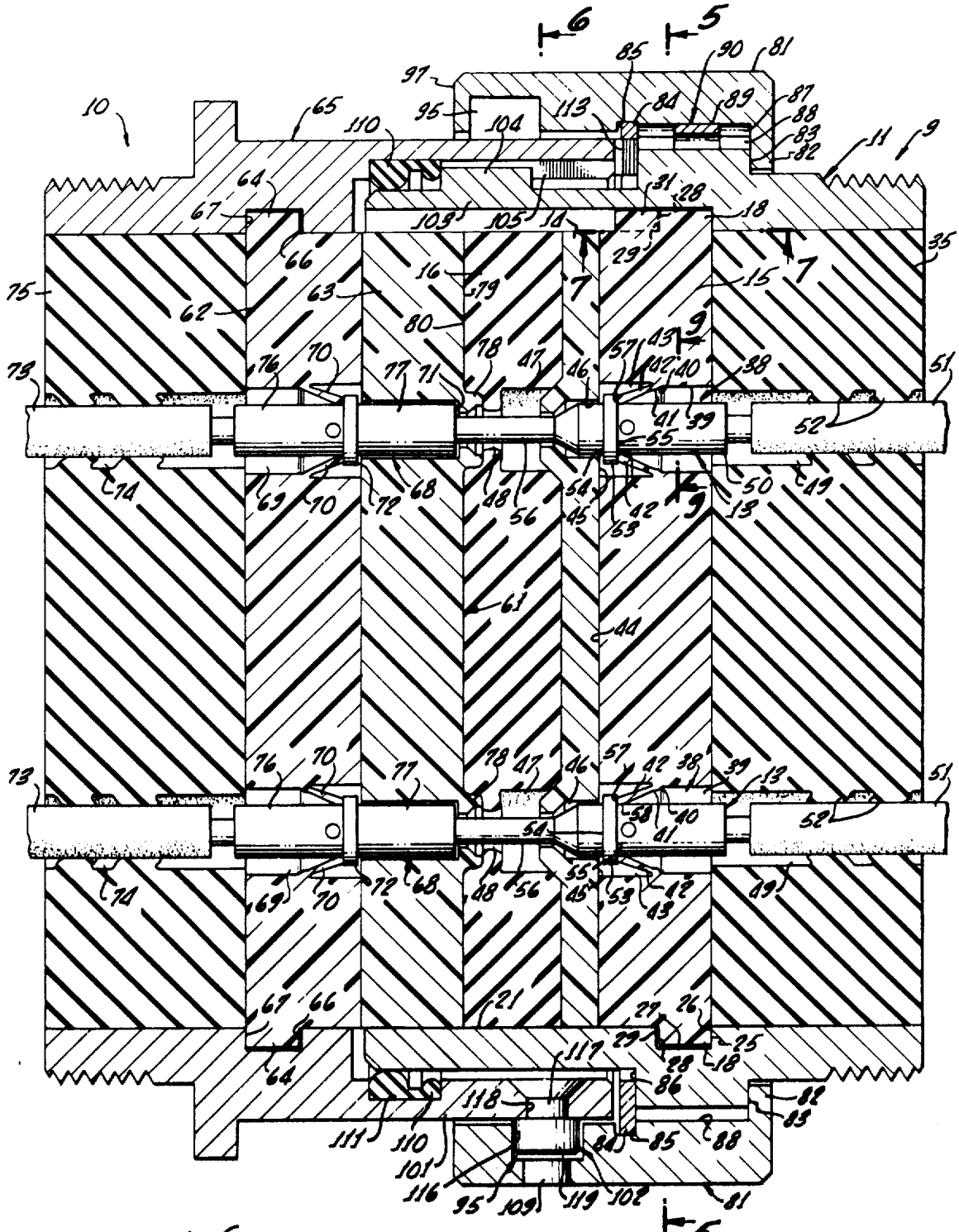


FIG. 3.

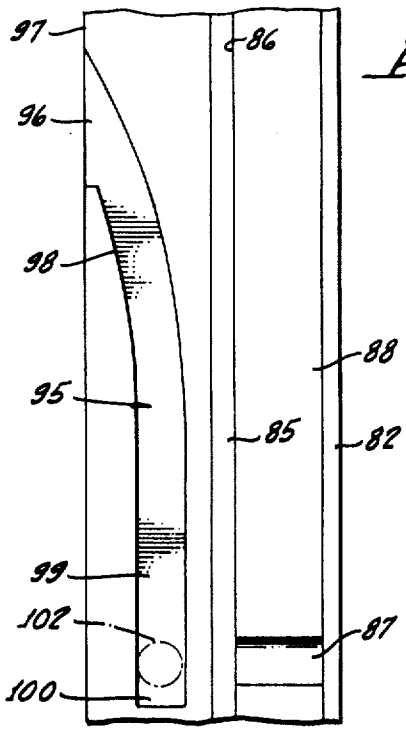
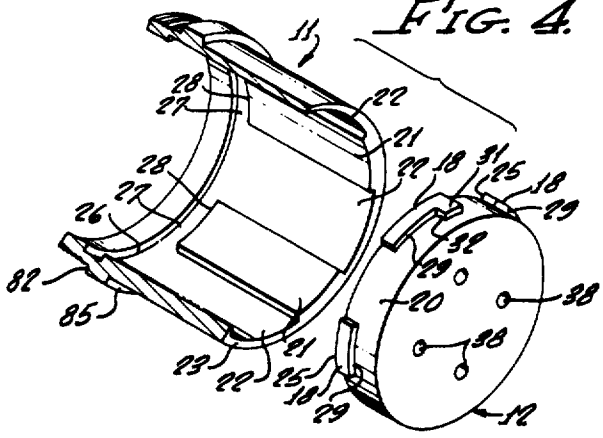


FIG. 14.

FIG. 4.



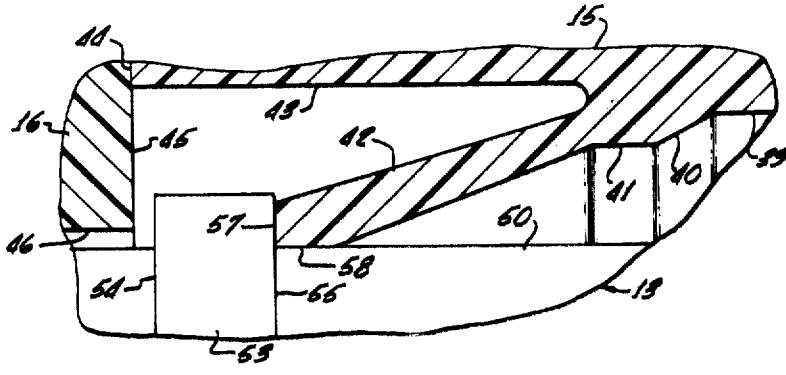


FIG. 10.

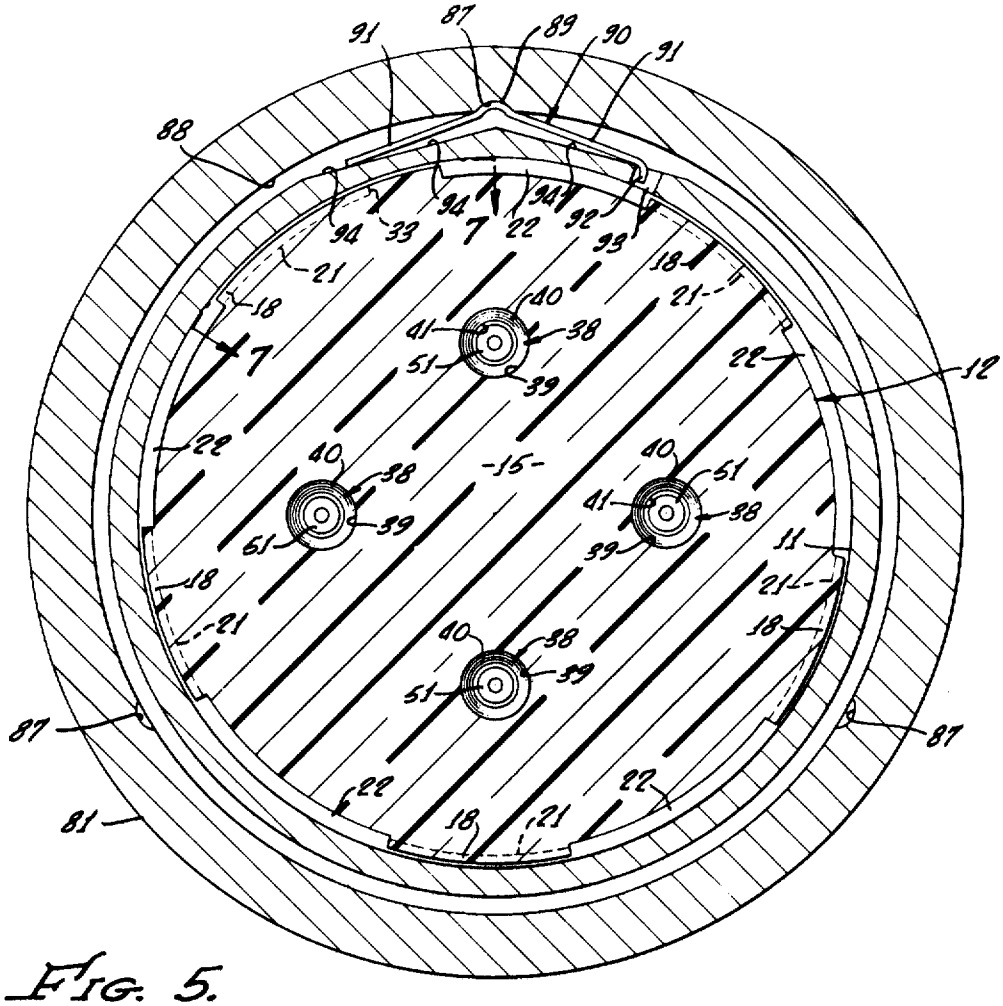


FIG. 5.

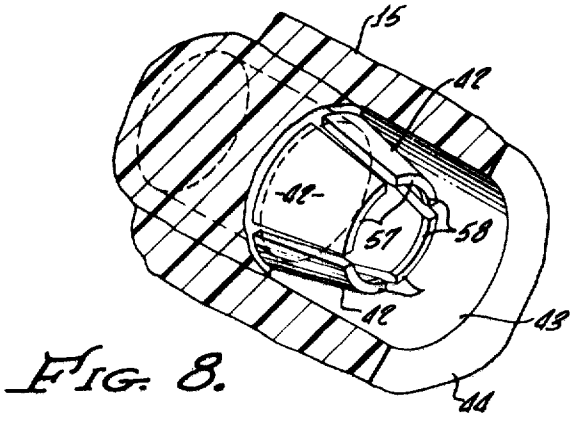


FIG. 8.

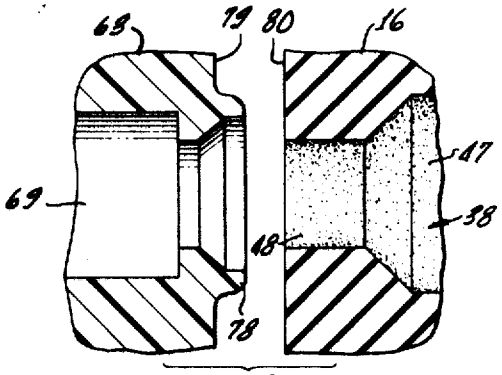


FIG. 13.

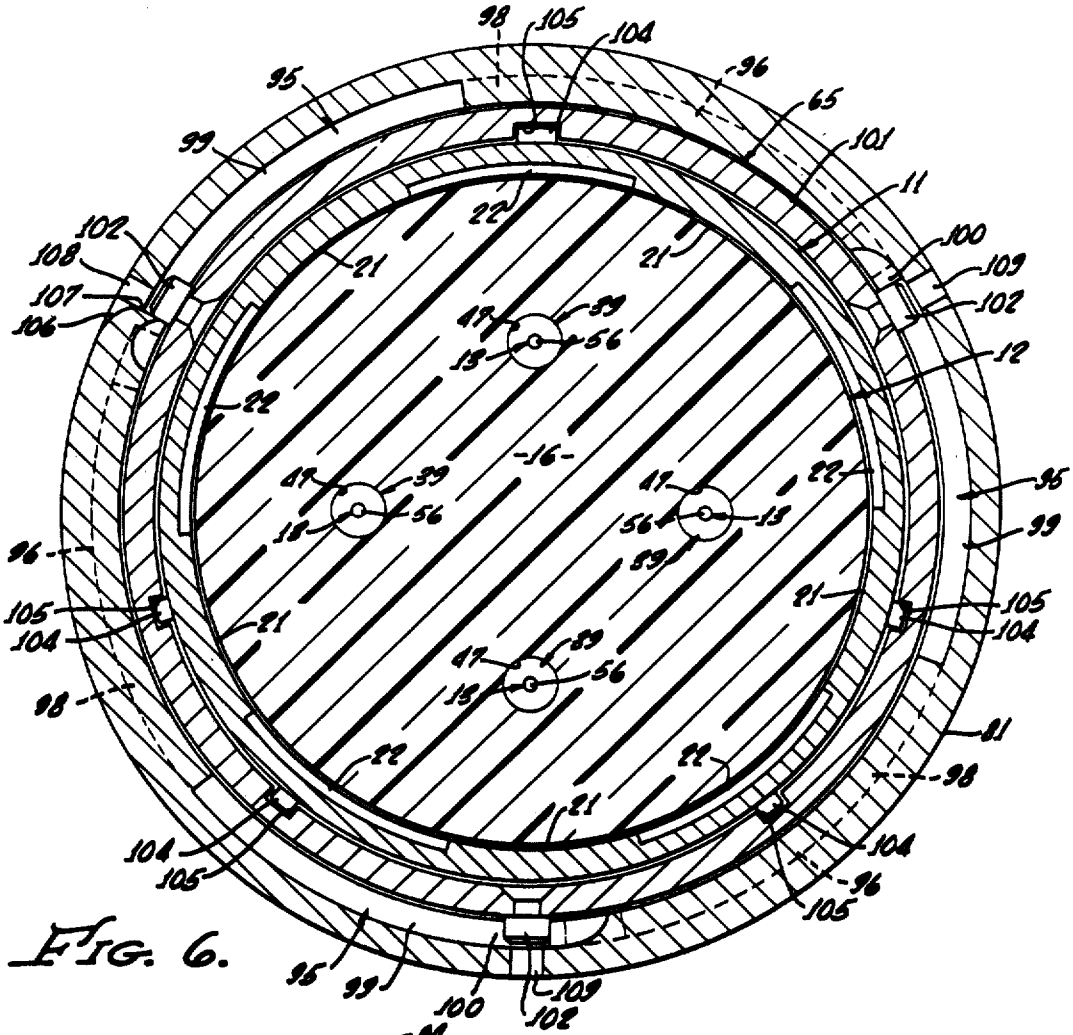


FIG. 6.

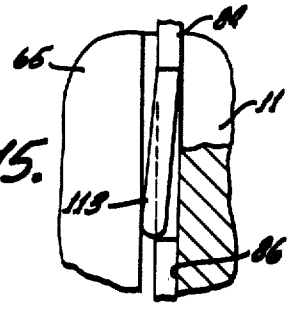


FIG. 15.

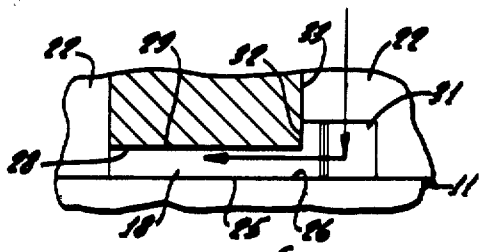


FIG. 7.

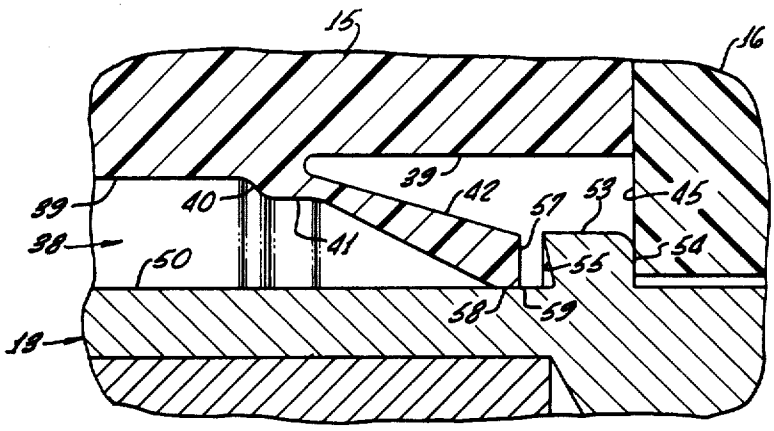


FIG. 11.

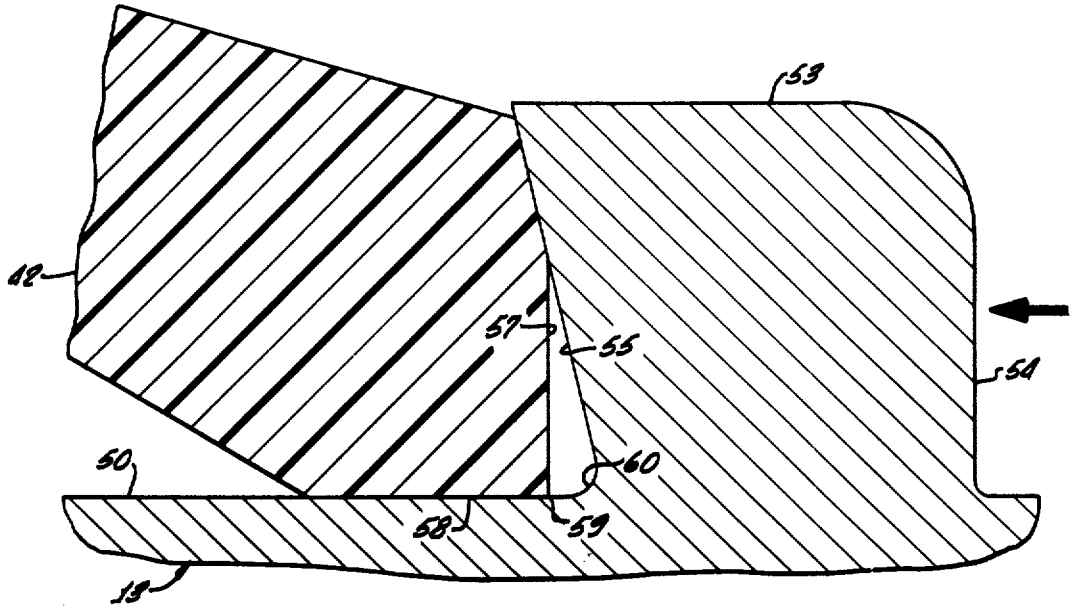


FIG. 12.

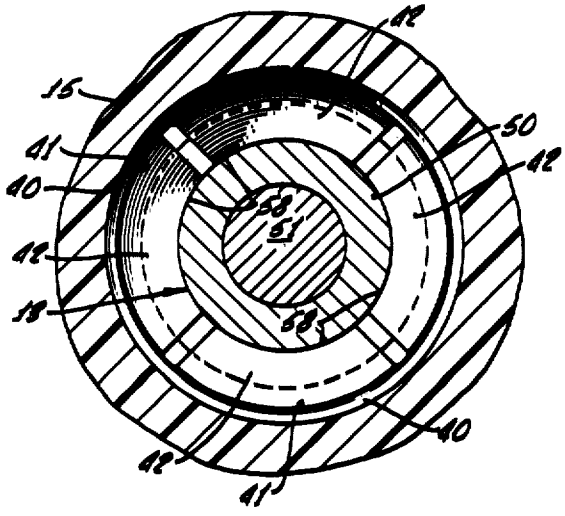
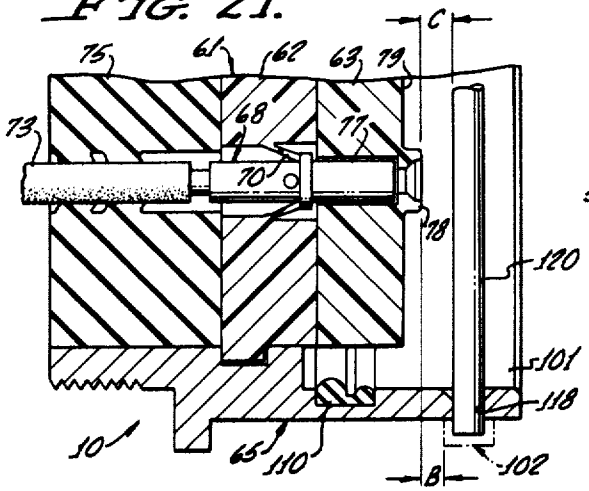


FIG. 9.

FIG. 21.



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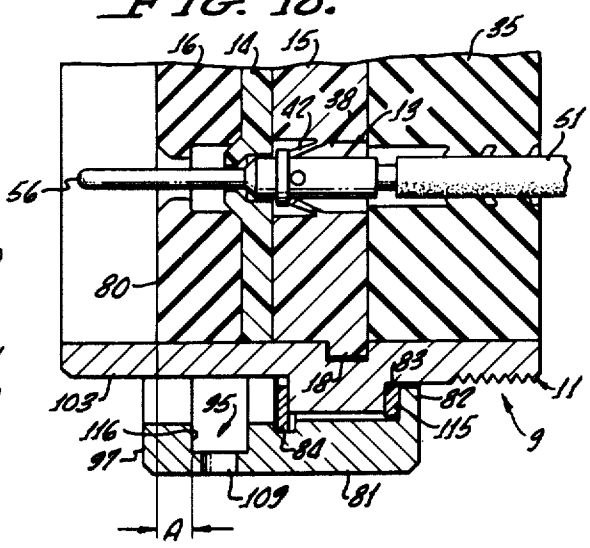

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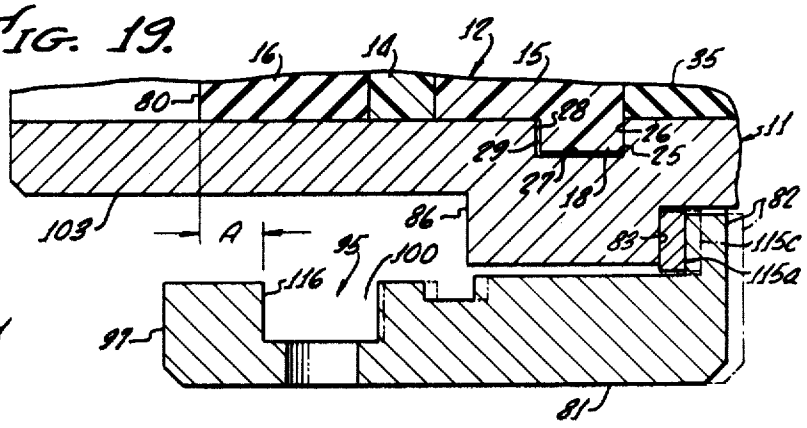
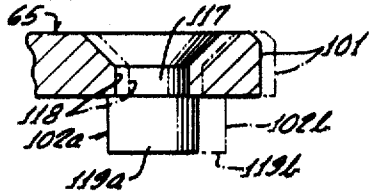
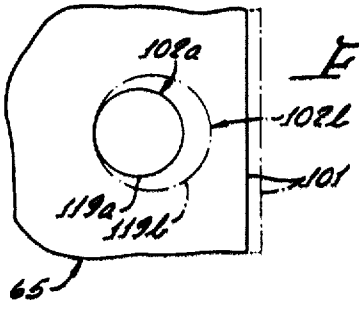


FIG. 23.





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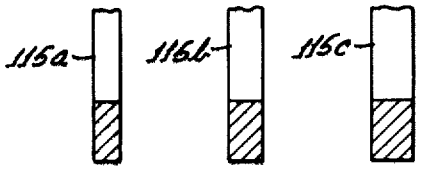
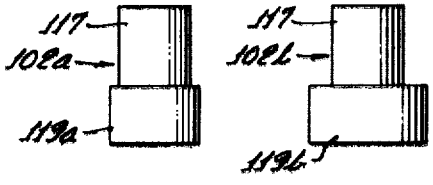


FIG. 20.

FIG. 22.



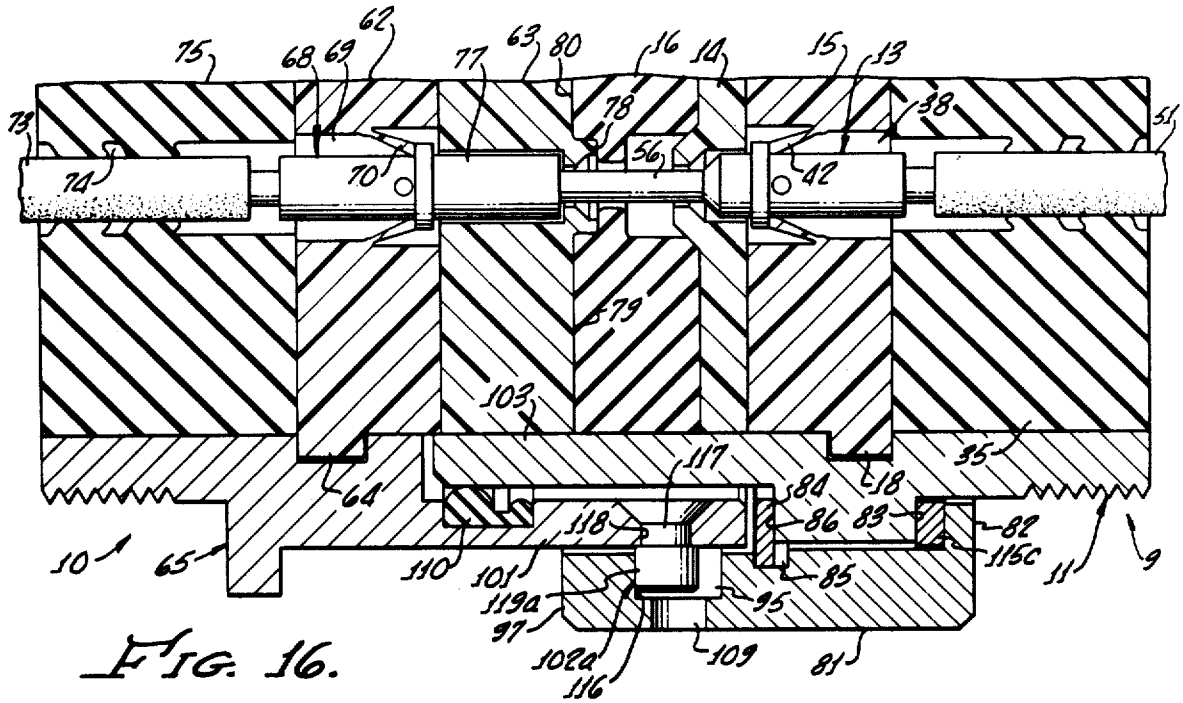

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FIG. 16.

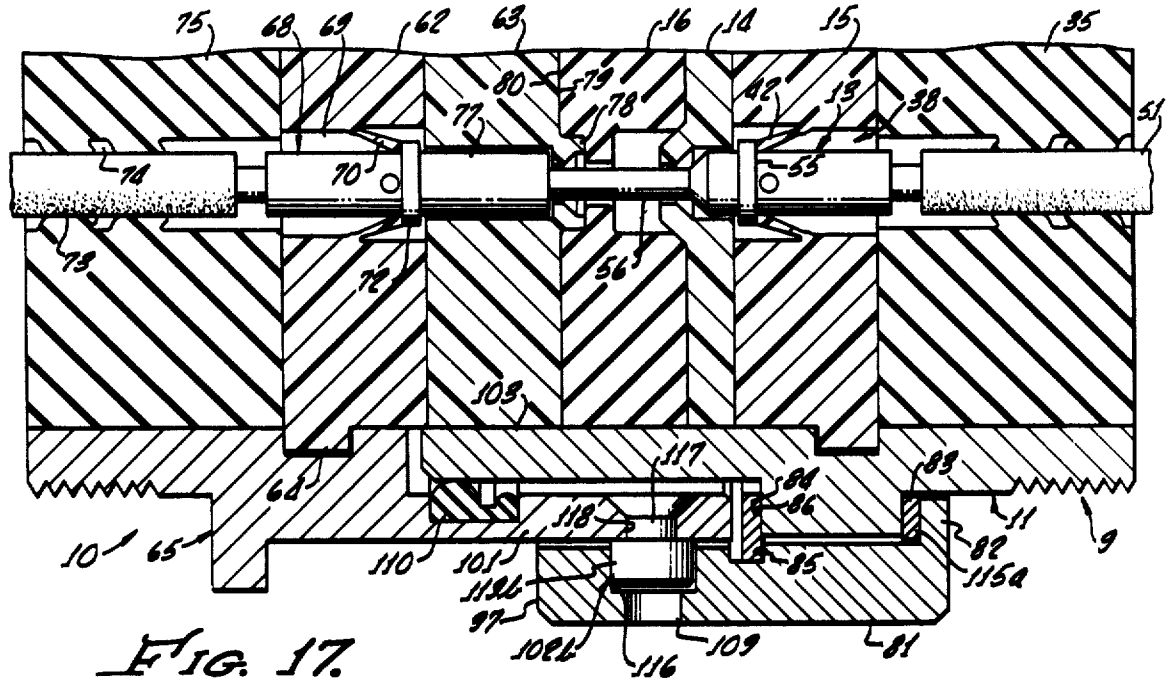
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FIG. 17.

COUPLING FOR ELECTRICAL CONNECTOR OR THE LIKE

REFERENCE TO RELATED APPLICATIONS

This application is a continuation of patent application Ser. No. 347,821, filed Apr. 4, 1973, now abandoned, for Coupling for Electrical Connector or the Like, which is a division of application Ser. No. 167,317, field July 29, 1971, for Electrical Connector (now U.S. Pat. No. 3,727,172), which is a continuation-in-part of application Ser. No. 83,782, filed Oct. 26, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical connectors.

2. Description of the Prior Art

Electrical connectors conventionally include a plug and receptacle. In order to secure the plug and receptacle of the connector together, a bayonet coupling mechanism frequently is used. This may include pins projecting radially outwardly from the shell of one of the sections of the connector, which are adapted to enter grooves in a coupling ring provided on the other section of the connector. The grooves have entrance portions at the forward end of the coupling ring, from which the grooves extend inwardly, terminating in recesses that extend back toward the forward end of the coupling ring. The pins enter the bayonet grooves as the connector is moved toward the mated position, moving to the inner ends of the grooves as the coupling ring is rotated. The coupling ring is engaged by a spring biasing it axially so that the bayonet pins are moved into the recesses at the ends of the bayonet grooves upon the termination of the rotation of the coupling ring. The spring force holding the pins on the recesses acts as a detent that retains the coupling ring against inadvertent rotation.

This arrangement means that the plug and receptacle are moved toward each other a distance beyond their normal mated position before the pins are allowed to enter the recesses at the ends of the bayonet grooves. As the pins are moved into the recesses, there is a slight separational movement of the connector plug and receptacle. Also, it is possible for the coupling ring detent spring to be overcome by an outward pull on the two sections of the connector. This can allow some separation of the plug and receptacle so that the contacts move relative to each other toward an unmated position. Therefore, in order to assure electrical continuity through the connector under all conditions, the pin and socket contacts must be made sufficiently long to permit some relative movement between them without causing disengagement. Consequently, the connector must be made large enough to accommodate the longer contacts, despite continued requirements for reduction in the size and weight of electrical connectors.

SUMMARY OF THE INVENTION

The present invention provides an improved electrical connector which overcomes the difficulties outlined above. In this connector, the coupling mechanism provides a secure bayonet connection, but does not depend upon the bayonet pins and grooves to provide the detent that holds the coupling ring against inadvertent rotation. Instead, there is a separate detent for this purpose. Consequently, the grooves in the coupling ring

are made circumferential in their inner portions, falling entirely in a radial plane and with no recesses at their inner ends for receiving the bayonet pins. Thus, when the coupling is moved to its mated position, the maximum relative axial movement of the plug and receptacle takes place as the bayonet pins enter the inner groove portions. Also, the coupling ring is axially fixed relative to the plug shell, unlike prior designs in which the coupling ring could be moved by overcoming a spring force. Once the connector has been coupled, the plug and receptacle are permitted no relative movement, so that outward forces on the connector sections cannot cause separation of the pins and sockets. Hence, the pins and sockets may be made quite short because there is no overtravel as the connector is mated, nor will the contacts be moved apart once the coupling has been engaged. This allows the connector to be made smaller and lighter than prior designs.

With no spring in the coupling mechanism, tolerances must be controlled so that the insert faces engage with a proper amount of compression. For the plug, a spacer washer is used to position the coupling ring axially so that the forward edge of the bayonet groove is a predetermined distance from the forward face of the plug insert. Measurements are taken so that a washer of proper thickness may be selected to accomplish the correct spacing between the groove and the insert. For the receptacle, the distance between the opening for the bayonet pin and the forward face of the receptacle insert is measured. Then, a bayonet pin is selected of a diameter such that its rearward surface is a predetermined distance from the forward surface of the insert.

The detent for the coupling ring is provided by a leaf spring which is held by the plug shell and has a central portion which is adapted to enter a recess in the inner circumferential surface of the coupling ring. This occurs when the coupling ring has been rotated to where the bayonet pins are properly positioned at the inner ends of the grooves. The spring is cammed out of the recess for reverse movement in the unmating of the connector.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an electrical connector made in accordance with this invention;

FIG. 2 is an exploded perspective view of certain portions of the connector, including in particular the parts used for coupling the plug and receptacle;

FIG. 3 is an enlarged longitudinal sectional view of the connector in the mated position;

FIG. 4 is an exploded perspective view, partially broken away, of the plug insert and shell;

FIG. 5 is a transverse sectional view taken along line 5—5 of FIG. 3;

FIG. 6 is a transverse sectional view taken along line 6—6 of FIG. 3;

FIG. 7 is a fragmentary sectional view taken along line 7—7 of FIG. 5;

FIG. 8 is a fragmentary enlarged perspective view of one portion of the plug insert assembly, illustrating the contact retention fingers;

FIG. 9 is a fragmentary transverse sectional view taken along line 9—9 of FIG. 3;

FIG. 10 is an enlarged fragmentary view illustrating the details of the finger shape and its engagement with the contact;

FIG. 11 is a fragmentary longitudinal sectional view showing the retention finger spaced from the contact shoulder when the contact is shifted forwardly;

FIG. 12 is a further enlarged fragmentary view illustrating the engagement between the retention finger and the contact shoulder, with the contact under rearward load;

FIG. 13 is an enlarged fragmentary longitudinal sectional view of the forward portions of the inserts of the plug and receptacle, shown slightly separated and illustrating the sealing arrangement for the openings;

FIG. 14 is a fragmentary flat pattern of the inside of the coupling ring, showing one of the bayonet grooves;

FIG. 15 is an enlarged fragmentary sectional view taken along line 15—15 of FIG. 3, illustrating the engagement of the spring tab on the snap ring and the forward end of the receptacle shell;

FIG. 16 is a fragmentary longitudinal sectional view of the connector incorporating one size of bayonet pin and spacer washer used in adjusting tolerances to assure proper engagement at the forward surfaces of the connector inserts;

FIG. 17 is a view similar to FIG. 16, but with different sizes of bayonet pin and spacer washer;

FIG. 18 is a fragmentary longitudinal sectional view of the plug showing the critical dimension between the edge of the bayonet groove and the forward face of the insert;

FIG. 19 is an enlarged fragmentary sectional view showing how the spacer washer controls the dimension between the edge of the bayonet groove and the insert face in different tolerance conditions;

FIG. 20 is a fragmentary transverse sectional view of a group of three different sized spacer washers, one of which is to be selected in properly spacing the forward edge of the bayonet groove;

FIG. 21 is a fragmentary longitudinal sectional view of the receptacle illustrating the manner of measuring to obtain the dimension from the opening for the bayonet pin to the forward face of the insert;

FIG. 22 is a side elevational view of two bayonet pins having outer ends of different sizes;

FIG. 23 is a fragmentary longitudinal sectional view of the receptacle shell and bayonet pin showing how different sizes of bayonet pins may be used in different situations to in both cases position the rearward edge of the pin at the same location; and

FIG. 24 is a fragmentary elevational view of the receptacle shell and bayonet pin of FIG. 23.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrated in the drawing is a multiple pin and socket connector that includes a plug **9** and a receptacle **10.** The general arrangement for retaining the contacts is the same in the plug and receptacle. In the embodiment illustrated, the pin contacts are in the plug and the socket contacts in the receptacle, although this may be reversed if desired. The plug **9** includes a plug shell **11,** which is a generally tubular metal member of circular cross section. Within the shell **11** is an insert assembly **12** that serves to retain and hold a plurality of pin contacts **13.** The insert assembly **12** includes disks **14** and **15** of a substantially rigid plastic. A suitable material for these members, because of its strength and temperature resistance, is a polyarylsulfone marketed under the trademark "Astrel" 360 plastic by Chemical Division, 3M Company, 3M Center, St. Paul, Minn. The disks **14** and **15** are suitably bonded together at their mating radial faces. At the forward end of the insert assembly **12** is bonded a gasket disk **16** of a resilient elastomeric material, such as silicone rubber.

The insert assembly **12** is retained in the plug shell **11** by means of interengaging castellations on the insert assembly and the plug shell. For this purpose, there are circumferentially extending lugs **18** that project outwardly from the periphery of the rearward disk **15,** as seen in FIG. **4.** In the embodiment illustrated, there are five of the lugs **18.** The circumferential surface **20** from which the lugs **18** project is substantially complementary to the inner surface **21** of the plug shell **11.** The slots **22** are made sufficiently wide to permit the insert assembly **12** to be introduced into the plug shell **11** by being slid inwardly from the forward end **23** of the plug shell, with the lugs **18** passing through the slots **22.** The insert assembly **12** is moved into the plug shell until the rearward radial edges **25** of the lugs **18** are brought into engagement with an annular shoulder **26** at the rearward portion of the plug shell.

Circumferential slots **27** are formed at the rearward portion of the inner surface **21** of the plug shell **11,** and are of widths substantially equal to the widths of the lugs **18.** This provides circumferentially extending shoulders **28** spaced opposite from the annular shoulder **26** of the plug shell. The shoulders **26** and **28** are spaced apart a distance corresponding to the dimensions of the lugs **18** longitudinally of the insert assembly **12.** This allows the insert assembly **12** to be rotated after the rearward edges **25** of the lugs **18** have been brought into engagement with the annular shoulder **26.** The rotation of the insert assembly brings the lugs **18** in back of the circumferential shoulders **28** and into the circumferential slots **27.** This positions the forward edges **29** of the lugs adjacent the circumferential shoulders **28** so that the radial shoulders **26** and **28** of the plug shell **11** hold the insert assembly **12** against longitudinal movement relative to the plug shell.

One of the lugs **18** may include a longitudinally forwardly projecting portion **31** having a side edge **32** which is brought into engagement with the side edge **33** of one of the longitudinal slots **22** in the plug shell for thereby limiting the rotational movement of the insert assembly **12** (see FIGS. **4** and **7**). When the forward projection is provided, it assures that the insert assembly **12** assumes the proper rotational alignment relative to the plug shell. After being properly positioned in the plug shell **11,** the insert assembly is locked in place so as to prevent it from being given reverse rotation. This may be accomplished by bonding the insert assembly to the plug shell.

With the insert assembly positioned in this manner, a rearward sealing element **35** made of a resilient elastomer, such as silicone rubber, is bonded to the rearward radial face of the insert assembly and to the rearward portions of the inner circumferential wall **21** of the plug shell.

The pin contacts **13** are received in spaced parallel openings **38** formed in the insert assembly **12.** The openings **38** are continuous from the front to the rear of the insert assembly **12,** and are separated from each other so that there is no communication from one opening **38** to the other. The connector is designed so that a large number of the pin contacts **13** may be retained in close adjacency, but, for clarity of illustration,

only a relatively few such contacts are shown in the drawing.

Each opening **38** includes a relatively wide-diameter portion **39** at the rearward end of the plastic disk **15** which, through a frustoconical portion **40,** tapers forwardly to a portion **41** of smaller diameter. A plurality of fingers **42** extends radially inwardly and axially forwardly from the portion **41** of the opening **38** into the continuation **43** of the opening **38** in the member **15.** This positions the fingers **42** inwardly and radially opposite the circumferential wall of the portion **43** of the opening **38.** The fingers **42** are shorter than the section **43** of the opening, so that their forward ends are inward of the forward radial face **44** of the member **15.** There are four of the fingers **42** in the example shown, as illustrated in FIG. **8.** The fingers **42** are rounded transversely so that collectively they define a generally frustoconical shape with narrow spaces between adjacent fingers. While the plastic member **15** is relatively hard and rigid, the fingers **42** are thin and, therefore, resilient. A radial shoulder is formed by the rearward face **45** of the member **14** where the diameter of the opening decreases at portion **46.** In the gasket member **16,** the opening has a relatively wide-diameter portion **47** at the rearward end and a smaller-diameter portion **48** at the forward end.

An opening **49** in the rearward sealing member **35** communicates with each of the openings **38.**

The pin contacts **13** may be of conventional construction, inclulding hollow, longitudinally elongated barrel portions **50** at their rearwards ends, which receive the ends of wires **51** from which the insulation has been stripped. The contact barrels **50** are crimped to the wires **51** to form a mechanical and electrical connection. The wires **51** enter the openings **38** through the openings **49** in the rearward member **35,** being engaged by annular sealing beads **52** formed on the circumference of the opening **49.**

Forwardly of the barrel portion **50,** each contact **13** includes a part **53** of enlarged diameter which defines forward and rearward shoulders **54** and **55,** respectively. Beyond the forward shoulder **54,** the contact narrows to a projecting pin portion **56** that is adapted to enter the socket contact. When installed in the opening **38,** the forward shoulder **54** of the contact is adjacent the rearwardly facing shoulder defined by the rearward face **45** of the insert **14,** which thereby prevents forward movement of the contact **13.**

In this manner, the contact is positioned within the insert assembly and securely retained. With the use of the integral fingers **42,** it is unnecessary to provide any auxiliary metal clip for retaining the contact, as in conventional connector construction. This simplifies the manufacture of the connector and lowers its cost. The danger of an improperly installed retainer clip is obviated. With the fingers **42** being entirely received in the section **43** of the opening **38,** which locates them rearwardly of the forward face **44** of the disk **15,** the bonding together of the inserts **14** and **15** will not adversely affect the fingers. In other words, the fingers are remote from the bond line so that any excess bonding material squeezed out at the joint will not interfere with the movement of the fingers.

As best seen in the enlarged illustration of FIG. **10,** the fingers **42** are thicker in cross section at their forward ends than they are at their points of attachment to the insert **15,** being tapered gradually in thickness to the rear. Also, each finger has a substantially radial forward end surface **57** which connects at a right angle to an inner end surface **58,** which is a cylindrical segment generally complementary to the barrel **50** of the contact **13.** When the finger **42** engages the contact **13,** the radial end surface **57** fits behind the rearward shoulder **55** of the contact, while the inner end surface **58** of the finger rests upon the barrel **50** adjacent the shoulder **55.**

The rearward transverse shoulder **55** of the contact **13** does not fall within a radial plane. Instead, it is inclined toward the forward end of the contact. Consequently, the shoulder **55** is undercut, being defined by a frustum of a cone. Desirable results are achieved when the shoulder **55** is inclined at around 12° relative to a radial plane. When the contact **13** is subjected to a force pushing it toward the rear, the undercut shoulder configuration and the inner finger surfaces **58** contribute greatly to the amount of force which can be absorbed before the retention fingers **42** will fail.

With the arrangement of this invention, the fingers **42,** loaded as columns, receive the forces on them near the neutral centers of the columns, minimizing the tendency to buckle. The plastic of the fingers **42,** being softer than the metal of the contact **13,** becomes distorted where it engages the radially outer portion of the shoulder **55,** as illustrated in particular in the enlarged view of FIG. **12.** This has the effect of embedding the shoulder in the outer ends of the plastic fingers **42,** stabilizing the finger ends. This increases the column strength of the fingers **42** because a column can withstand more loading if its ends are stabilized.

An additional stabilizing effect is realized because of the arcuate inner surfaces **58** of the fingers **42** substantially complementarily engaging the periphery of the barrel **50** of the contact adjacent the base of the shoulder **55.** This helps to anchor the free ends of the fingers. The inclined configuration of the shoulder **55** results in a force component on the fingers **42** helping to hold the surfaces **58** toghtly against the circumference of the barrel **50** to enhance the column stabilizing effect.

The greater wall thickness of the fingers at their outer ends adds to their strength in shear and in bending. The bending strength resists the buckling of the fingers under load.

Another advantage comes from the fact that the inner corner **59** of the finger **42,** between the end surface **57** and the inner surface **58,** becomes spaced rearwardly from the fillet **60,** which necessarily is formed between the shoulder **55** and the barrel **50** when the contact **13** is machined. When there is a straight radial shoulder, the inner corners of the retention fingers will engage the fillet at the base of the shoulder. This deflects the fingers outwardly, thereby tending to cam the fingers out of engagement with the shoulder. The undercut shoulder **55** permits the finger to clear the fillet **60** without requiring a recess in the finger and without sacrifice in the strength of the fingers.

The insert assembly **61** for the receptacle **10** includes a plastic disk **62** that is similar to the member **15.** To it is bonded or otherwise suitably secured a forward cover disk **63.** The members **62** and **63** also may be made of "Astrel" 360 plastic. Outwardly projecting lugs **64** on the disk **62** correspond to the lugs **18** on the member **15.** The lugs **64** secure the insert assembly **61** to the receptacle shell **65** in the same way that the lugs **18** attach the insert assembly **12** in the plug shell **11.**

The insert assembly **61** is introduced into the receptacle shell **65** by passing the lugs **64** through axial grooves in the inner surface of the receptacle shell **65**, whereupon subsequent rotation of the insert assembly **61** places the lugs **64** between opposed forward and rearward shoulders **66** and **67**, respectively, in the receptacle shell. This holds the disk **62** and the cover element **63** within the receptacle.

The socket contacts **68** are retained in continuous separate openings **69** in the insert assembly of the receptacle, positioned against axial rearward movement by integral fingers **70** that project forwardly and inwardly from the insert disk **62**. A shoulder **71** on the insert member **63**, where the opening **69** reduces in width, is adjacent the forward end of the contact **68** and precludes forward movement of the contact. The fingers **70** are engageable with the rearward edge of the annular enlargement **72** on the socket contact. A wire **73** extends inwardly through an opening **74** in the rearward sealing member **75** of the receptacle **10** for each of the socket contacts **68**. The end portions of the wires **73** are stripped of insulation and connected by crimping to the rearward barrel ends **76** of the socket contacts **68**. When the forward ends **77** of the socket contacts receive the projecting pin portions **56** of the pin contacts **13** upon the mating of the connector, circuits are completed between the wires **51** and **73**.

A rounded annular bead **78** projects outwardly from the forward radial face **79** of the cover disk **63** of the receptacle insert around each of the openings **69**. The bead **78** is engaged by the flat forward face **80** of the gasket **16** of the plug **9** when the connector is in the assembled position. Consequently, the bead **78** displaces the resilient material of the gasket **16** and an efficient moisture seal is produced. This type of seal does not rely upon the entry of a projecting part of the resilient elastomer into a recess in the hard plastic of the mating part as in some prior-art designs. Unlike the previous designs, swelling of the gasket **16** from attack of fluids will not appreciably interfere with the mating of the connector so that the axial force required will not vary significantly under those conditions.

The mechanism for securing the plug and receptacle together in the mated position includes a coupling ring **81** that circumscribes the plug shell **11**. The rearward end of the coupling ring includes a radially inwardly extending flange **82** in back of a rearwardly facing shoulder **83** on the plug shell. A snap ring **84** fits in an annular recess **85** in the intermediate portion of the inner circumferential wall of the coupling ring **81**. The snap ring **84** is positioned in front of a forwardly facing radial shoulder **86** on the plug shell **11**, cooperating with the flange **82** in retaining the coupling ring **81** on the plug shell **11**. This allows the coupling ring **81** to rotate relative to the plug shell **11**, but relative axial movement is prevented.

Intermediate the snap ring **84** and the flange **82**, the coupling ring **81** is provided with three short, arcuate, longitudinally extending recesses **87** in its inner surface **88** (see FIGS. **2** and **5**). These recesses are adapted to receive the outer rounded portion **89** of a leaf spring **90**. The latter member has normally straight legs **91** terminating in an inwardly bent end **92** which is received within a radial opening **93** in the periphery of the plug shell. This holds the spring **90** to the plug shell **11**. Adjacent the legs **91** of the spring **90** are flat chordal surfaces **94** which provide a clearance for permitting flexure of the spring **90**.

By this construction, the coupling ring **81** can be rotated relative to the plug shell **11**, but there is a detent action tending to prevent relative rotation when the portion **89** of the spring **90** enters a recess **87**. This retaining force may be overcome by applying adequate torque to the coupling ring to cam the rounded spring portion **89** out of the recess **87**, compressing the spring inwardly and allowing the spring portion **89** to slide along the circumferential surface **88** of the coupling ring intermediate the recesses **87**.

Forwardly of the snap ring **84**, three bayonet grooves **95** are formed in the inner circumferential surface **88** of the coupling ring. Each groove **95** includes a wide entrance opening **96** at the forward end **97** of the coupling ring, from which there extends an inclined portion **98** of the groove, leading to a circumferential inner part **99** of the groove. The axis of the latter portion of the bayonet groove **95**, as best seen in FIGS. **2** and **14**, falls entirely within a radial plane as there is no recess for the bayonet pin at the inner end **100** of the groove.

The receptacle shell **65** includes a forward portion **101** of enlarged diameter which provides a clearance around the insert assembly **61**. At the end of the forward portion **101** of the receptacle shell are three radially outwardly projecting bayonet pins **102**.

When the electrical connector is to be mated, the forward end portion **103** of the plug shell **11** enters the forward portion **101** of the receptacle shell **65**, fitting in the clearance space around the insert assembly **61** of the receptacle. Keys **104** on the plug shell fit in keyways **105** in the receptacle shell, assuring the proper rotational alignment of the plug and receptacle. With the keys in the keyways, the detent spring, when in a recess **87** in the coupling ring, positions the coupling ring so that the entrances **96** of the bayonet grooves **95** are aligned with the bayonet pins **102**. Therefore, the bayonet pins **102** are brought to the entrances **96** of the bayonet grooves **95** in the coupling ring **81** as the plug and receptacle are advanced axially toward each other. Subsequent rotation of the coupling ring **81** moves the bayonet pins **102** through the inclined portions **98** of the grooves **95** and into the circumferential portions **99**, drawing the plug and receptacle into the fully mated position. The coupling ring **81** is turned until the pins **102** are adjacent the inner ends **100** of the grooves **95**, which occurs as the outer portion **89** of the spring **90** enters a detent recess **87** in the coupling ring.

A positive stop is provided in one of the bayonet grooves to prevent rotation of the coupling ring **81** past the detent position when the connector is mated. This is accomplished by bending inwardly a small section **106** of the circumferential wall of the coupling ring, presenting an abutment surface **107** in the bayonet groove where it can be contacted by the bayonet pin at the termination of the rotation of the coupling ring **81** (see FIG. **6**). This location corresponds to the positioning of the outer portion **89** of the detent spring **90** in a detent receptacle **87**. An opening **108** is formed in the wall of the coupling ring adjacent the stop **107**, while two additional openings **109** in the coupling ring are spaced 120° from the opening **108**. This permits visual exterior inspection of the connector when in the mated position to ascertain whether or not the bayonet pins **102** have moved a sufficient distance into the bayonet grooves **95**. When the ends of the pins **102** (which may

be painted) can be seen through the openings **108** and **109**, it is known that the bayonet pins are in the inner portions of the bayonet slots and that the plug and receptavle are coupled properly.

By this arrangement, the plug and receptacle are advanced axially toward each other the maximum distance when the bayonet pins are adjacent the ends **100** of the grooves **95** that receive them. No outward movement occurs as the connection is made, and, when the bayonet pins **102** reach the circumferential portions **99** of the grooves **95**, the parts are held in their position of full maximum engagement. Even though subjected to a separating force, no relative movement of the plug and receptacle can take place, so that electrical continuity through the contacts is assured. The bayonet pins **102** are held against the forward sides of the bayonet grooves **95** when separating forces are imposed, while the coupling ring **81** is prevented from movement axially by the engagement of the flange **82** with the rearwardly facing shoulder **83** of the plug shell **11**. This provides a solid connection of the parts.

When the connector is in the fully mated position, the forward outer periphery of the forward end of the plug shell **11** engages an annular seal **110**. The latter member is held in an annular groove **111** in the receptacle shell **65** by bonding.

In some instances, the snap ring **84** may be provided with forwardly projecting tabs **113** that are brought into engagement with the end of the forward portion **101** of the receptacle shell **65** when the connector is mated (see FIG. **15**). This puts a desirable tension on the coupled plug and receptacle, eliminating any clearance in the coupling mechanism. This also makes an electrical connection between the plug shell **11** and the receptacle shell **65**.

The plug and receptacle are disconnected by reverse rotation of the coupling ring **81** to free the bayonet pins **102** from the bayonet grooves **95**. As this is accomplsihed, the detent spring **90** is forced out of one detent recess **87**, and its central part **89** slides along the surface **88** of the coupling ring **81** to the next detent recess **87**. In the latter detent position, the bayonet pins **102** have reached the entrances **96** to the grooves **95** and the plug and receptacle may be pulled apart axially.

When the connector is mated, the plug **9** and the receptacle **11** are held together by the reaction of the rearward surfaces of the bayonet pins **102** against the forward edges of the bayonet grooves **95**. This causes the forward faces of the inserts in the plug and receptacle to be brought into interengagement and held under compression. When assembled properly, the sealing bead **78** engages and becomes embedded in the forward face **80** of the resilient insert **16** around the mating pin and socket contacts. It is important that the bead **78** of the forward cover disk **63** and the forward face **80** of the insert **16** assume the proper relative position when the connector is mated. If they are advanced toward each other an inadequate distance, the bead **78** will not bear against the gasket disk with sufficient force to form a seal. Too much movement of one insert toward the other will cause overcompression at the mating connector surfaces, making it difficult to mate the plug and receptacle. While some variation is not harmful, manufacturing tolerances can build up so that either objectionable condition can exist.

In conventional connector design, where there is a spring in the coupling mechanism, dimensinonal variations of this sort are not important because the movement permitted by the spring will allow for tolerances and keep the mating faces under proper compression. with the present invention, however, there is no spring in the coupling mechanism, and tolerance buildup requires a different solution. This is accomplished by controlling the positions of the working surfaces of the bayonet grooves and the bayonet pins relative to the forward surfaces of their respective insert assemblies. Each is controlled separately to a predetermined dimensional range.

For the coupling ring **81**, tolerance control is effected by menans of a spacer washer **115** which fits between the abutments defined by the rearward flange **82** of the coupling ring **81** and the shoulder **83** on the shell **11** (see FIGS. **16–20**). By selecting a spacer washer **115** of proper axial dimension, the distance A (indicated in FIG. **18**) between the forward edge **116** of the bayonet groove **95** and the forward face **80** of the gasket insert **16** can be held within acceptable limits. Normally, in a carefully manufactured connector, the distance A can be controlled adequately by having available only a limited number of sizes of the spacer washers **115**. Three such washers, such as the washers **115***a*, 115*b* and **115***c* shown in FIG. **20**, will suffice.

In the assembly procedure, the coupling ring **81** is positioned on the shell **11** with one thickness of washer, selected by estimation or arbitrarily, positioned between the flange **82** and the shoulder **63**. The distance A then is measured. Obviously, if the selected washer causes the distance A to fall within the proper range, nothing more need be done. However, if the distance A is over or under the specified range, the originally chosen washer is replaced by one of a thickness such that the distance a will be brought to within proper limits. Simple addition orr subtraction will establish the choice of spacer washer. a thicker washer will move the forward edge **116** of the groove **95** closer to the surface **80**. and a thinner washer will increase the distance between the forward edge **116** and the suyrface **80**.

In the receptacle **10**, it is necessary to maintain the correct distance B between the rearward working surfaces of the bayonet pins **102** and the forward edge of the bead **78** (see FIG. **21**). This is accomplished by providing bayonet pins **102** with different diameters at their exposed portions, permitting selection of a bayonet pin of proper size. This may be a choice from among two pins, such as the pins **102***a* and **102***b* illustrated in FIG. **22**. In each instance, the shank portion **117** is the same and can fit complementarily in the opening **118** in the shell **65**. However, the enlarged outer parts **119***a* and **119***b*, which are adapted to fit in the bayonet groove **95**, are of different diameters.

In selecting the proper bayonet pin, the distance C is measured from the rearward edge of the opening **118** in the receptacle shell **65** to the forward edge of the bead **78**. With this distance being known, it is possible then to select the bayonet pin having its outer part **119***a* or **119***b* dimensioned so as to result in a distance B within accepted limits. Obviously, when the distance C is at a minimum, the bayonet pin with the smaller outer end **119***a* is selected, while larger distances C require the bayonet pin having end **119***b*.

Because the opening **118** and the forward face **79** of the receptacle insert are radial with respect to the connector, the distance C may be found by first inserting a rod **120** through the opening. The rod **120** is ex-

tended inwardly parallel to the forward face **79** of the insert **63.** A measurement can be made without difficulty between the rearward edge of the rod **120** and the forward edge of the sealing bead **78.** This is the same dimension as that between the rearward edge of the opening **118** and the bead **78,** which is the distance C.

The foregoing detailed description is to be clearly understood as given by way of illustration and example only, the spirit and scope of this invention being limited solely by the appended claims.

I claim:

1. In combination with a first body and a second body, an arrangement for coupling said first body to said second body comprising

an annular member circumscribing said first body,

means retaining said annular member to said first body so that said annular member is rotatable relative to said first body and substantially axially fixed relative to said first body including

a first radially extending shoulder on said first body,

a second radially extending shoulder on said first body,

an inwardly directed flange on said annular member adjacent said first shoulder for preventing movement of said annular member relative to said first body in one direction,

said annular member having an internal annular recess, and a snap ring received in said recess and extending

therefrom to a position of adjacency with said second shoulder so that said snap ring engages said first body and said annular member for preventing movement of said annular member relative to said first body in the opposite direction,

said snap ring including at least one resilient tab extending outwardly therefrom for engaging said second body and exerting a resilient force thereon when said first and second bodies are coupled and providing an electrical connection to said second body,

said annular member having an inner circumferential surface having at least one groove therein,

said groove having an opening at one end of said annular member providing an entrance thereto,

said groove having an inner portion and an inclined portion interconnecting said entrance and said inner portion of said groove,

said inner portion of said groove being circumferential relative to said annular member,

the longitudinal axis of said inner portion falling in a plane that is substantially radial relative to said annular member,

a pin on said second body projecting outwardly therefrom,

said pin being adapted to enter said groove and to be transmitted through said entrance and said inclined portion to said inner portion of said groove upon rotation of said annular member relative to said

first body and said second body,

said second body having an annular portion adapted to circumscribe a part of said first body intermediate said first body and said annular member when said pin so enters said groove,

and resilient detent means engaging said first body and said annular member to resist rotation of said annular member relative to said first body when said pin is in said inner portion of said groove.

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