Nov. 23, 1965 L. J. QUINTANA 3,219,557

METHOD OF PRODUCING A ROTARY COUPLING

Filed April 12, 1962

FIG. 1

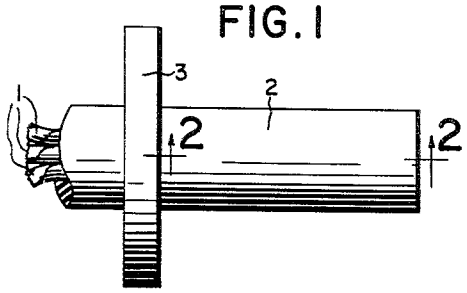


FIG. 2

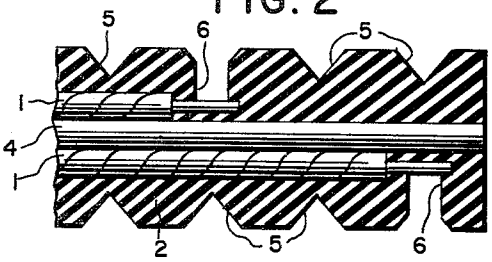


FIG. 3

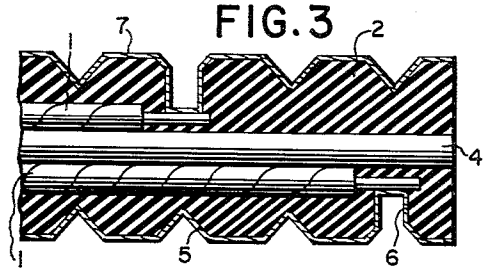


FIG. 4

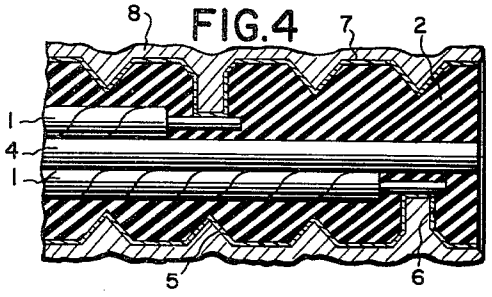


FIG. 5

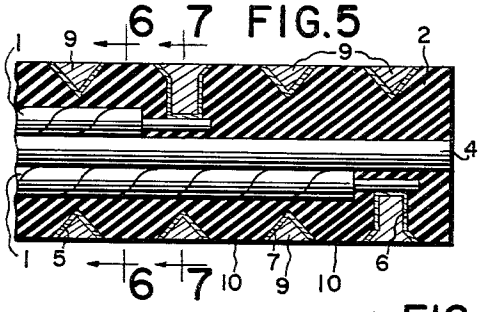


FIG. 6

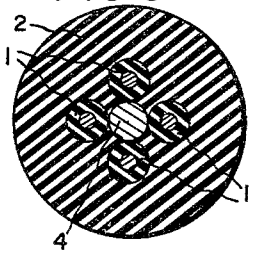


FIG. 7

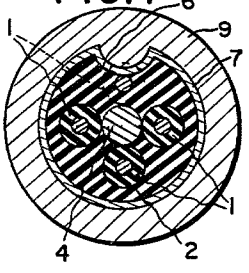


FIG. 8

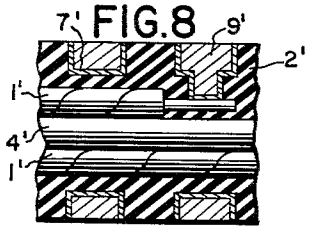


FIG. 9

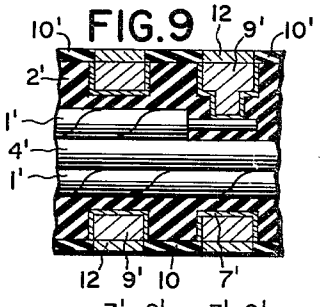


FIG. 10

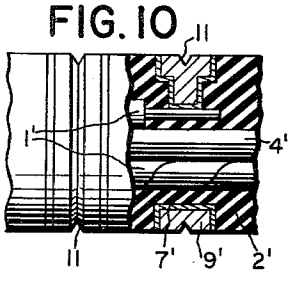
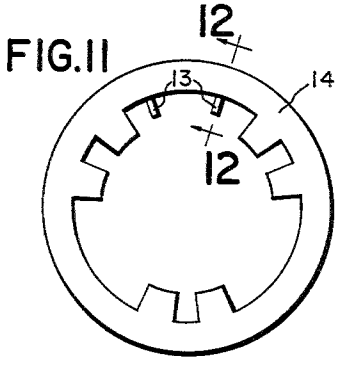


FIG. 11



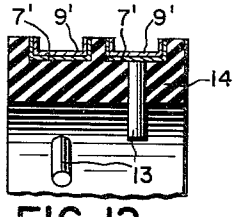


FIG. 12

INVENTOR.
LEO J. QUINTANA

BY Paul B. Hunter

ATTORNEY

United States Patent Office

3,219,557

Patented Nov. 23, 1965

3,219,557

METHOD OF PRODUCING A ROTARY COUPLING

Leo J. Quintana, Anaheim, Calif., assignor to Pacific Scientific Company, San Francisco, Calif., a corporation of California

Filed Apr. 12, 1962, Ser. No. 187,125
1 Claim. (Cl. 204—20)

This invention relates to rotary couplings, switches and/or commutators, and the invention has reference, more particularly, to a novel improved rotary coupling and method of making the same. Rotary couplings, switches, commutators and slip rings have heretofore generally been fabricated either by the assembly of separate insulated and conducting parts held together by fasteners which method is not only expensive to carry out but ofttimes results in inaccuracies in product measurements, or by electroplating conductive material in grooves, which process has not been entirely satisfactory since the wires or leads connected to conducting rings in the grooves ofttimes have a poor contact with the conducting rings due to the lack of a molecular bond between the wires or leads and the rings. Since the wires are in a confined opening within an insulating body, it is extremely difficult to get the deposited material to penetrate sufficiently into the apertures of the body to form a molecular bond with the wires, resulting in a slippage of the rings away from the wires or leads in use. Furthermore, rotary couplings and slip rings heretofore produced by electroplating employ a conductive coating in the grooves of the insulating body. This coating consists usually of a powdered metal, such as silver, and a binder, such as a lacquer, upon which the desired conducting metal such as silver is electroplated. A difficulty arises here in that surfaces are not always homogeneous, are not pure metal, contain contaminants, and thus are poorly suited to ideal electrodeposition.

The principal object of the present invention is to provide a novel rotary coupling, switch, or slip ring, etc., that employs an insulating body having grooves into which a thin metallic ring or rings of copper is initially chemically deposited so as to form a molecular bond to the lead wire terminal, which ring is furthermore bonded to the insulating body due to sensitizing the body for receiving the chemically bonded ring, whereupon the thus firmly held ring is electroplated to any thickness desired with the particular metal or metals desired.

Thus, it is a feature of the present invention to provide an improved rotary coupling and method for producing the same which avoids the disadvantages and limitations of prior art structures of this character by causing the electroformed metal conducting rings of the rotary coupling to have good electrical and permanent contact with the lead or contact wires due to the bonding of the electrodeposit to a chemical-metal deposit, which in turn is molecularly bonded to the lead or contact wires.

Other features and advantages will become apparent as the description proceeds. For a better understanding of the present invention reference is made to the following brief description of the drawings:

FIG. 1 is a side elevational view with parts broken away of an insulating body having conducting wires embedded therein, shown prior to the machining of the body;

FIG. 2 is an enlarged longitudinal sectional view of a portion of the structure of FIG. 1 taken along lines 2—2 of FIG. 1, looking in the direction of the arrows of FIG. 1, but shown after the initial machining of the body;

FIG. 3 is a view similar to FIG. 2 but shows the structure after a layer of chemically deposited metal has been applied to the insulating body and to the conducting end portions of the lead wires;

FIG. 4 is a view similar to FIG. 3 but shows the structure after the electroplating of a deposited conducting metal upon the chemically deposited metal layer;

FIG. 5 is a view similar to FIG. 4 but shows the appearance of the coupling body after excess metal has been removed from the body of the coupling by a machining operation;

FIG. 6 is a sectional view taken along lines 6—6 of FIG. 5 and looking in the direction of the arrows;

FIG. 7 is a view similar to FIG. 6, taken along lines 7—7 of FIG. 5;

FIG. 8 is a fragmentary sectional view of a somewhat modified structure;

FIG. 9 is a view similar to FIG. 8 of a further modified structure;

FIG. 10 illustrates the use of V-grooves in the structure of FIG. 8 or 9, which groove could also be applied to the structure of FIG. 5;

FIG. 11 is a side view of a somewhat modified rotary coupling; and

FIG. 12 is a fragmentary sectional view taken along the line of 12—12 in FIG. 11, looking in the direction of the arrows.

Referring now to FIGS. 1 through 7 of the drawings, initially insulated wires or leads 1 are encapsulated within a dielectric body 2, such as a thermosetting epoxy which may be any one of several thermoplastics, shown provided with a flange 3. Within the body 2 there is provided a support or stiffening wire or shaft 4 which is rigid enough to support insulated contact wires or leads 1 which surround the shaft 4. It should be noted that the insulated wires 1 project different distances into the plastic body 2 and that their end portions are bared. The number of lead wires 1 used is dependent upon the number of conducting rings desired for the coupling. Preferably, the wires 1 are glued or otherwise attached to the rigid support shaft 4 and encapsulated within the insulating material of the body 2. The resulting molded body 2 is now V-grooved as shown by grooves 5, the number of V-grooves 5 corresponding to the number of contact rings the coupling is to possess, which corresponds to the number of wires used. The insulation or dielectric material 2 is removed at the bottom of each groove 5, as shown at 6 in FIG. 2, in the vicinity of the wire terminating at such groove so that the bare wire is exposed. In this way all contact or lead wires will be exposed in their respective grooves.

The surfaces of the V-grooves and their exposed leads are then made electrically conductive by completely coating or metallizing the same with a thin metallic film of copper. This film of copper is chemically deposited on both the material, i.e. the plastic material, of the V-grooves and the exposed copper lead wires after first oxidizing the exposed portions of the copper lead wires and then activating and sensitizing the material of the V-grooves in order that it may accept the chemical deposit of copper. The procedure for metallizing the grooves is as follows:

Firstly, the V-grooves are thoroughly cleaned mechanically. This is done by scrubbing with a mild cleanser such as levigated alumina or magnesium oxide paste, as by using a soft bristle brush. The unit is then pickled with a 10% solution of sulfuric acid with vigorous agitation, followed by rinsing in water. The exposed lead wires 1 of copper are then etched by any of several etchants for copper, such as ammonium persulfate (6 ox./gal.), after which the body is thoroughly rinsed with distilled water to remove all traces of the etchant. The unit with the freshly etched exposed wire end portions is then immersed in a caustic solution including a chlorite salt of an alkali metal, such as sodium chlorite in a sodium hydroxide solution, which caustic solution serves to oxi-

dize the exposed metallic ends of the leads **1** to a black finish. The caustic solution may consist of sodium chloride (5 to 50 gm./liter) and sodium hydroxide (10 to 1000 gm./liter). The black ends of the leads **1** are then well rinsed again in distilled water and inserted into a sensitizing solution, preferably a mixture of stannous chloride in hydrochloric acid (2 to 5 grams of stannous chloride per liter, 3 to 5 grams of hydrochloric acid per liter), after which the part is again rinsed in distilled water. After being thusly sensitized, the body is immersed in an activating or seeding solution which may consist of a palladium chloride in hydrochloric acid:

	Grams per liter
Palladium chloride	0.1 to 0.3
Hydrochloric acid	0.5 to 2.0

whereupon the body is again rinsed in distilled water.

The body is now immersed into any of a number of electroless or chemical copper reduction solutions such as a copper Fehling solution, such as a solution composed substantially of the following:

Anhydrous copper sulfate	g.	2
Silver nitrate	g.	0.2
Rochelle salt	g.	4
Potassium hydroxide	g.	4
Distilled water	cc.	100

Reduced with 5% formaldehyde solution.

In this solution a thin continuous adhering coating of copper is deposited on both the dielectric (plastic) material of the body and on the exposed copper lead wires. The exposed copper lead wires, which have been protected by the copper oxide layer, are thusly chemically coated with an adherent layer of tin, palladium and copper because the sensitizing solution not only activates the plastic surface of the body but it also reduces the copper oxide on the ends of the bare leads **1** to metallic copper to which the tin, palladium, and copper is adherently deposited by molecular adhesions. When the desired thickness of copper is obtained, i.e. from 15 to 30 minutes, the body is removed from the copper solution and again rinsed, producing the structure as shown in FIG. 3 of the drawings wherein **7** designates the chemically deposited metal coating.

The thusly treated body **2** is now ready to receive an electro-deposit of a desired metal such as silver, copper or gold. This is accomplished by placing the "coppered" body **2** which has been properly cleaned and acid pickled in a suitable electrolyte as the cathode between suitable anodes, the composition of the latter depending upon the metal to be deposited, and passing direct current between anode and cathode through the electrolyte. For example, if a gold coating is desired, the electrolyte could be a potassium gold cyanide solution and the anodes could be pure gold bars. The metal is electroplated until the desired thickness is obtained, as illustrated in FIG. 4 by the electro-deposited coating **8**. The electroplated body is then lathe turned to a diameter which will provide metal rings **9**, as shown in FIG. 5, of the desired width separated by a predetermined width of dielectric material **10**. The rings can then be polished and again electroplated, if desired, with thin coatings of other metals such as platinum, rhodium, or rhenium. Another variation is to machine a V-groove in the resultant rings which would serve as contact wire guides, as illustrated by the V-grooves **11** in FIG. 10. It will thus be noted that the resultant metal rings become an integral part of the body assembly and that said metal rings are in good electrical contact with the lead wires **1** due to the bonding of the electro-deposit to the chemical-copper deposit which in turn is well bonded to the lead wires **1**.

A slightly modified structure shown in FIG. 8 employs rectangular grooves rather than V-shaped grooves for receiving the chemical coating **7'**, and the metal rings **9'** become an integral part of the assembly and are in good electrical contact with the lead wires **1'**. In FIG. 9 the structure of FIG. 8 has been further modified by encapsulating the same in any of several thermosetting plastics that properly adhere to the original dielectric material used. The properly cured and trimmed assembly is then lathe turned to clean up the diameter and grooves are circumferentially machined over the underlying rings **9'**, whereupon the body is electroplated or electroformed by placing the properly cleaned and pickled assembly in the electrolyte as a cathode between suitable anodes and passing direct current through the cell. For example, if gold rings are desired over the copper base rings **9'**, the electrolyte could be potassium gold cyanide and the anodes could be gold sheet or bars. The metal is electroplated or electroformed to a thickness greater than the depth of the grooves, with good adhesion and electrical contact resulting between the electro-deposited metal and the metal base ring **9'**. The body is again lathe turned to a diameter which will clean the electro-deposited metal, providing metal rings **12** as of gold, with the desired width and thickness separated by a dielectric material **10'** as desired. The rings can then be polished and V-grooved if desired, as shown at **11** in FIG. 10, where such groove is desired as a guide for contact wires.

In FIGS. 11 and 12, lead wires **13** are shown extending radially through the plastic body of the rotary coupling **14**. In this structure the chemically deposited metal layer **7'** is bonded to the ends of the leads **13** and the rings **9'** are electro-deposited upon the chemically deposited rings **7**.

Thus it will be seen that a novel rotary coupling has been produced wherein the bond between the lead wires and the slip rings is excellent and is a true molecular bond. By virtue of sensitizing the plastic and chemically plating to it, the initial chemically deposited ring is bonded to the plastic and in turn the electro-deposited overlay is molecularly bonded to the chemically deposited ring. Further, there is no possibility of electroplating solution getting between the chemically deposited metal ring and the plastic bonded thereto. Heretofore such solutions would tend to work into the banded overlay or banded coating applied to the plastic so as to receive the electro-deposited metal, resulting in a weakening of the resulting electro-deposited ring and over-stressing the lead wire during machine operations and in use. Thus, the present process, because of its direct bond to the plastic, and then another direct bond in the plating tank, leaves no cavities of any size to trap plating solutions so that a long life of the coupling results.

Since obvious changes could be made in the above construction and many apparently different structural embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

The method of making rotary couplings for conducting electricity between two relatively movable members, comprising encapsulating a conductor within a suitable insulating body of thermosetting material, cutting a groove into the periphery of said body and removing thermosetting material of the body in the vicinity of the conductor at the bottom of the groove so that the groove connects with the conductor, cleaning the groove and conductor by scrubbing with a mild cleanser, pickling the insulating body and conductor in an acid solution with agitation, rinsing in water, chemically bonding a metal coating to the walls of the groove and to the thusly exposed conductor providing a molecular bond therewith by the following steps: firstly etching the exposed conductor in an etching solution, secondly rinsing the insulating body in distilled water to remove etchant, thirdly oxidizing the etched conductor to a black finish in an alkaline solution

including a chlorite salt of an alkali metal, fourthly treating the walls of the groove of the insulating body and the oxidized conductor after rinsing in distilled water with an acid stannous chloride sensitizing and activating solution that serves to reduce the copper oxide on the conductor and activates the plastic surface of the groove, fifthly rinsing and immersing in an activating solution of palladium chloride in hydrochloric acid to prepare the same for acceptance of a chemical deposit of metal, sixthly applying a chemical copper metal coating to the bare reduced conductor and to the walls of the groove, and electroplating a layer of metal upon said chemical coating in said groove and on said conductor until sufficient metal is deposited to form a conducting slip ring, the chemical bonding of the chemically deposited metal coating to the walls of the groove and to the conductor eliminating the entry of foreign substances and providing a

permanent and strong bond between the slip ring and the conductor.

References Cited by the Examiner

UNITED STATES PATENTS

2,473,526	6/1949	Hood et al.	339—5
2,696,570	12/1954	Pandapas	339—5
2,786,985	3/1957	Merdty	339—5
2,903,403	9/1959	Strauss	304—32
2,940,018	6/1960	Lee	204—15
2,961,385	11/1960	McGall	204—15
2,965,551	12/1960	Richaud	204—32
2,967,283	1/1961	Medney	204—15
2,997,527	8/1961	Kessel et al.	174—110.9 X

JOHN H. MACK, *Primary Examiner.*

JOSEPH D. SEERS, *Examiner.*