July 9, 1963 J. A. COOLEY 3,097,031

ELECTRICAL CONNECTOR

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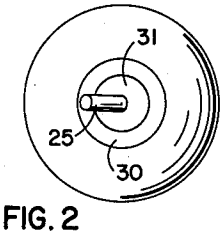

FIG. 2

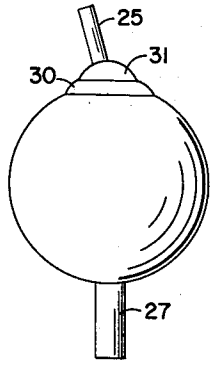

FIG. 3

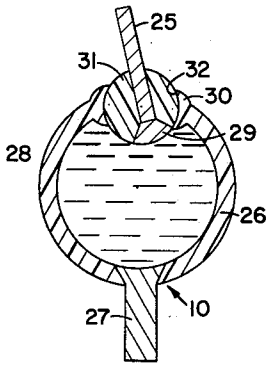

FIG. 1

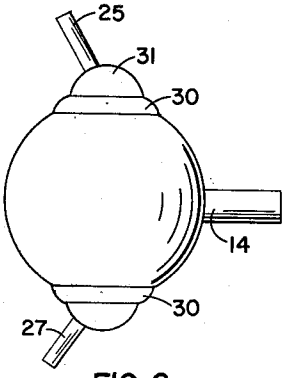

FIG. 6

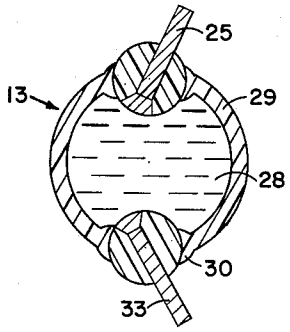

FIG. 4

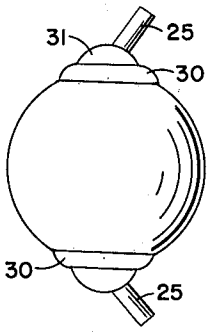

FIG. 5

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ELECTRICAL CONNECTOR

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The invention set forth herein may be manufactured and used by or for the Government for governmental purposes, without the payment of royalty thereon.

This invention pertains to electrical conductors, and in particular to movable electrical connectors capable of connecting together two or more circuits either directly or selectively.

This invention pertains to electrical connectors, and in various ways, but generally these ways fall into two main groups; connections between two points by means of a flexible solid conductor, or connection between two points by means of movable contacts. Each of these methods has its own disadvantages. The flexible solid connector, such as braided wire, etc., is limited in its movements (for example, it cannot be used to connect to a rotating member) and the material of which it is made is subject to fatigue and subsequent breakage. On the other hand, movable contacts, such as are found in switches, armatures, and slip-rings are subject to sparking, corrosion, poor connections due to oxidation, vibration and wear, and to frictional losses of energy. Therefore, it is the purpose of this invention to provide a movable electrical connector which is not subject to fatigue, breakage, wear, sparking, corrosion, oxidization or vibration, and which is relatively unlimited in its movement, and which has minimal frictiona llosses.

Heavy liquid metals are known in the art for use as slip-rings, switches and movable contacts. The prior attempts to utilize the desirable properties of conductive fluid, however, have either been unsuccessful or they have been unduly cumbersome. The two most common approaches to the problem have been the use of centrifugal force to keep the liquid in the desired location, or liquid metal wetted sponges, as described by H. W. Cole in U.S. Patent 2,890,304. Both of these methods are clumsy and complex, hence not entirely satisfactory. The difficulty in getting a movable seal, between two parts, of sufficient tightness has prevented simpler structures from being made. In addition, the great corrosive power of many liquid metals in contact with other metals complicates the problem. I have found, however, that certain organic plastic materials, especially Teflon and nylon have certain desirable properties which permit them to be used in a sealed structure of the type desired.

Firstly, these materials have low coefficients of friction and are non-corrosible, enabling their use as moving parts without a lubricant. Secondly, the materials of this group are quite resilient, hence enabling their use in applications where small negative clearances are employed. Thirdly, these materials form a seal between smooth pieces. This seal has some of the properties of an adhesive force, and is fluid-tight. Because of the nature of the seal, such seals will be herein referred to as—"solid molecular interface journals." This invention, then utilizes these solid molecular interface journals to obtain a freely movable connection through a liquid metal medium without the danger of leakage or corrosion.

Other advantages and features of this invention will become evident through the following specification, taken in connection with the illustrations, in which:

FIGURE 1 is a cross section of a first embodiment of the invention.

FIGURE 2 is a top view of the first embodiment.

FIGURE 3 is a side view of the first embodiment.

FIGURE 4 is a cross section of a second embodiment.

FIGURE 5 is a side view of the second embodiment.

FIGURE 6 is a side view of a modification of the second embodiment.

Referring now to FIGURE 1, an elementary embodiment **10** of the invention is shown. A Teflon body **26** is formed in the shape of a hollow sphere having a rounded lip **30** curved on the inside edge. This curved inside edge mates with a Teflon ball **31** holding a conducting element **25** imbedded in it. The juncture of the ball and the body **26** forms a solid molecular interface journal **32** which prevents leakage of a metallic fluid **28**, which fills the body **26**. In this case the metallic fluid **28** is mercury. The conducting element **25** has an enlarged contact face **29** which is wet by the mercury **28**. A second, similar conducting element **27** is imbedded in the case **26**, in order to make contact with the mercury. Both conducting elements are extended to the outside of the unit for connection to apparatus in which the invention is to be used, thus forming a connection means. FIGURE 2 is a top view of the device of FIGURE 1, while FIGURE 3 shows a side view of the device. It can be seen that the ball-joint with its conductor **25** is free to move in the manner of a universal joint, while still maintaining a non-corrosible contact with the relatively stationary conductor **27**.

FIGURE 4 gives another form of the invention which might be used to connect together two movable parts.

The device **13** of FIGURE 4 varies from that of FIGURES 1, 2 and 3 by the presence of two movable conducting elements, **25** and **33**. The second movable conducting element **33** is constructed in the same manner as the first moving conducting element **25**. Chains of these movable connectors may be made for a flexible, non-wearing connector to a part of parts of apparatus (not shown) having complex motions. FIGURE 5 shows a side view of the embodiment of FIGURE 4. FIGURE 6 shows a modification of the embodiment of FIGURE 4, in which a third, stationary, conductive element **14**, similar to that **27** of FIGURE 1 is added. This allows connection from one item to two other items (not shown) having movement relative to the first and, possibly, to each other. From this it may be seen that almost any number of connections, both stationary and movable may be made on the some unit, according to the use to which the device is to be put.

Those familiar with the art will perceive that the principles set forth here, alone and in combination, comprise an improvement over the art of liquid metal contact devices, by virtue of the herein described solid molecular interface journal, and they will also realize that many other embodiments are obvious; hence it is desired that the following claims not be limited by the foregoing embodiments. What, therefore, is claimed as new, and it is desired to secure by Letters Patent of the United States is:

I claim:

1. An electrical connector comprising a hollow sphere, said sphere being made of a non-conductive material and having at least a first and second opening therein, said first opening being closed by a rotatable, non-conductive solid sphere having an electrical conductor embedded therein, one end of said electrical conductor disposed in a flush relationship with the outside surface of said solid sphere and the other end of said electrical conductor extending through said solid sphere and externally of said hollow sphere, a second electrical conductor disposed in and closing said second opening and extending externally of said hollow sphere, a liquid metal enclosed by said hollow sphere and in contact with said solid sphere and each of said electrical conductors so as to provide a continuous path for current flow, one portion of said solid sphere disposed outside the hollow sphere and another portion of said solid sphere disposed inside the hollow sphere.

2. An electrical connector comprising a hollow sphere, said sphere being made of a non-conductive material and having at least a pair of openings therein, each of said openings being closed by a rotatable, non-conductive solid sphere having an electrical conductor embedded therein, one end of each of said electrical conductors disposed in a flush relationship with the outside surface of said solid sphere, the other end of each of said electrical conductors extending through said solid sphere and extending externally of said hollow sphere, a liquid metal enclosed by said hollow sphere and in contact with each of said electrical conductors so as to provide a continuous path for current flow, one portion of each of said solid spheres disposed outside the hollow sphere and another portion of each of said solid spheres disposed inside the hollow sphere.

References Cited in the file of this patent

UNITED STATES PATENTS

1,170,388	Anschutz-Kaempfe	Feb. 1, 1916
1,667,660	Gehm	Apr. 24, 1928
1,852,366	Pietenpol et al.	Apr. 5, 1932
2,179,693	Goldstein	Nov. 14, 1939
2,702,890	Hildebrandt	Feb. 22, 1955
2,716,223	Griefen	Aug. 23, 1955
2,889,531	Ellerman et al.	June 2, 1959