United States Patent [19]

Cochrane

[11] **3,855,568**

[45] **Dec. 17, 1974**

[54] **FORCED CONTACT ELECTRICAL CONNECTOR**

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[73] Assignee: **General Electric Company,** Philadelphia, Pa.

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[52] **U.S. Cl.** ..... **339/95 R,** 339/183, 339/262 R

[51] **Int. Cl.** **H01r 9/06**

[58] **Field of Search** 339/95, 259, 262, 182, 339/183, 258

[56] **References Cited**

UNITED STATES PATENTS

2,533,343	12/1950	Bac	339/259 R
3,383,648	5/1968	Tems	339/242
3,614,717	10/1971	Boersma et al.	339/262 R

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[57] **ABSTRACT**

Female contact elements are a stacked plurality of dished washers radially slotted from the central hole toward the outer edge so that they form a plurality of flexible fingers which extend in the direction from which a male rod connector (or plug) is inserted. A pressure shoulder on the male rod presses against the fingers of the first washer, forcing the fingers toward the plane of the outside edge of the washer, and causing their tips to move centrally and press firmly against the male rod. In so moving, the fingers press against those of the next washer in the stack, similarly pressing its fingers against the male rod. The female contact elements are mounted in an elastomeric housing whose open, or male rod receiving, end is provided at its end with an inside lip which closes over a retainer shoulder on the male rod, retaining it in place against the reaction forces of the washer fingers, which would tend to push it out. The retainer shoulder may be axially elongated to form a sealing plug which will seal the connector against the entry of external fluids. The device is particularly suitable for providing a heavy current path, with high contact pressures, even in the presence of an ambient insulating fluid, such as oil.

3 Claims, 3 Drawing Figures

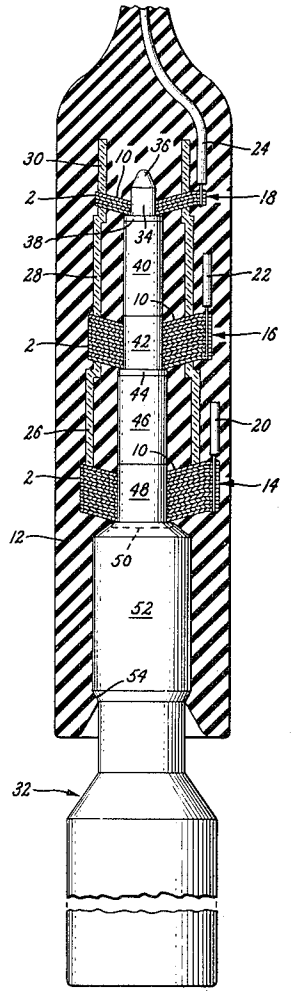


Fig. 1.

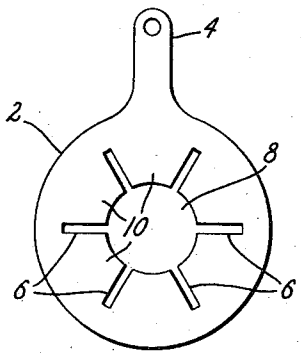


Fig. 2.

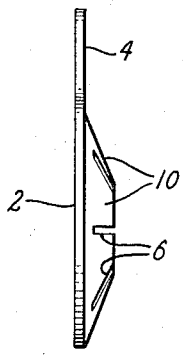
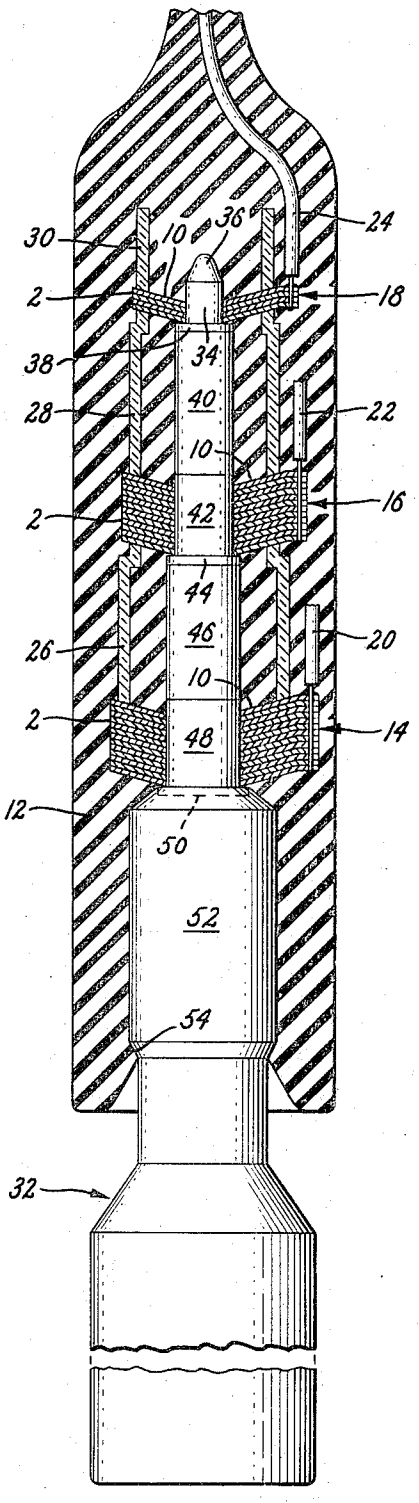


Fig. 3.



FORCED CONTACT ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention pertains to the art of plug and receptacle type electrical connectors.

2. Description of the Prior Art

The use of flexible fingers, both separate and as integral parts of a washer, is in general well known. Bels, U.S. Pat. No. 2,423,548, discloses a contact for engaging contact sleeves of a stepped vacuum tube, conventionally known as a lighthouse tube. His problem is to provide a self-centering contact array in which the force required to effect complete engagement between the contact member and the contact array is minimized. To this end he employs stacks of washers having V-shaped internal fingers (35 of FIG. 2*a*) which make contact by their own elasticity without any supplemental pressure applied to them (FIG. 1) and which extend away from the direction from which the male contact is inerted in them. Bac, U.S. Pat. No. 2,533,343, teaches the use of a plurality of frusto-conical washers, slotted to provide fingers which in all his several embodiments extend away from the direction of entrance into engagement of the mating electrode, and are not subject to additional locking pressure.

Vanderhoof, U.S. Pat. No. 2,652,522, discloses a locking type washer (4 or 5 of FIG. 1) whose internal fingers are not for electrical connection, but engage an insulating sleeve 1 for mechanical retention, and which make electrical connection only by the pressure of their smooth circular body 6 against flat rectifier plates 2; the internal fingers of the washers make no electrical contact. Tems, U.S. Pat. No. 3,383,648, discloses the use in a tube socket of fingers similar to those of Bac.

Daniels, U.S. Pat. No. 3,193,636; Neidecker, U.S. Pat. No. 3,161,451; Kielenstijn, U.S. Pat. No. 2,762,990; Jonaitis, U.S. Pat. No. 2,691,770; and Page, U.S. Pat. No. 2,551,630 deal with various types of connectors but are too obviously not pertinent to the present invention to merit discussion despite their listing for completeness.

SUMMARY OF THE INVENTION

The invention is of a connector comprising a plug and mating receptacle so constructed that a plurality of flexible contact fingers are forced strongly against (and may actually dig into) a generally smooth mating surface. This feature increases the possibility of penetrating any insulating or highly resistive layer between the mating surfaces, such as oil or an oxide coating, and tends to produce a very low resistance contact suitable for passing heavy currents such as are required for driving large mechanical equipment.

The receptacle comprises an elastomeric housing in which there is provided at least one stack of washers, dished in the direction from which the male member or plug is inserted, and radially slotted from their central periphery part way to their outer periphery, thereby forming a number of contact fingers. The plug contact is a rod having an associated shoulder which, when the plug is inserted, presses against the radial fingers of the first washer nearest the point of insertion, forcing those fingers radially inward so that they are pressed strongly against the central rod of the plug. The displacement of the fingers of the first washer causes them to similarly displace the fingers of the next washer, and similarly throughout the stack. The undisplaced fingers may, prior to their displacement by the shoulder of the rod, actually be clear of the rod so that the initial insertion of the plug encounters negligible resistance. An internally directed lip at the end of the receptacle housing, around the aperture at which the plug is inserted, is provided to surround the end of the plug and lock it in place against the pressure of the fingers upon the shoulder of the central rod of the plug. This lip also wipes clean the male sealing surface of the rubber on rubber, high pressure sealing system.

The foregoing description pertains to the simplest case, of a single pole connector. However, the plug may be a composite of several coaxial sleeves, insulated from each other, the outer sleeve being the shortest and engaging a first stack of disks. The next sleeve is somewhat longer and of smaller diameter, and extends into a second stack of disks of smaller internal opening, appropriately insulated from the first stack. The number of separate circuits which may be connected is, of course, equal to the number of separate sleeves and matching stacks of disks.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a dish washer;

FIG. 2 is an elevation of the washer;

FIG. 3 is a sectional view of the receptacle and plug.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 are plan and elevation, respectively of a dished washer 2, which is provided with a soldering tab 4, and has radial slots 6 extending from its central opening 8 only partly toward its outside periphery, forming contact fingers 10. A typical thickness for the material of dished washer 2 would be five thousandths of an inch, and a conventional material would be beryllium copper alloy or phosphor bronze. Any conventional spring contact material may be used; composite laminated of good spring material with highly conductive metal may be particularly suitable for very high current applications.

FIG. 3 represents partly in section a receptable according to my invention with a plug inserted. The receptable housing 12 is of an insulating elastomeric material, and may conveniently be a molded rubber composition. Three stacks 14, 16, and 18 of dished washers 2 are connected respectively to conductors 20, 22, and 24 passing through the holes in the soldering tabs 4 of the dished washers 2. One might, by suitable tooling, mold the various stacks into position directly into housing 12, and so formulate and cure the housing 12 that the dished washers 2 of the various stacks 14, 16, and 18, would be retained with sufficient rigidity that the contact fingers 10 would be forced into strong contact with the central plug. As a preferred design, I provide insulating spacers, conveniently ceramic, 26, 28, and 30 to provide a rigid separation and spacing of the successive stacks 14, 16, and 18 as represented in the drawing. The plug 32 is somewhat more conventional in structure, being somewhat similar to a telephone plug, with a central conductive rod 34, which has preferably a somewhat rounded or tapered tip 36. Rod 34 is insulated, conveniently by a sleeve not shown, below shoulder 38, the portion above the shoulder being bare

for contact with the contact fingers **10** of washer stack **18.** An insulating sleeve **40** extends from the lower side of shoulder **38** (which may be a washer fastened by brazing or other suitable means to rod **34,** or may be formed by machining rod **34** from a larger diameter stock) to the conductive surface of sleeve **42,** which engages the contact fingers **10** of the washers **2** of stack **16** when they are displaced by shoulder **44.** Similarly, insulating sleeve **46** extends from shoulder **44** to sleeve **48,** the third conductive part of plug **32,** which engages the contact fingers **10** of the washers **2** of stack **14** when these are displaced by the shoulder **50.** Below shoulder **50,** and forming actually a continuation of it, an enlargement **52** is provided to fit snugly into the mating part of housing **12,** chamfered at its lower end for better locking of the plug in place by lip **54** against the reaction forces of the various displaced contact fingers **10.** This enlargement **52** also provides a seal against the entry of external fluid. Alternative means of fastening, such as a threaded locking ring, may be preferable for particular applications, particularly in large embodiments with large contact areas provided by large members of large contact fingers **10.**

It is an advantage of this invention that the undisplaced contact fingers **10** may be so spaced that they clear the portion of the plug **32** during initial insertion of the plug so that the application of force to displace them into contact is required only during the final seating of the plug in the receptacle. This is an appreciable convenience in operation in cramped or otherwise inconvenient environment, since alignment of the plug in the receptacle is accomplished against minimal forces. If a locking ring or sleeve is used, it may be made long enough so that the final greater force is provided with the mechanical advantage provided by the thread in the locking ring. Removal of the plug is aided by the reaction forces from the contact fingers **10.**

It is possible to invert the preferred embodiment, that is, to turn it inside out and have the smooth mating surfaces and displacing shoulders in the receptacle, and equip the plug with dished washers which are slit from the outside toward the center. This has the disadvantage that the contact fingers in such a design are exposed to mechanical damage in handling of the plug, and would ordinarily not be desirable.

The preferred embodiment can function even if the plug is coated with some nonconductive material, such as oil, since the contact fingers **10** will be forced through the oil film. If it were desired to operate under such conditions that the space inside receptacle housing **12** were completely filled with, e.g., oil, it mibht be desirable to provide a vent to permit exit of excess oil during the insertion of the plug. Oil filling would prevent corona between the various stacks **14, 16,** and **18;** but the design of the preferred embodiment readily permits any desired spacing between these at no cost except increased length, so that oil filling appears not to be a preferred stratagem under ordinary circumstances.

While the preferred embodiment has included an elastomeric housing, electrically insulating, it is clear that a rigid housing may be employed where the conditions render one suitable, in which case the locking means provided by lip **54** must be replaced by some other means such as the threaded locking ring previously mentioned. Similarly, if the plug and receptacle is employed as a grounding connection, it may be permissible to make the entire housing of the receptacle and (depending upon the application requirements) possibly also the plug, completely of conductive material. In such case the stacks of disks **2** would not require to be insulated.

Since it is desirable to employ some generalization in particularly pointing out what I consider to be my invention, it is pointed out that the rod **34** and sleeves **42** and **48** are circularly cylindrical contact surfaces, and that the protruding shoulder which displaces contact fingers **10** into contact with one of them may be stated to be not only adjacent to but associated with it. The lip **54** of the receptacle housing, or its substitutes such as a threaded locking ring, constitute retaining means. It is evident from the drawings that the protruding shoulder must, to permit insertion of the plug into the receptacle, be no greater in diameter than the next adjacent contact surface with which the shoulder is not associated.

I claim:

1. An electrical connector comprising a plug and receptacle in which

a. the plug comprises a first circularly cylindrical portion including a contact surface and a second circularly cylindrical portion positioned contiguous and concentric with said first portion and having a greater diameter than said first portion, the second portion thus providing a protruding shoulder of greater diameter than the contact surface contiguous to the contact surface and associated therewith;

b. the receptacle comprises a stack of annular dished washers slotted from their inner periphery to from a plurality of centrally extending contact fingers, the said dished washers in the stack being stacked against one another with their contact fingers extending in the direction from which the plug is to be inserted;

c. retaining means are provided to retain the plug in the receptacle with the protruding shoulder displacing the contact fingers into contact with the associated contact surface of the plug.

2. The connector claimed in claim **1** which

d. the plug comprises a plurality of contact surfaces each with an associated protruding shoulder as recited in a) of claim **1,** and the diameter of each protruding shoulder is not greater than the diameter of the next adjacent contact surface with which the shoulder is not associated; and

e. the receptacle comprises a plurality of stacks of dished washers, the number of such stacks being equal to the number of contact surfaces in the plug, each such stack being so located in the receptacle and having contact fingers of such dimensions that they can be displaced by a protruding shoulder into contact with the contact surface associated with the protruding shoulder simultaneously with similar displacement of the contact fingers of each of the other stacks of the plurality into contact with a contact surface by the protruding shoulder associated therewith.

3. The connector claimed in claim **2** in which each contact surface of the said plurality thereof is insulated from the others, and each stack of dished washers is insulated from all the other stacks of the said plurality thereof.

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