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Geib

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[45] **June 10, 1975**

[54] **HIGH VOLTAGE QUICK DISCONNECT ASSEMBLY**

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Related U.S. Application Data

[63] Continuation of Ser. No. 243,723, April 13, 1972, abandoned.

[52] **U.S. Cl.** ..... **339/46**; 339/45 M; 339/91 B; 339/94 M; 339/111

[51] **Int. Cl.** **H01r 3/54**

[58] **Field of Search** 339/45, 46, 59–61, 339/65, 66, 75, 89–91, 94, 111, 176

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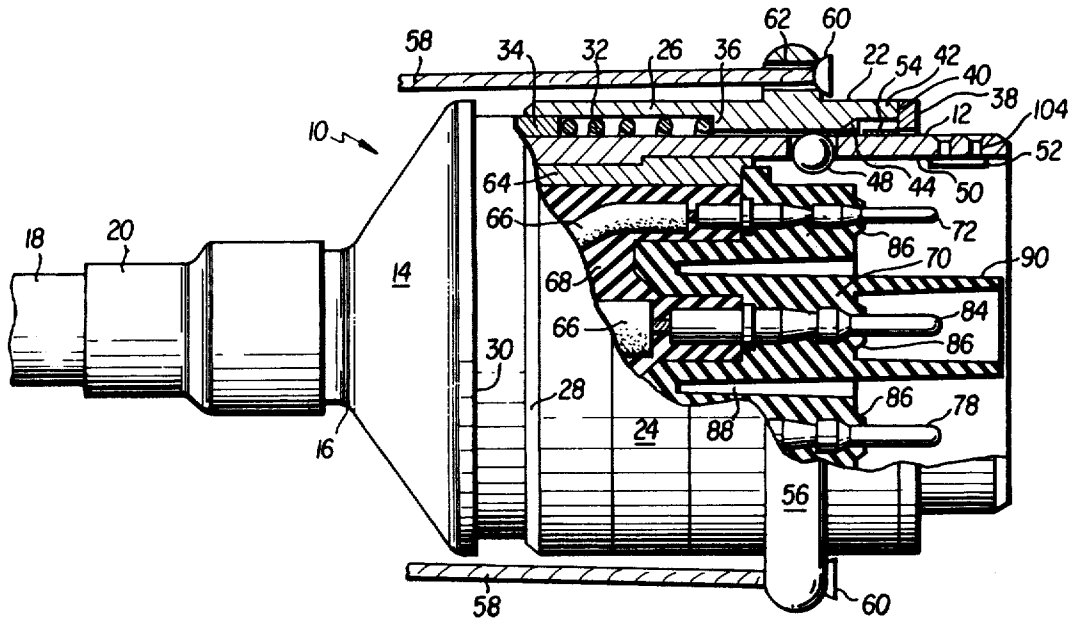
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Assistant Examiner—Terrell P. Lewis
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[57] **ABSTRACT**

A high voltage connector assembly is disclosed which includes a plug and a receptacle which may be coupled together by a lock having a quick disconnect feature. The plug portion of the connector assembly includes a plurality of ball bearing locking members which cooperate with a groove in the receptacle portion of the connector assembly to lock the two portions of the connector assembly together. A spring biased locking ring, which may be either manually or mechanically operated, controls the position of the ball bearing locking members. Pulling the locking ring against the force of its biasing spring releases the ball bearing locking members, and permits the two connector portions to be rapidly separated. A stripe of brightly colored material is provided to indicate whether the locking ring is open or closed. The connector houses a plurality of pin-type electrical connectors which are embedded in an insulating cap formed of a material, such as silicone rubber, which is resilient and is not adversely affected by wide variations in ambient temperature.

11 Claims, 4 Drawing Figures



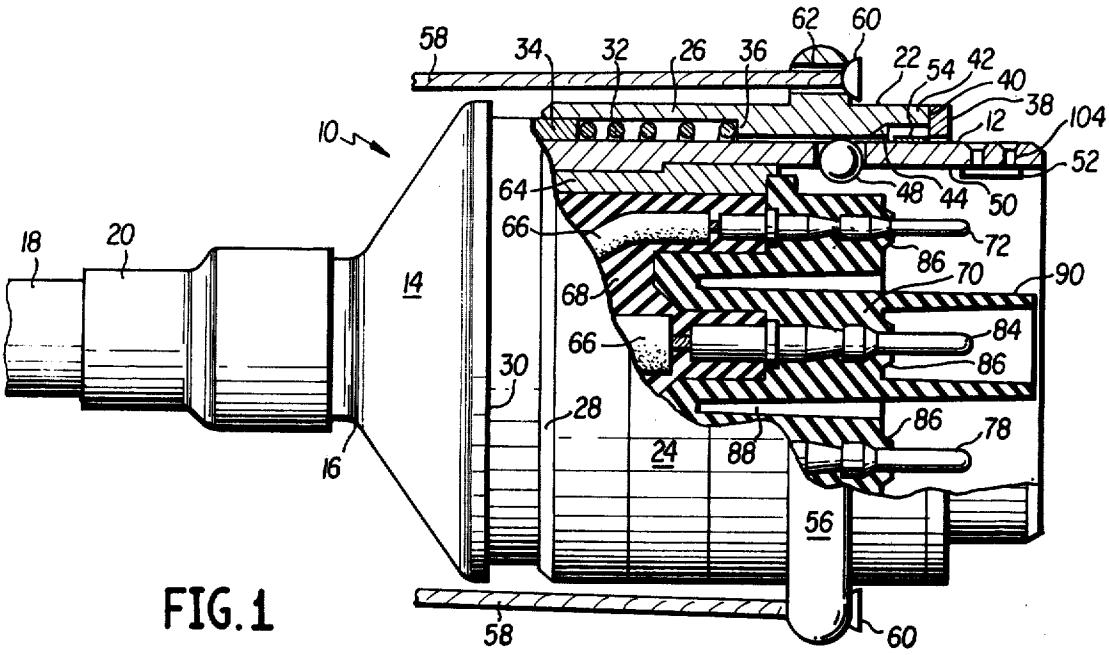

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FIG. 1

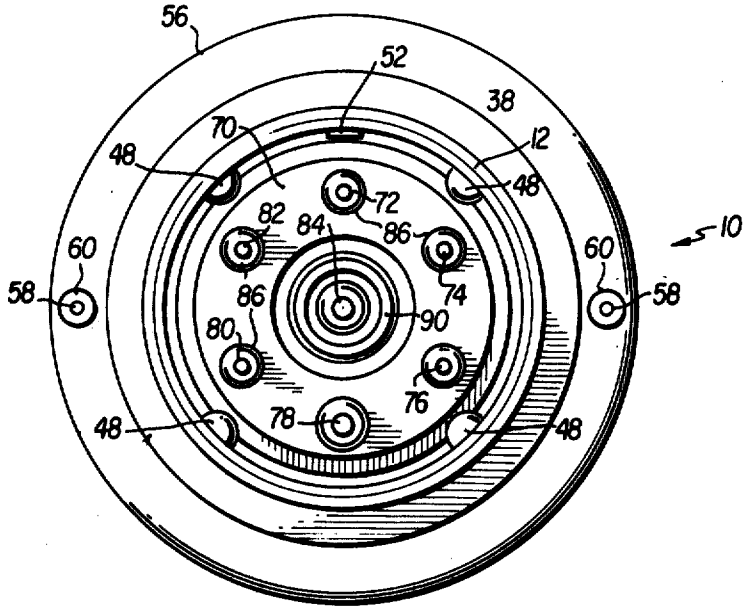

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FIG. 2

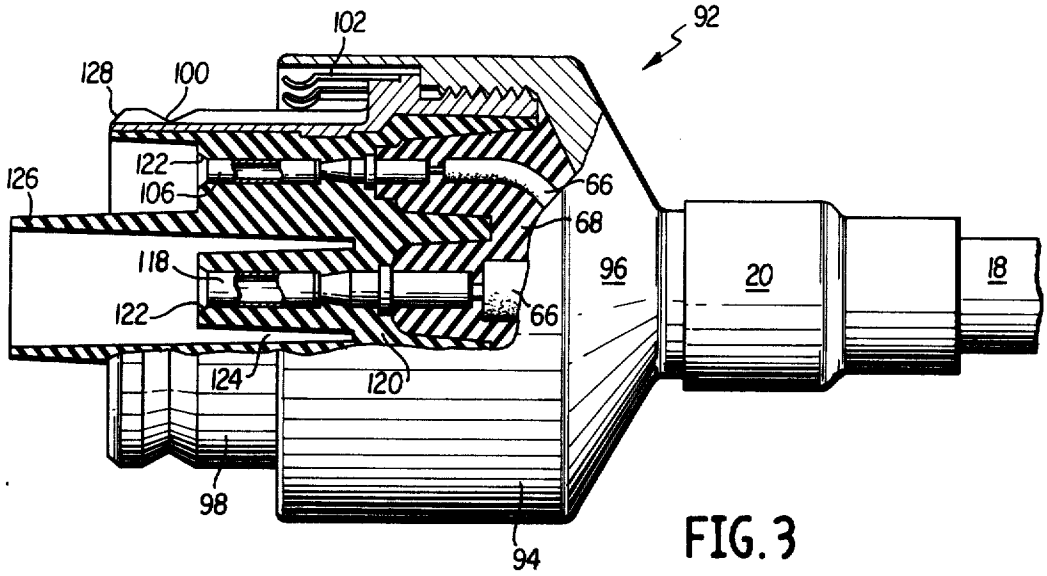

102
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FIG. 3

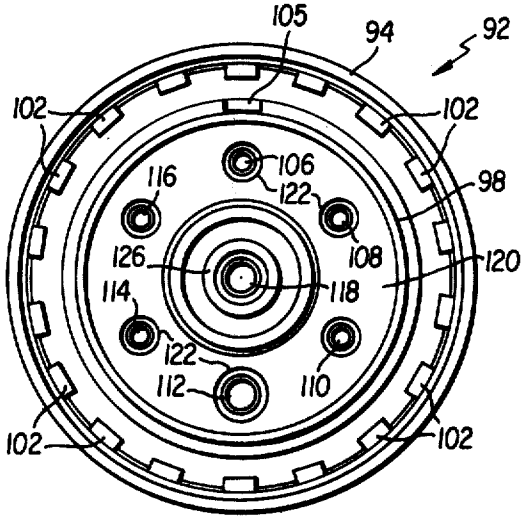

105
94
92
102
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110
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102

FIG. 4

HIGH VOLTAGE QUICK DISCONNECT ASSEMBLY

This is a continuation of Ser. No. 243,723, filed Apr. 13, 1972, now abandoned.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates generally to electrical connectors, and more particularly to a high voltage connector assembly including a quick disconnect feature.

2. Description Of The Prior Art

Many types of electrical connectors having quick disconnect features are known in the prior art. However, many of such known quick disconnect structures are suitable for use only at low voltage levels. Consequently, a need exists for a reliable plug and receptacle structure for providing the capability of quickly disconnecting high voltage lines. In addition, many of the previously known quick disconnect structures were capable of accommodating only two electrical connections, although in many environments it is highly desirable to have a quick disconnect structure capable of handling substantially more than two circuits simultaneously.

In addition to these shortcomings, quick disconnect structures available in the past have been somewhat awkward to use and have been unsuitable for use in environments having widely varying temperature fluctuations. For example, many quick disconnect structures require a quarter turn to release a mechanical locking assembly. Such a turning requirement is undesirable in situations where a very rapid uncoupling of a connector is required. For extremely rapid disconnections, it is preferable that a straight pulling action alone is sufficient to release a locked connector structure. A straight pull release is particularly desirable for providing a mechanical or automatic unlocking feature, which is actuated by an extended strain or pull on the connector structure. In addition, the interior assemblies of previously available quick disconnect structures have generally lacked a high quality insulating material which remains durable and structurally sound even when subjected to extreme heat and cold. Finally, previously available structures have lacked any means for quickly and conveniently indicating whether the connector lock is fully closed.

SUMMARY OF THE INVENTION

Accordingly, one object of this invention is to provide a novel high voltage quick disconnect assembly.

Another object of this invention is to provide a novel plug and receptacle combination having a quick disconnect feature.

Yet another object of this invention is to provide a high voltage connector structure capable of being quickly disconnected by a straight pulling action.

Yet another object of this invention is to provide a high voltage quick disconnect assembly which remains operative even though subjected to extreme heat and cold.

A still further object of this invention is to provide a high voltage quick disconnect assembly including a unique positive mechanical locking arrangement.

Another object of this invention is to provide a novel high voltage quick disconnect assembly including a simple, yet highly durable and reliable mechanical locking assembly.

A still further object of this invention is to provide a high voltage quick disconnect assembly including a novel internal structure for providing a tight seal between plug and receptacle components.

Yet another object of this invention is to provide a high voltage quick disconnect assembly having a mechanical locking arrangement equipped with a novel indicator for providing a rapid visual indication of whether the mechanical lock is fully closed.

Briefly, these and other objects of ths invention are achieved by providing a plug assembly including a metal shell containing an insulating structure which remains substantially unaffected, even when subjected to extremely high and extremely low temperatures, in which a plurality of pin-type electrical contacts are mounted. A movable, spring biased metal cap is positioned around the outside of the metal shell, and includes a camming surface at one end thereof for positioning a plurality of ball bearings mounted in apertures in the metal shell. A receptacle assembly, which is designed to interfit with the plug assembly includes a groove for cooperating with the ball bearing locking assembly of the plug. An irridescent stripe is provided on the outer portion of the metal shell of the plug, to indicate whether the locking assembly is fully closed.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying Drawings, wherein:

FIG. 1 is a partially cut-away side view of the plug assembly of the present invention;

FIG. 2 is a front view of the plug assembly illustrated in FIG. 1;

FIG. 3 is a partially cut-away side view of the receptacle assembly of the present invention; and,

FIG. 4 is a front view of the receptacle assembly illustrated in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the Drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG. 1 thereof, a preferred embodiment of the plug assembly **10** of the present invention is illustrated. The plug assembly **10** includes a cylindrical shell **12**, which is preferably constructed of a metal such as aluminum or steel. One end of the cylindrical shell **12** is secured to one side of a base portion **14**, which is preferably constructed of the same material as the cylindrical shell **12**. The side of the base portion **14** not connected to cylindrical shell **12** tapers to a relatively narrow neck **16** where an electrical cable **18** enters the plug **10**. A short length of shrink tubing **20** is preferably placed over the junction of the electrical cable **18** and the base portion **14** of the plug **10** to completely seal and insulate the juncture, and to add structural strength to the junction point.

A locking cylinder **22** is slidably positioned around the exterior surface of the cylindrical shell **12**. The locking cylinder **22**, which is preferably constructed of the same material as the cylindrical shell **12**, may include a knurled ring **24** about its exterior surface to fa-

cilitate manual gripping. The locking cylinder **22** includes a sleeve portion **26** which surrounds a portion of the cylindrical shell **12** near the base portion **14.** The sleeve portion **26** terminates at an end surface **28** which is designed to abut a shoulder portion **30** formed around the entire periphery of base portion **14.** Thus, the locking cylinder **22** may only be moved toward the base portion **14** until the end surface **28** of the sleeve portion **26** engages shoulder **30** of base **14.** A coil spring **32** is positioned between the outer surface of the cylindrical shell **12** and the sleeve portion **26** of locking cylinder **22.** One end of coil spring **32** abuts shoulder **34** coupled to cylindrical shell **12** while the other end of the coil spring abuts a shoulder **36** which forms a portion of locking cylinder **22.** Thus, the coil spring **32** biases the locking cylinder **22** away from base portion **14.**

A flange **38** is formed near the end of cylindrical shell **12** which is opposite base portion **14.** The flange **38** is designed to abut a forward end **40** of the locking cylinder **22,** thereby restraining the locking cylinder **42** against the biasing force of coil spring **32.** The forward end **40** of locking cylinder **22** constitutes one end of a forward rim **42** of the locking cylinder **22.** The forward rim **42** of the locking cylinder **22** is joined by a camming surface **44** to a main body portion **46** of the locking cylinder **22.** The camming surface **44** is provided to operate a plurality of ball bearing locking members **48,** in a manner which will be explained in more detail hereinafter. Although four ball bearing locking members **48** are illustrated in the Drawings (see FIG. 2), any suitable number of locking members **48** may be used. It will be understood, of course, that a greater number of ball bearing locking members tends to increase the strength of the locking apparatus, while increasing the friction involved in operating the locking member, and therefore increasing slightly the force required to lock and unlock the device. Similarly, the use of fewer ball bearing locking members, preferably not less than two, weakens somewhat the strength of the locking apparatus, and reduces the friction in the apparatus, and therefore reducing somewhat the force required to lock and unlock the apparatus. Each of the ball bearing locking members **48** is movably positioned in an aperture **50** in the wall of cylindrical shell **12.** Each of the apertures **50** is tapered slightly toward the interior of cylindrical shell **12** so that the ball bearing locking members **48** cannot fall completely through to the interior of the plug **10.**

An aligning key **52** is mounted to the interior forward surface of cylindrical shell **52** to insure proper alignment between the plug **10** and its receptacle. A lock condition indicator **54** is placed around the exterior surface of cylindrical shell **12** in an area beginning below flange **38** and extending as far as aperture **50,** if so desired. The lock condition indicator **54** may, for example, be comprised of a strip of irridescent red paint surrounding a portion of the cylindrical shell **12.** Clearly, other materials than paint and colors other than red may be suitably employed, although the lock condition indicator **54** must be comprised of a material which is clearly visible provided the forward end **40** of the locking ring **42** is not firmly engaged with the lower surface of flange **38** of cylindrical shell **12.** Thus, if the locking cylinder **20** is not fully closed, the lock condition indicator **54** will be visible, immediately indicating to an operator that the high voltage connector of the present invention is not properly locked.

An upstanding operating ring **56** is formed integral with locking cylinder **22,** and is positioned around the outer periphery of the locking cylinder **22.** The operating ring **56** may essentially comprise a ridge on the locking cylinder **22** for permitting a firm grip to be maintained on the locking cylinder **22** for moving the locking cylinder. Alternatively, a pair of cables **58** may be coupled to the operating ring **56** for remotely and/or automatically operating the locking cylinder. The cables **58,** which may be of stainless steel, for example, may be secured to a bulkhead, or other immovable object. Thus, when a strain is exerted on the plug **10,** the cables **58** will retract the locking cylinder **22** automatically. The cables **58** may be coupled to the operating ring **56** by conventional means, such as flange members **60** mounted to the ends of cables **58** to prevent the cables from slipping through apertures **62** in operating ring **56.**

A cylindrical, molded epoxy glass insulator **64** is positioned inside cylindrical shell **12** toward the base portion **14** thereof. A plurality of electrical leads **66** are positioned inside the cylindrical insulator **64.** A suitable potting material **68** surrounds the ends of the electrical leads **66** to hold them firmly in place. An insulating cap **70,** which is preferably made of silicone rubber, is placed on top of the potting material **68,** so that the potting material conforms to the shape of one side of the insulating cap **70.** Silicone rubber is a particularly good material from which to construct the insulating cap **70,** since it is a very good insulator, is flexible, and is substantially unaffected by wide fluctuations in environmental temperatures.

A plurality of contact pins **72** through **84** (see FIG. 2) are embedded in the insulating cap **70.** The contact pins are coupled to the electrical leads **66** at one end thereof, and protrude through the surface of the insulating cap **70** at the other end thereof, forming exposed male contact members. As illustrated more clearly in FIG. **2,** the contact pins **72** through **82** are disposed in a generally symmetrical circular pattern around the central contact pin **84.** Although seven contact pins are specifically illustrated in the drawings, it will be understood that substantially any number of contact pins may be used within the scope of the present invention. The various contact pins may also be of different sizes, representing different voltage levels or different circuit functions. For example, the contact pin **72** is illustrated as having a relatively small diameter, while the contact pin **78** has a larger diameter, and the contact pin **84,** which is centrally positioned, is the largest of the contact pins. Thus, in the embodiment illustrated in FIG. **1,** the central contact pin **84** represents the highest voltage circuit. For example, the voltage on contact pin **84** may be in the range of from 25 to 30 kilovolts. Similarly, the voltages applied to the other contact pins may be in the range, for example, of from 0 to 6 kilovolts. The larger diameter pin **78** may obviously be used to represent a particular circuit function which is not represented by the other pins in the connector. It will, of course, be apparent to those skilled in the art that the various contact pins may be sized or coded in any suitable manner which is appropriate to a particular use of the connector structure.

The insulating cap **70** is formed to include a sealing ridge **86** surrounding the base of the exposed portion

of each contact pin **72** through **84**. The insulating cap **70** also includes a cylindrical channel **88** surrounding the lower portion of the central contact pin **84**. A flexible, tubular or cylindrical shield **90** is formed integral with the inner walls of the channel **88** of insulating cap **70**, and forms a protective insulating shield around the exposed portion of the contact pin **84**. The shield **90** thus forms an insulating barrier around the exposed portion of high voltage contact pin **84**, preventing arcing between the contact pin **84** and the other contact pins, or between the contact pin **84** and the cylindrical shell **12**, while the plug **10** is in a disconnected state.

Referring now to FIGS. **3** and **4**, a receptacle assembly **92** is shown which is adapted to cooperate with the plug assembly **10** illustrated in FIGS. **1** and **2**. The receptacle assembly **92** includes a generally cylindrical housing **94**, which is preferably constructed of the same material as the cylindrical shell **12**. An outer end **96** of the housing **94** is tapered to receive a length of electrical cable **18**. As with the plug assembly **10**, a length of shrink tubing **20** may be used to seal the joint between the electrical cable **18** and the outer end **96** of the receptacle housing **94**. A cylindrical fitting **98**, preferably constructed of the same metal as housing **94**, is securely mounted within the housing **94**. The cylindrical fitting **98** extends substantially outward from the housing **94**, and includes a locking groove **100** located near its outwardly extended end. The locking groove **100** is adapted to cooperate with the ball bearing locking members **48** of the plug assembly **10**. A ring of spring fingers **102** is coupled to the cylindrical fitting **98** at a point within the housing **94**. The ring of spring fingers **102** is adapted to engage an outer rim **104** of the plug assembly **10** to both aid in the alignment of the plug assembly and the receptacle assembly, and to improve the mechanical coupling between the plug and receptacle. The ring of spring fingers **102** tends to bias the receptacle assembly toward a position at which its axis is parallel to the axis of the plug **10**. However, the ring of spring fingers also permits some flexing motion of the plug and receptacle about their joint axis, even after they are locked together.

A keyway **105** (see FIG. **4**) is provided in the upper portion of cylindrical fitting **98** for cooperating with the aligning key **52** of the plug **10**. Thus, the cooperating aligning key **52** and keyway **105** provide a rapid and convenient method of properly orienting the plug and receptacle assemblies to permit them to be easily and conveniently mated with one another.

A plurality of electrical leads **66** extends from the electrical cable **18** into the interior of receptacle housing **94**. The electrical leads **66** are individually coupled to a plurality of female connectors **106** through **118**. The arrangement of these connectors is illustrated more clearly in FIG. **4** as a generally circular symmetrical pattern surrounding a central female connector **118**. Obviously, this pattern must cooperate with the pattern of contact pins illustrated in FIG. **2**. Thus, large and small female connectors are illustrated for cooperating with the large and small contact pins illustrated in FIG. **1**. Again, it will be apparent to those skilled in the art that any suitable pattern of female connectors, and any suitable number of female connectors may be used, provided they cooperate with the pattern of contact pins selected for the plug assembly **10**.

A suitable potting material **68** is placed in the receptacle housing **94** to hold the electrical leads rigidly in place, and to seal the connections between the electrical leads **66** and the various female connectors **106** through **118**. An insulating receptacle cap **120**, which is preferably formed of molded glass epoxy, is mounted within the receptacle housing **94** and the cylindrical fitting **98**. The potting material **68** conforms to the inner surface of the receptacle cap **120**, forming a tight seal therewith. Each of the female connectors **106** through **118** extends through the receptacle cap **120** to permit insertion of the contact pins **72** through **84**, respectively, into them. The receptacle cap **120** is formed to include a recess **122** at the opening of each of the female connectors **106** through **118**. The recesses **122** are designed to cooperate with the sealing ridges **86** of the plug assembly **10** to hermetically seal all of the electrical connections when the plug and receptacle assemblies are mated. A cylindrical channel **124** is formed in the receptacle cap **120** between the main body of othe receptacle cap and the central female connector **118**. This channel is adapted to receive the shield **90** of plug assembly **10**. Similarly, a protruding cylindrical portion **126** of the receptacle cap **120** is adapted to interfit with the channel **88** of the plug assembly **10**.

The mating and locking of the plug and receptacle assemblies may be accomplished as follows. The locking cylinder **22** is first withdrawn either manually, or through the cables **28** against the biasing force of coil spring **32**. The locking cylinder must be withdrawn a sufficient distance so that its forward rim **42** is positioned adjacent the ball bearing locking members **48**. The receptacle **92** is then advanced toward the plug assembly **10**, with its keyway **105** aligned with the aligning key **52** of plug assembly **10**. The protruding cylindrical portion **126** of the receptacle assembly must also be positioned to slide over the shield **90** of the plug **10**. However, since the shield **90** is constructed of flexible silicone rubber, the shield **90** will bend slightly to accommodate the protruding cylindrical portion **126** of the receptacle, thereby aiding in the axial alignment of the receptacle and plug assemblies. The receptacle assembly **92** is then inserted into the plug, or vice versa, so that a camming surface **128** located at the protruding end of the cylindrical fitting **98** engages the ball bearing locking members **48**. The camming surface **128** forces the ball bearing locking members out through apertures **50** in the wall of cylindrical shell **12**, so that the ball bearing locking members protrude into an annular space defined by the outer surface of cylindrical shell **12** and the forward rim **42** of locking cylinder **22**. The receptacle assembly is then advanced until the contact pins **72** through **84** are firmly mated with the female connectors **106** through **118**, respectively, and the sealing ridges **86** are positioned in the recesses **122**. In this position, the locking groove **100** is positioned substantially adjacent to the ball bearing locking members **48**. The locking cylinder **22** may then be released, to move forward under the biasing force of coil spring **32**. The camming surface **44** on the locking cylinder **22** will thus force the ball bearing locking members **48** into the locking groove **100**. However, if the locking groove **100** is not fully aligned with the ball bearing locking members **48**, the locking cylinder **22** will not return to its fully closed position, in which its forward end **40** abuts the flange **38**. Thus, the lock condition indicator will be clearly visible, informing the operator of the connector that the connector assembly is not fully locked. The operator may then apply a pushing force

to the operating ring **56**, which will force the ball bearing locking members **48** down the inclined edges of locking groove **100**, until the ball bearing locking members are positively seated in the locking groove. In this condition, locking cylinder **22** will be fully closed, and the lock condition indicator **54** will no longer be visible.

To disconnect the plug and receptacle assemblies, the locking cylinder **22** is first withdrawn, and the receptacle **92** is pulled away from the plug assembly **10**. THis pulling motion causes the sloped edge of the locking groove **100** to cam the ball bearing locking members **48** out through apertures **50** into the space defined by the inner surface of the forward rim of the locking cylinder **22** and the outer surface of cylindrical shell **12**. The receptacle **92** may then be withdrawn completely from the plug assembly **10**.

Various modifications of the high voltage quick disconnect assembly of the present invention are possible. For example, the contact pins and the female connectors can be interchanged. Thus, the contact pins **72** through **84** can be positioned in the receptacle assembly **92**, and the female connectors **106** through **118** can be mounted in the plug assembly **10**. This reversal of the connector parts in no way influences or changes the operation of the present invention.

Plastic insulating covers can also be provided to cover the mating surfaces of the plug and receptacle assemblies, when the assemblies are not mated. These covers protect those handling the disconnected plug and receptacle assemblies from the danger of high voltage shocks, and also protect the connector assemblies from physical damage.

Although in the preferred embodiment of the invention described above, the insulating cap **70** of the plug assembly **10** is made of silicone rubber, it could also be made of harder, non-resilient molded glass epoxy, if desired. The receptacle cap **120** of the receptacle assembly **92** would then preferably be made of a soft, resilient material, such as silicone rubber.

Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A high voltage quick disconnect assembly comprising:

a plug assembly including a housing having an opening at one end thereof,

movable lock operating means mounted around at least a portion of said housing and movable axially of said housing,

actuating means coupled to said lock operating means for actuating said lock operating means,

a plurality of movable locking members positioned in apertures in said housing, said housing including means for limiting movement of said locking members inwardly of said housing, said locking members being movable outwardly of said housing,

a resilient biasing member surrounding the housing and located rearwardly of the locking members for biasing said lock operating means in a first direction,

said lock operating means including a plurality of surfaces for engaging and selectively positioning said plurality of locking members in locked and unlocked position,

indicating means mounted on said housing capable of providing a locked and unlocked visual indication and responsive to positioning of said locking members a predetermined distance outwardly from said point of limited inward movement thereof for providing said unlocked visual indication,

a first plurality of electrical connectors positioned within said housing, and

insulating means mounted within said housing surrounding at least a portion of said first plurality of electrical connectors,

receptacle means for mating with said plug assembly including:

a protruding portion shaped to fit into said opening in said housing, said protruding portion defining a locking groove means for interfitting with said plurality of locking members,

said receptacle means including a ring of spring fingers for resiliently engaging an outer surface of said housing of said plug assembly.

2. A high voltage quick disconnect assembly as in claim **1** wherein:

said receptacle means includes a second plurality of electrical connectors for engagement with said first plurality of electrical connectors.

3. A high voltage quick disconnect assembly as in claim **2**, wherein:

said receptacle means includes a body of insulating material surrounding at least a portion of said second plurality of electrical connectors,

said body of insulating material including a sealing configuration for forming a hermetical seal with said insulating means of said plug assembly.

4. A high voltage quick disconnect assembly as in claim **1**, wherein:

said insulating means includes a cap portion formed of a material which is resilient, highly insulative, and impervious to wide fluctuations in environmental temperatures.

5. A high voltage quick disconnect assembly as in claim **1**, wherein:

said insulating means includes a cap portion formed of silicone rubber.

6. A high voltage quick disconnect assembly as in claim **1**, wherein:

said first plurality of electrical connectors includes a plurality of connectors placed in a circular pattern and a first high voltage connector located at the center of said circular pattern,

a first tutublar insulating portion surrounding and extending beyond the end of said high voltage connector,

and receptacle means for mating with said plug assembly having a circular pattern of second connectors for cooperating with the first plurality of connectors and a second high voltage connector for engaging the first high voltage connector, and a tubular insulating portion surrounding the second high voltage connector and extending beyond the end thereof for mating with the first tubular portion.

7. A high voltage quick disconnect assembly as in claim **1**, wherein:

each of said locking members comprises a ball bearing.

8. A high voltage quick disconnect assembly as in claim **1**, wherein:

said indicating means comprises a ring of brightly colored material.

9. A high voltage quick disconnect assembly as in claim **1** wherein:

said plurality of surfaces includes a camming surface for forcing said plurality of locking members toward the interior of said housing as said lock operating means is moved in said first direction.

10. A high voltage quick disconnect assembly as in claim **1**, wherein:

said actuating means includes a protruding ring formed integral with said lock operating means.

11. A high voltage quick disconnect assembly as in claim **10**, further comprising:

a plurality of cables coupled to said protruding ring for permitting remote operation of said actuating means.

* * * * *