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R. J. O'NEILL
ELECTRIC SWITCH

2,856,486

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2 Sheets-Sheet 1

Fig. 1

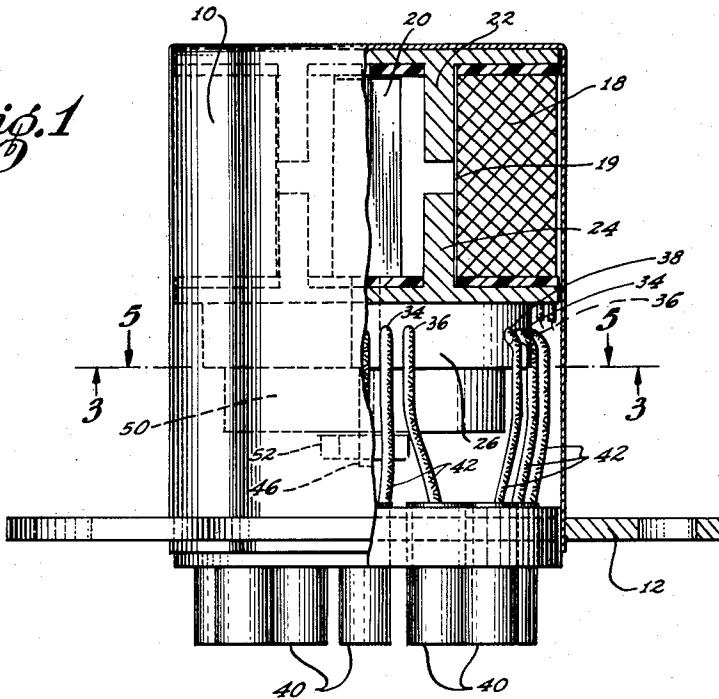
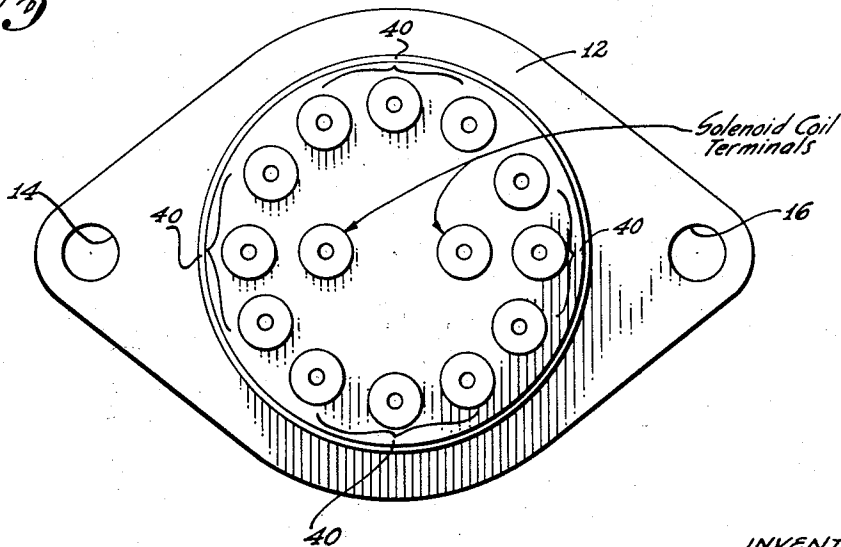


Fig. 2



INVENTOR:
Richard J. O'Neill

Be Smyth & Roston
Attorneys

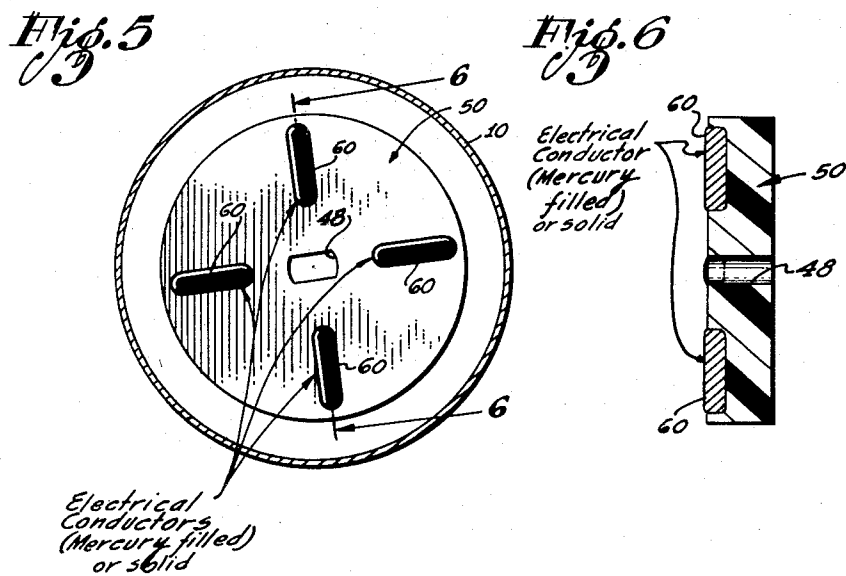
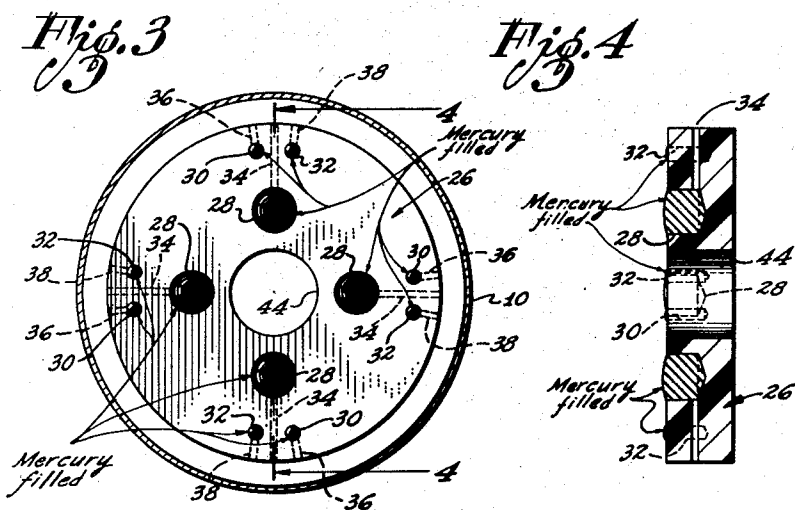
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INVENTOR
Richard J. O'Neill

By *Ameyth & Roston*
Attorneys

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ELECTRIC SWITCH

Richard J. O'Neill, Fullerton, Calif.

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4 Claims. (Cl. 200—112)

The present invention relates to electric switches employing a conductive liquid, such as mercury, as a contact medium.

Mercury switches in general are extremely well known, and a large variety of such switches are in widespread use at the present time. Prior art mercury switches, however, for the most part are limited to the single-pole-single-throw variety; and such prior art switches usually depend upon the gravity flow of a pool of mercury to establish or break electric contact between a pair of fixed solid contacts.

The present invention also uses a fluid, such as mercury, for establishing selective contact between a plurality of switch terminals. However, in accordance with the present invention, and unlike the prior art switches, a series of pools of mercury are supported in grooves in a unique manner in the structure of the invention for selective contact with one another. Such use of coating pools of mercury, and in a manner to be described, provides for feasible and convenient structures for the multiple switching function of the multiple-pole-multiple-throw type of switch.

In one embodiment of the invention, a pair of members of insulating material that are not susceptible to being "wetted" by mercury are mounted in close-fitting coating face-to-face relation for relative movement with respect to one another. A series of grooves or depressions are formed in the coating faces of the members, and these grooves are adapted to hold individual isolated pools of mercury which are electrically insulated from one another. Terminal connections are made to the individual pools on at least one of the members. Then, as the members are moved with respect to one another, the mercury pools in the grooves on one of the coating faces establishes selective connections between the isolated mercury pools on the other. This provides switching contact between the various terminals of the switch, and in accordance with a predetermined pattern.

Mercury switches of the present invention, as described in the preceding paragraph, are well suited for multiple-pole-multiple-throw switching operations. This obtains because not only can each of the described pairs of coacting insulating members support a plurality of liquid make-and-break switching contacts, but a series of such pairs of members can be stacked on a single operating shaft for multiple simultaneous operation.

Switches constructed in accordance with the invention, such as described above, have many inherent favorable features and characteristics. For example, the moving parts of the switch are reduced essentially to a pair of rugged insulating members. Switches constructed in accordance with the invention are, therefore, extremely reliable and capable of long trouble-free use.

The insulating members referred to above may be composed of any suitable plastic which exhibits the desired electrical insulating properties and which is not subject to being "wetted" by the liquid contact material. For example, "Teflon" is ideal for the purpose because it is long

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wearing and self-lubricating, in addition to possessing superior insulating characteristics and not being susceptible to wetting by mercury.

The switching structure of the invention also exhibits favorable electrical characteristics. The liquid is not subject to oxidation because it is almost completely enclosed. The contacts, moreover, are self-cleaning and any oxidation that might occur is rubbed off by the coating faces of the members and the mutual engagement of the liquid pools. Therefore, the contacts continue to exhibit low contact resistance even after long periods of use. This, plus the fact that there is no arcing problem involved in this type of switch, provides a long life for the switches and eliminates any contact maintenance problems.

The switch of the invention also is small in size. This renders the switch suitable for a wide variety of uses in which a multiplicity of switching operations are required and where space is at a premium. Present day computers are a typical example of such an application, and switches constructed in accordance with the invention are well suited for use in computers and similar complicated equipment.

The embodiment of the invention illustrated in the accompanying drawings and which will be described in detail is a solenoid controlled type of switch. However, it will be evident as the description proceeds that the switch is not limited to any particular control. In fact, any suitable control, either electrical, magnetic, mechanical or manual, and so on, could be used. For example, switches constructed in accordance with the invention may be provided with a manually operable control shaft and with a threaded bushing for mounting on a control panel.

It will also be evident from the ensuing description that although two mutually rotatable discs form the coacting insulating members of the illustrated embodiment of the invention, these insulating members need not necessarily be discs, nor need their movement with respect to one another necessarily be rotational. When rotating discs are used, however, it would appear that a more convenient mechanical construction can be realized. The use of rotatable discs and the like also adapts the structure to further applications, such as commutators in direct current machinery, and the like.

Other features and advantages of the present invention will become apparent from the following description, particularly when taken in connection with the accompanying drawings, in which:

Figure 1 is a partly sectional, side elevational view on an enlarged scale of a solenoid actuated, multiple contact rotary switching assembly constructed in accordance with the invention;

Figure 2 is a bottom view of the switching assembly showing the various terminals of the switch and also showing an appropriate wafer bracket for mounting the switch on a supporting chassis;

Figure 3 is a cross-sectional view of the switching assembly of Figure 1, substantially on the line 3—3, illustrating the surface of a stationary disc-like insulating member incorporated in the assembly;

Figure 4 is a sectional view of the disc-like insulating member of Figure 3, substantially on the line 4—4, illustrating certain circular depressions formed in the disc and also showing conduits for such depressions extending radially from respective ones of the depressions to the rim of the disc-like member;

Figure 5 is a cross-sectional view of the switching assembly of Figure 1, substantially on the line 5—5 of Figure 1, showing the face of a rotatable disc-like insulating member which coacts with a face of the stationary disc-like member of Figure 3; and

Figure 6 is a sectional view of the rotatable disc-like

insulating member of Figure 5 taken along the line 6—6 and showing two of a group of radial grooves formed in the coating face of that disc-like member.

The switching assembly illustrated in the drawings includes a housing 10 which may be supported on any conveniently shaped mounting bracket 12. The bracket 12 may, for example, be a wafer with a usual elliptical shape and with a pair of mounting holes 14 and 16 at its opposite ends. As previously noted, the bracket 12 serves to support the assembly on a suitable chassis.

The switching structure itself may be suspended from the top of the housing, and it includes an energizing winding 18. The energizing winding is wound on a tubular core 19, and an armature 20 is pivotally mounted within the tubular core for pivotal motion about the longitudinal axis of the core. The core includes a pair of pole pieces 22 and 24 which extend within the core. The armature 20 is mounted within the housing for limited rotational movement about the longitudinal axis of the core, and the pole pieces 22 and 24 are shaped so that the armature is moved from one annular position about this axis to another when the winding 18 is energized. The armature then returns to its first angular position when the winding 18 is deenergized.

The assembly described in the preceding paragraph is a usual rotary solenoid. Since this construction is known, a more detailed description is not believed to be necessary. Moreover, and as pointed out previously, this represents but one possible control for the assembly.

The switching assembly includes a stationary disc-like member 26 of insulating material. This member may be fastened to the bottom of the energizing winding assembly by appropriate screws, not shown, or by any other suitable means. As mentioned earlier, it is desirable for the member 26 to exhibit good insulating properties, and that it be non-wettable by mercury.

The stationary insulating disc-like member 26 has a series of circular depressions 28 formed in its lower surface. These depressions are positioned equi-distantly from the center of the member 26, in the illustrated embodiment of the invention, and they are disposed at equi-distant angular positions about a circular path.

A particular number and disposition of the depressions 28 is shown in the illustrated embodiment. However, it is to be understood that more or less depressions, and other patterns, may be used depending upon the application to which the switch is to be put.

Two depressions 30 and 32 are respectively associated with each of the depressions 28. These depressions 30 and 32 are also positioned equi-distantly from the center of the disc-like member 26, and they, too, extend around a circular path and are disposed at equi-distant angular points. The radius of the circular path of the depressions 30 and 32 is greater than the radius of the circular path of the depressions 28.

The relation between each of the depressions 28 and its associated depressions 30 and 32 in the pattern of the particular illustrated embodiment is such that each depression 30 is displaced on one side of the radial axis from the center of the disc-like member 26 through its corresponding depression 28, and the associated depression 32 lies on the other side of this radial axis.

Each of the depressions 28 has a radial conduit 34 extending from it to the rim of the disc-like member 26. Likewise, each of the depressions 30 has a radial conduit 36 extending from it to the rim of the disc-like member 26, and each of the depressions 32 has a radial conduit 38 extending from it to the rim of the disc-like member.

All of the depressions 28, 30 and 32 are intended to be filled with a liquid electrically conductive substance, such as mercury. A plurality of isolated pools of mercury are thereby formed on the face of the disc-like member 26, and these pools are electrically insulated from one another.

As shown, for example in Figures 1 and 2, a plurality of electrically conductive terminals 40 extend through the bottom of the housing 10. The housing bottom may conveniently be an insulating disc, and this disc serves to support the terminals in mutually insulated relation. A plurality of electrical connections, such as the lead 42 respectively connect individual ones of the terminals 40 with corresponding ones of the mercury pools in the depressions 28, 30 and 32 in the lower face of the stationary disc 26. These connections extend into respective ones of the conduits 34, 36 and 38 to establish the desired individual electrical connections to the various pools of mercury.

It will be appreciated, that at each group of pools in the depressions 28, 30 and 32, the fixed contacts of a single-pole-double-throw switch are formed, with a connection between the mercury in the depression 28 and the mercury in the depression 32 establishing one operative condition for the switch, and a connection between the mercury in the depression 28 and the mercury in the depression 30 establishing a second operative condition for the switch.

The stationary disc-like member 26 has a central aperture 44 which permits the drive shaft 46 from the armature 20 to extend through this member. This drive shaft also extends through a central aperture 48 in a rotatable insulating disc-like member 50. This latter armature has a rectangular configuration which is shaped to conform with the configuration of the drive shaft 46. Therefore, rotation of this shaft by the armature 20 causes the disc-like member 50 to rotate. A nut 52 threadably engages the bottom of the shaft 46 to hold the disc-like member 50 in coaxial relation with a stationary disc-like member 26, and with the upper face of the member 50 coacting with the lower face of the member 26 in close contact.

The drive shaft 46 is affixed to the armature 20, so that the limited rotation of the armature from one angular position to another when the energizing winding 18 is energized and deenergized produces a corresponding limited rotation to the shaft. The aperture 48 in the disc-like member 50 is of rectangular shape, as noted above, to engage the shaft and to cause that member to rotate as the shaft is rotated in its limited extent. The shaft 46, however, passes freely through the aperture 44 in the stationary disc-like member 26. Therefore, when the winding 18 is energized, the resulting rotation of the drive-shaft 46 causes the disc-like member 50 to rotate with respect to the disc-like member 26 from one predetermined angular position to another. Likewise, the control is such that when the energizing winding 18 is deenergized, the member 50 is rotated in the opposite direction with respect to the member 26 back to its first angular position.

The rotatable member 50, like the member 26, is composed of a suitable insulating material that is not wettable by mercury. This latter member 50 has a series of radial depressions or grooves 60 formed on its upper surface. This is the surface of the rotatable member 50 which coacts with the lower surface of the stationary member 26.

The grooves 60 extend radially outwardly from the center of the disc-like member 50, and they correspond in number to the number of depressions 28 in the lower face of the stationary member 26.

The grooves 60 are so positioned that in one angular position of the rotatable member 50 corresponding, for example, to its position when the winding 18 is not energized, each of the grooves 60 extends across a corresponding depression 28 and across its associated depression 30 to bridge these latter two depressions. Then, when the rotatable member 50 moves to its second angular position, corresponding, for example, to its position when the winding 18 is energized, each groove 60 extends across the corresponding depression 28 and its associated depression 32 to bridge these latter depressions.

The grooves 60 are also adapted to be filled with mercury or other liquid conductor. Therefore, the limited

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rotation of the disc 50 with respect to the disc 26 causes the mercury in the depressions 28 to be connected by the mercury in the grooves 60 either to the mercury in the depressions 30 or to the mercury in the depressions 32.

Therefore, and as previously stated, a multiplicity of single-pole-double-throw multiple switches are effectively formed between each group of depressions 28, 30 and 32.

Switches constructed in accordance with the invention may be extremely small. For example, a constructed embodiment of the particular switch described above was made with the following dimensions, which are listed herein merely by way of example:

Disc-like member 26:	Inches
Diameter -----	.750
Thickness -----	.125
Disc-like member 50:	
Diameter -----	.700
Thickness -----	.125
Casing 10:	
Height -----	1.350
Diameter -----	1.000

The switching assembly of the invention is susceptible to simple and convenient construction. For example, the depressions in the disc-like members 26 and 50 may be filled with mercury in a convenient manner. This may be done merely by immersing the members in a mercury bath, and by clamping them together as they are withdrawn from the bath. The isolated mercury pools on the two members are thereby brought into contact, and any excess mercury is easily removed by rubbing the surfaces of the two members together.

As noted above, "Teflon" is well suited for the members 26 and 50 since it is an efficient insulator, and also because it is not wettable by mercury and possesses self-lubricating properties. The pools in the various depressions and grooves in the disc-like members are almost completely enclosed by the two members and are not susceptible to oxidation. Moreover, and as previously explained, any oxidized portion of the pools is quickly removed by the rubbing action of the faces and coating pools of the two members.

Although the illustrated embodiment is actuated and controlled by a rotary solenoid, it is evident that other controls may be conveniently used. It should also be evident that the members 26 and 50 will lend themselves conveniently to multiple stacking along the drive shaft 46 so that a multiple-pole-multiple-throw switching assembly may be housed in an extremely small package.

The invention provides, therefore, a simple and relatively inexpensive multiple contact switching assembly. The assembly of the invention is susceptible to convenient and economical construction, and it is rugged and capable of long and trouble-free operation.

It is evident that the favorable and improved properties of the switch of the invention may be retained when only one of the switch sections includes the fluid contact areas. For example, solid copper conductors may be formed on the stationary disc 50 of Figure 5 instead of the pools of mercury. These solid conductors may be embedded in the disc 50 to be flush with the surface of the disc. Under some operating conditions this latter construction appears to exhibit improved coaction between the solid conductors on the movable disc 50 and the mercury pools on the stationary disc 26.

I claim:

1. An electrical switching assembly including, a stationary disc-like member composed of insulating material and having a first series of isolated depressions formed on a first surface thereof and positioned equi-distantly from the center of said disc-like member at equi-distantly spaced angular positions around a first circular path, said stationary disc-like member further having a series of pairs of further depressions respectively associated with said depressions of said first series and positioned equi-distantly from the center of said stationary disc-like mem-

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ber at equi-distantly spaced angular positions around a second circular path of greater radius than said first circular path, a corresponding plurality of mutually insulated pools of mercury disposed in said depressions of both said series, a corresponding plurality of electrical terminals, means for individually connecting said terminals to respective ones of said pools of mercury, a rotatable disc-like member composed of insulating material and having a plurality of isolated grooves formed in a first surface thereof and extending radially outwardly from the center thereof, a corresponding plurality of mutually insulated pools of mercury disposed in said last-mentioned grooves, and means for supporting said rotatable disc-like member for limited rotation with respect to said stationary disc-like member and with said first surfaces of said members coacting with one another, so that said pools of mercury in said grooves in said rotatable disc-like member may selectively establish individual connections between said pools of mercury of said first series of depressions in said stationary disc-like member and individual ones of said pools in each of said pairs of depressions of said second series and respectively associated therewith.

2. An electric switch assembly including a stationary member which includes a first insulating body having at least one pair of isolated depressions formed on a first surface thereof, a corresponding plurality of mutually insulated electrically conductive bodies disposed in the isolated depressions in said first surface of said first insulating body, a plurality of electrical terminals for the switch assembly supported solely on said stationary member, means supported by said stationary member for individually connecting said terminals to respective ones of said electrically conductive bodies in said depressions in said first insulating body, a movable member which includes a second insulating body having at least one groove formed in a first surface thereof, a corresponding electrically conductive body disposed in the groove in said second insulating body, and means for supporting said movable member for movement with respect to said stationary member with said first surface of said first insulating body coacting with said first surface of said second insulating body so that the conductive body in the groove in the second insulating body may establish a connection between the electrically conductive bodies in a corresponding pair of said isolated depressions in said first insulating body, at least one of said electrically conductive bodies being composed of an electrically conductive liquid.

3. An electric switch assembly including, a stationary member which includes a first self-lubricating insulating body incapable of being wetted by mercury and having at least one pair of isolated depressions formed on a first surface thereof, a corresponding pair of mutually insulated pools of mercury respectively disposed in the pairs of said depressions in said first insulating body, a plurality of electrical terminals for the switching assembly supported solely on the stationary member, means supported by the stationary member for individually connecting said terminals to respective ones of said pools of mercury in the depressions in said first body, a movable member which includes a second self-lubricating insulating body incapable of being wetted by mercury and having at least one groove formed in a first surface thereof, a corresponding pool of mercury disposed in the grooves in said second insulating body of said movable member, and means for supporting said movable member for movement with respect to said stationary member with said first surface of said first insulating body coacting with said first surface said second insulating body so that each of said pools of mercury on said movable member may establish a connection between the pools constituting a corresponding pair of said pools of mercury on said stationary member.

4. An electrical switching assembly including, a sta-

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tionary disk-like member composed of insulating material and having a first series of isolated depressions formed on a first surface thereof and positioned equi-distantly from the center of said disk-like member at equi-distantly spaced angular positions around a first circular path, said stationary disk-like member further having a series of pairs of further depressions respectively associated with said depressions of said first series and positioned equi-distantly from the center of said stationary disk-like member at equi-distantly spaced angular positions around a second circular path of greater radius than said first circular path, a corresponding plurality of mutually insulated electrically conductive bodies disposed in said depressions of both said series, a corresponding plurality of electrical terminals, means for individually connecting said terminals to respective ones of said electrically conductive bodies, a rotatable disk-like member composed of insulating material and having a plurality of isolated grooves formed in a first surface thereof and extending radially outwardly from the center thereof, a corresponding plurality of mutually insulated electrically conductive

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bodies disposed in said last-mentioned grooves, and means for supporting said rotatable disk-like member for limited rotation with respect to said stationary disk-like member and with said first surface of said members coacting with one another, so that said conductive bodies in said grooves in said rotatable disk-like member may selectively establish individual connections between said conductive bodies of said first series of depressions in said stationary disk-like member and individual ones of said conductive bodies in each of said pairs of depressions of said second series and respectively associated therewith, at least one of said electrically conductive bodies being composed of an electrically conductive liquid.

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