This invention relates to an electric plug connection with a hermetically sealed housing having a housing base member and a housing cover member, each of the members containing one of a pair of mating electric plug connectors. The invention encompasses a closure which, in a closed position elastically urges the two housing members together in a sealing relationship. The closure is in the form of a plate pivotally mounted on a shaft in the base housing member and is rotatable thereon until the rounded end portion of the closure is elastically secured to a shaft in the cover housing member. The closure has a gripping tongue which extends substantially perpendicular to the plane of the closure to provide ready access to the closure member for manipulation by an operator. In alternative forms of the invention, the closure may be adjustable in grip length or the distance between the shafts secured by the closure may be adjustable. In all of the embodiments of the invention, however, the closure cooperating with shafts disposed in the two housing members holds the shaft members against the biasing action of a resilient means in order to maintain the closure in a closed position and to maintain a hermetic seal between the two housing members.

4 Claims, 8 Drawing Figures
1 ELECTRIC PLUG CONNECTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electric plug connection, and in particular plug connectors in which two mating plug members are brought together in a hermetically sealed relationship.

2. Brief Description of the Prior Art

It has long been recognized in the art that hermetically sealed connectors are of significant value for use in electrical installation and on electrically controlled machines where it is required to mechanically couple the pins of a plug into the recess of a receptacle while further providing substantial mechanical integrity and protection against contamination in the environment.

Attempts to provide such a connector in the past have had relatively little success. In one known arrangement of connectors of this type, two pins are provided projecting out of opposite sides of the housing cover to be engaged by a pair of crescent-shaped latching members extending from the housing cover member. A lever means is mounted on the base housing cover and mounted on two axially projecting posts. The lever means comprises crescent-shaped extensions, such that, upon actuation of the lever means, the crescent-shaped extensions embrace the pins disposed on the cover housing member and clamp the two housing members hermetically against one another. Through a recess in the crescent-shaped extensions, the lever means is secured against releasing the engagement of the crescent-shaped extensions with the pins.

The above-mentioned prior art embodiment, however, has particular deficiencies, in that the clearance necessary for movement of the lever is quite large, thereby requiring a relatively large space to be provided surrounding the connector. In addition, the known arrangement has a further disadvantage, in that the crescent-shaped extensions, after multiple use, rapidly wear due to the sliding action of the crescent-shaped extensions along the pins. After several operations of the connector levers, the recesses in the crescent-shaped extensions begin to fail to hold the lever means in a secured position, and the housing may be easily opened under the influence of vibrations or inadvertent bumping of the connector.

BRIEF DESCRIPTION OF THE INVENTION

It is an object of the present invention to provide an electric plug connection of the above-mentioned type provided with a closure which is easily actuated, is designed to take up little space, and which is subject only to slight mechanical wear.

It is a further object of the invention to provide a closure for two mating plug connections mounted in respective housing covers such that, when the closure is closed, the housing members are hermetically sealed against the environment external to the housing members.

It is a further object of the invention to provide a closure of the type described above, in which the closure is adjustable in grip length to thereby accommodate variations in manufacturing tolerances and permanent deformations of the constituent parts of the plug connectors.

It is yet another object of the present invention to provide a closure for hermatically sealing a pair of electric plug connectors in which the members engageable by the closure are adjustable in position to accommodate manufacturing tolerances and wear of the closure and/or corresponding structure on the connectors engageable by the closure.

In accordance with the invention, there is provided a closure movably supported on one of the housing members and engageable with a closure element mounted on the other of the housing members, the engagement between the closure and the closure element being secured by the biasing action of an elastic means.

It will be appreciated that a multiplicity of such closures could be operatively mounted for effecting a hermetic seal between two mating plug connectors and housing members or that a single closure could be used in conjunction with a hinge or other means of securing the portions of the housing opposite the closure. For the purposes of explanation below, only a single closure is described, together with its associated parts on the housing members. It is to be understood, however, that two or more of the closures are contemplated to be utilized, if desired from among several.

To simplify manual fastening of the closure, it is advantageous to provide the closure with a gripping tongue protruding outwardly from the housing members and extending substantially perpendicular to the same.

A particularly space-saving arrangement is realized if the positioning and the mounting of the closure element is counter-sunk into the housing, in such a manner that in the closed position of the closure only the gripping tongue extends out of the housing surface. In this arrangement, the danger of damage to the critical portions of the closure and associated parts on the housing is avoided.

In order to provide the requisite hermetic sealing of the two opposing housing members, an elastic means is provided to maintain a sufficient and reliable hermetic seal between the housings.

In one embodiment of the invention, the elastic means is in the form of an elastic sealing ring mounted between the joining housing members, thereby tending to force the housing members apart against the gripping action of the closure.

The elastic means may also exist in the closure itself, the closure being constructed from elastic material. In this embodiment of the invention, a seal may be provided for the two housing members for the purposes of sealing the same, by the tensioning forces to maintain a reliable seal is accomplished by the elasticity of the closure member tending to force the two housing members together.

In a preferred embodiment of the invention, the housing closure is rotatably mounted on a shaft in the base housing member, while an end portion of the closure embraces another shaft disposed in the cover housing member, the end portion of the closure being rounded in construction to embrace the shaft in the cover housing member about a circumference of the shaft greater than 90°, and preferably about 140°.

In order to compensate for manufacturing tolerances extant in the production of the housing members and/or the closure, the closure may be provided with means for adjusting the grip length of the closure. Such an arrangement is implemented by providing the closure in two parts, the two parts being slidable with respect to one another, yet maintainable in a fixed de-
sired relative position, such that the grip length of the composite closure is set at a desired or predetermined amount. One means of producing such a construction of the closure is to provide on the mutually contacting surfaces of the two parts, a plurality of grooves which interengage, the two parts being held together at a predetermined grip length by the provision of a tightening screw.

Since the housing closure may be profitably constructed from a single piece of material, such as sheet material, it may be advantageous to provide an adjusting means for effectively adjusting the grip length by providing a means for varying the distance between the shaft upon which the closure is mounted and the shaft embraced by the rounded portion of the closure.

It is contemplated that the closure member may, in an alternative embodiment, be rotatably mounted on a shaft in the housing cover member rather than in the base housing member. In such an alternative embodiment, the direction of movement of the gripping tongue of the closure corresponds to the direction of movement of the housing cover upon opening and closing of the closure. In this manner, both operation of the closure and the motion to remove the housing cover member is easily accomplished by the operator.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages and features of the invention than those discussed above will be apparent from consideration of the following description taken in connection with the accompanying drawings. In the drawings:

FIG. 1 shows the front view of a housing with a closure according to the invention;

FIG. 2 shows the side view of the housing according to FIG. 1.

FIG. 3 shows the plan view of the housing according to FIG. 1.

FIG. 4 shows a closure according to the invention;

FIG. 5 shows a sectional illustration through a further embodiment of a closure according to the invention;

FIG. 6 shows the front view of a closure according to FIG. 5;

FIG. 7 shows the front view of a closure adjustable as to length, according to the invention; and

FIG. 8 shows a further embodiment of the closure according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The complete housing shown in FIG. 1 is composed of a housing cover member 1 and a housing base member 2. The plug connection arrangement within the interior of the housing, as well as the manner in which the cables supply the plugs, are not shown in the drawing and can be structured along the lines of known plug connection and cable assemblies. When fully assembled, cables can be routed to the separate housing members by means of passageways 3 and 4 in the housing members 1 and 2, respectively. The cable ends may be held in position by means of screw clamps and suitable seals.

Upon closure of the housing, the housing base member 2 engages in the housing cover member 1 until, as shown in FIG. 2, the base member comes into position in a step-like relationship with the housing cover member 1.

Situated between the upper edge of the base member 2 and the corresponding portion of the housing cover member 1 is an elastic means shown in FIG. 2 as an elastic sealing ring 5, surrounding the peripheral edge of the housing. The sealing ring 5 may be made of elastic material such as rubber or synthetic form tubular. FIG. 1 shows a pair of closure elements 6 disposed on opposite side walls of the housing 1,2. The closures are constructed from a basic sheet material such as sheet metal and shaped at one edge in the form of a cylindrical tube 13. The radius of the tubular portion of the closure is chosen to be pivotally mountable on a shaft 7 which is fixedly anchored in recess 8 of the housing base member 2. The housing cover member 1 is provided with corresponding recesses 9 in which a shaft 10 is supported. The closure 6 rotates about shaft 7 until a rounded portion 11 of closure 6 mates with and engages shaft 10 which acts as a mating closing element for the closure 6.

As viewed in FIG. 4, the closure 6 has two extended portions, one of which is disposed in the area of shaft 10 and is provided with a curved rounded portion 11 which is formed to partially surround shaft 10 by an angle of more than 90°, and preferably about 140°. The other extension of closure 6 is shown as a gripping tongue 12 which projects outwardly from the general plane of the closure 6, and when the closure is in a closed position, the gripping tongue 12 extends outwardly from the exterior of housing members 1 and 2. In order to protect the more critical parts of the closure 6 and the shafts 7 and 10, the shafts 7 and 10 are disposed within the housing members 2 and 1 in a recessed relationship therewith, so that tongue 12 is the only portion of the closure which projects exteriorly of the housing members 1 and 2. The open and closed position of closure 6 can be seen in the right and left hand sides, respectively, of the structure shown in FIG. 1.

FIGS. 2 and 3 show a side view and plan view respectively, of the housing 1,2 showing the plate-like form of closure 6. From both FIGS. 2 and 3, the relative width of the closure 6 with reference to the recesses 8 and 9 in housing members 2 and 1, respectively, is apparent.

The spacing between the pair of shafts 7 and 10 and/or the dimensions of the closure between the tubular portion 13 and the rounded portion 11 are so selected that the elastic ring 5 disposed in the housing, upon closing of the closure, is compressed, and thus a tensile force is exerted by the closure tending to draw the two shafts 7 and 10 together. Inasmuch as the rounded portion 11 of closure 6 spans the circumference of shaft 10 by more than 90°, the closure forms, together with the elastic means 5, a "snap-closure." FIG. 4 shows an enlarged illustration of the closure 6 in a closed position holding the two shafts 7 and 10 tensioned toward one another. From this illustration, it is apparent that the closure 6 may be formed from a single piece of sheet metal strip. The lower tubularly formed portion 13 of the closure element 6 is of narrower width than the remaining portion of the closure 6 so that the material required to form tubular portion 14 may be stamped from the material used to form the gripping tongue 12.

FIGS. 5 and 6 show a closure 14 comprised of two parts, namely a clasp part 15 and a gripping part 16. Both parts 15 and 16 are assembled as shown in FIG. 6 and welded together at preferably at least three points 38 by spot-welding techniques.
As indicated earlier, it is advantageous to provide a closure having an adjustable grip length. FIG. 7 shows an embodiment of an alternative closure 17, which in the embodiment shown in FIG. 7, is comprised of two parts, a gripping part 18 and a clasp part 21. The gripping part 18 comprises a gripping tongue 19 and a tubular portion 20 formed to rotate about shaft 7. As with the closure of FIG. 4, the rounded portion 23 of clasp part 21 is shaped to extend circumferentially about shaft 10 by at least 90°. Clasp part 21 has a generally flat plate portion 22, from which the rounded portion 23 extends, the flat portion of plate 22 being provided with grooves 24 extending parallel to the shafts 7 and 10. Similarly, the flat portion of part 18 is also provided with a similar set of grooves 24 which are selectively engageable with the grooves 24 of plate 22. In this manner, the grip length of the closure 17 is made variable by sliding the two parts 18 and 21 relative to each other to obtain the predetermined or desired grip length. In order to maintain the selected grip length, the part 18 is provided with a threaded aperture 25 for receiving the threads of a screw 26. The part 21 has an elongated slot 27 in the plate portion 22 thereof through which screw 26 passes. Thus, upon tightening the screw 26, the two parts 18 and 21 are clamped in a locked position. Upon wear and/or changes in closure members, the screw 26 can be loosened, parts 18 and 21 can be realigned to attain a different grip length, and screw 26 can be retightened.

Rather than providing a closure which can be adjusted in grip length, it may be more advantageous in certain applications to mount one of shafts 7 or 10 in its respective housing in an adjustable manner. FIG. 8 shows a closure pivotally mounted on shaft 30, fixedly mounted in base housing member 29, and gripping shaft 31 mounted in housing cover member 28. In the embodiment shown in FIG. 8, the shaft 31 is disposed within the housing cover member 28 and is adjustable vertically, (with reference to the view shown in FIG. 8) in grooves 32. To effect an adjustment of shaft 31, there is provided a set screw 33 having left hand and right hand threads 34 disposed on alternate sides of knurled member 35 which is used to rotate set screw 33. One end of the set screw 33 is threadedly received in a threaded recess 41 in housing cover member 28. The other end of set screw 33 is threadedly received in shaft 31 in a threaded aperture 42 passing vertically through shaft 31. Due to the opposite-handed thread arrangement of set screw 33, upon turning knurled member 35, the shaft 31 is drawn towards or away from the shaft 30 in the opposing housing member 29.

To secure the set screw 33 against loosening under vibration, etc., a lock nut 34 is provided to be tightened against the surface of shaft 31. A recess 40 may be provided in the upper portion of the closure 36 shown in FIG. 8 in order to avoid interference with the set screw 33 when the closure is in the closed position. A gripping tongue 37 is provided on closure 36 in the same manner as was previously discussed in connection with the other embodiments of the closure. It will be appreciated that in the embodiment shown in FIG. 8, the closure 36 can be rotatably supported on either of shafts 30 or 31 while the rounded portion of closure 36 can be adapted to receive the other of shafts 30 and 31. It is further contemplated that the lock nut may be provided on the upper portion of set screw 33 to lock against the lower surface of housing cover 28, rather than against shaft 31 as shown in FIG. 8.

The above description of the invention has been directed to preferred embodiments of the invention and should not be interpreted as being limited to the specific examples indicated. There are a great number of modifications of the invention which are possible without departing from the spirit and scope of the invention. For example, portions of the housing members themselves can be used in place of shafts 7 and 10. Further, rather than a variably adjustable positioning of the shafts 30 and 31, a series of in-line shafts provided such that the closures 6, 17, or 36 may be snap-fitted over whichever shaft corresponds to the appropriate grip length of the closure. Obviously, one of the two closures 6 shown in FIG. 1 can be replaced by a hinge between the two housing members 1 and 2, the clamping and sealing action of a single closure 6 providing the necessary and requisite forces to hermetically seal the housing. Additionally, the gripping tongues do not necessarily have to be constructed of the same material as the clasp-like part of the closure, e.g., the gripping tongue may be a synthetic material disposed on a rigid or flexible clasp-like part of the closure.

Thus, it is to be understood that the invention is not limited to the embodiments described herein and is intended to be limited only by the appended claims.

What we claim is:

1. An electrical plug connector comprising:
   a first plug member mounted in a first housing member,
   a second plug member adapted to mate with said first plug member and mounted in a second housing member,
   housing closure means movably supported on said first housing member and engageable with a closure element mounted on said second housing member,
   the engagement between said closure means and said closure element being secured by the biasing action of an elastic means interposed between the housing members,
   a first shaft slidably received in a mounting slot in one of said housing members,
   a second shaft supported in the other housing member,
   said closure means including a gripping tongue rotatably mounted on one of said shafts, having a rounded end portion forming a hook engageable with the other of said shafts, said rounded portion embracing said other shaft by more than 90° when said gripping tongue engages said other shaft,
   a set screw threadedly coupled to said first shaft at one end of said set screw and threadedly coupled to the housing member in which said first shaft is received at the other end of said set screw, the threads at said one end being opposite handed from the threads at said other end, and
   adjusting means intermediate the ends of said set screw for rotating said set screw, whereby turning of said adjusting means changes the position of said first shaft in said mounting slot and thereby adjusts the distance between said first and second shafts.

2. The connector as claimed in claim 1, wherein said gripping tongue is formed from a sheet material and said rounded end portion is provided with a recess...
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therein to avoid interference with said tongue by said set screw.
3. The connector as claimed in claim 1, wherein said closure is rotatably mounted on said shaft.

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4. The connector as claimed in claim 1, wherein said gripping tongue is rotatably mounted on said second shaft.

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