Feb. 16, 1965 W. J. MAIRS ETAL 3,170,047

ENCAPSULATED ROTARY SWITCHES

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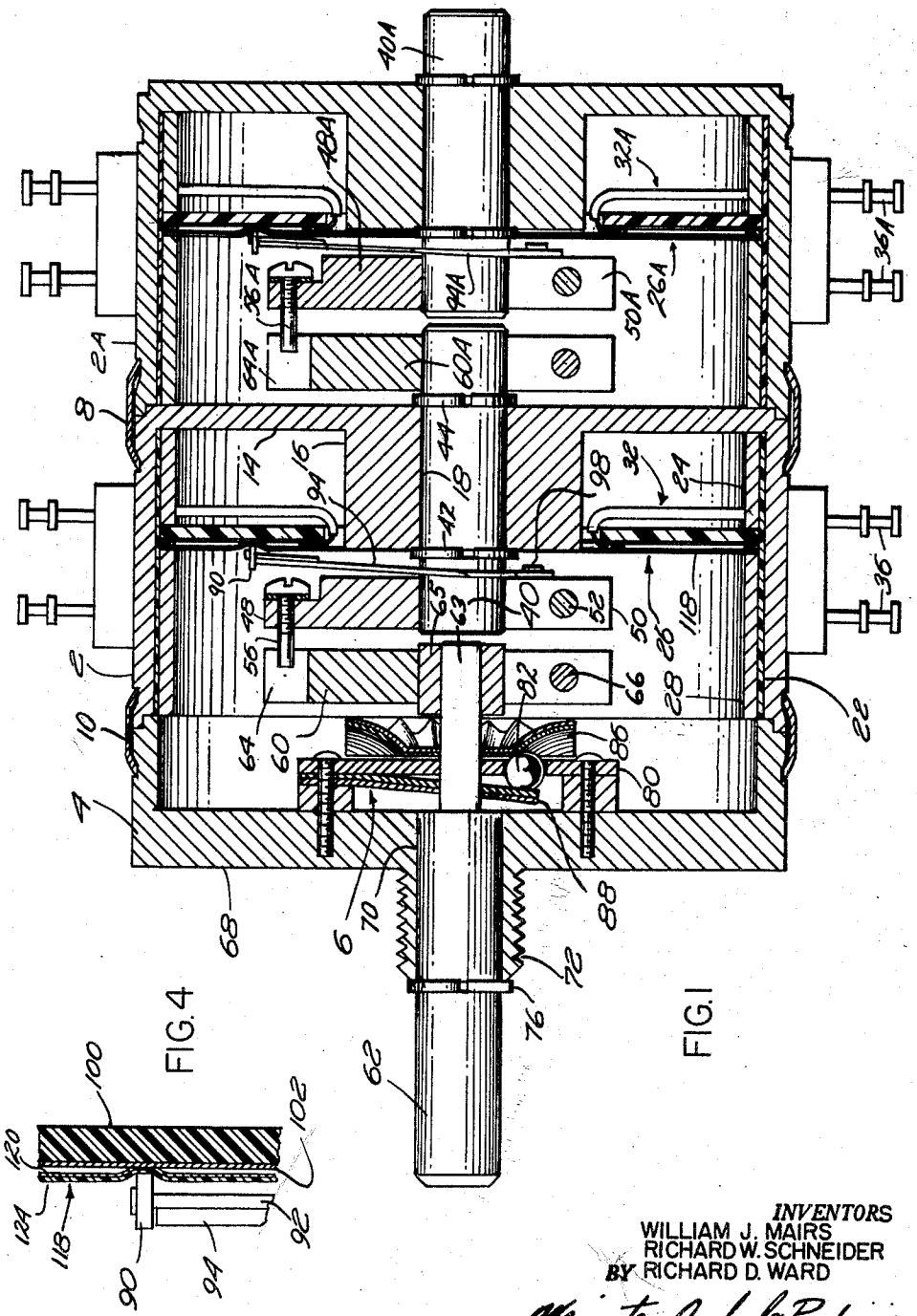


FIG. 1

FIG. 4

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FIG. 2

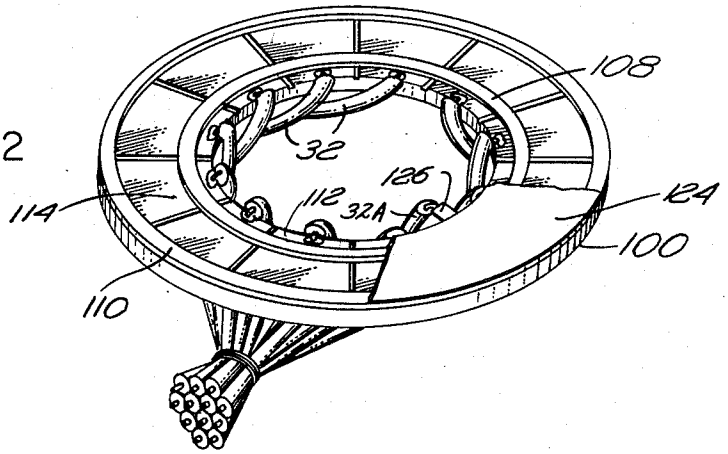
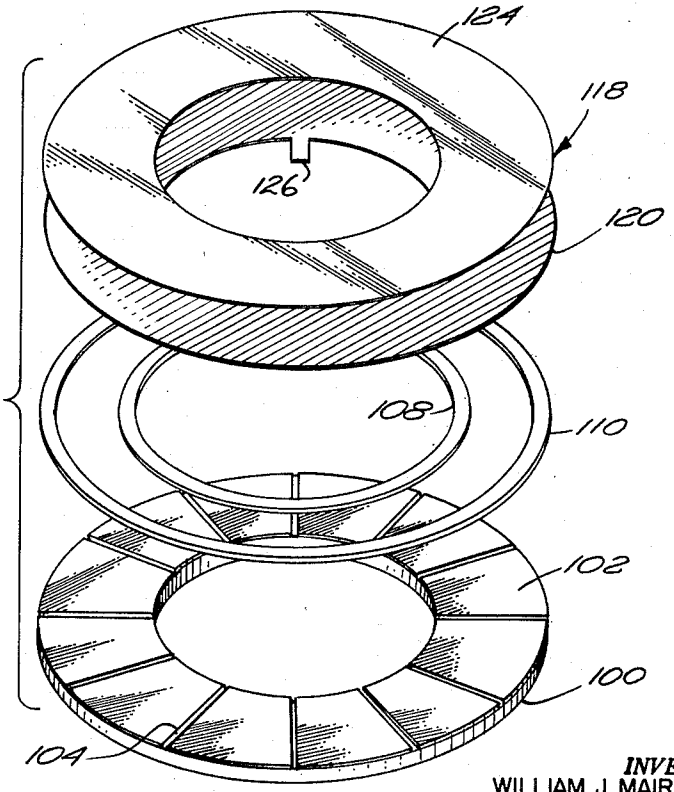


FIG. 3



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ENCAPSULATED ROTARY SWITCHES

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This invention relates to electrical switches and more particularly to encapsulated rotary switches.

The primary object of this invention is to provide a rotary switch assembly which can be used in an explosive environment.

A further important object of this invention is to provide a long-life rotary switch which can be designed for use as a multi-position selector switch having detent means restraining it in a selected position, or as a high-speed continually operating commutator switch.

A further object of the present invention is to provide rotary switches which can be ganged together for in-or-out-of-phase switching, are completely sealed against dust and moisture, are free of contact chatter, and can be constructed with a large or small number of switching contacts with substantially equal ease.

The invention which achieves the foregoing objects can be described briefly as comprising a housing having an end wall, a shaft journaled in the end wall, an annular capsule contact assembly within the housing spaced from the end wall, the contact assembly comprising (1) a rigid annular non-conductive switch disk having a plurality of conductive switch segments on one face, (2) a flexural annular contact laminate overlying and secured to the switch disk in spaced relation to the switch segments, the contact laminate comprising a conductive inner layer and a resilient non-conducting outer layer, (3) a plurality of leads each connected at one end to one of the switch segments and at the other end to a separate terminal on the outside of the housing, and (4) an additional lead connected at one end to the inner layer of the contact laminate and at the other end to a terminal on the outside of the housing, and a pressure piece attached to the shaft and engaging the outer layer of the contact laminate for causing the contact laminate to engage each segment in turn as the shaft rotates, whereby to effect precise switching from one to another of said switch segments. In the preferred embodiment of the invention, the capsule contact assembly is supported only at its periphery and the leads are connected to the segments at the center of the assembly.

Other objects and many of the attendant advantages of the present invention will become more readily apparent as reference is had to the following detailed specification when considered together with the accompanying drawings wherein:

FIG. 1 is a sectional view of a 2-gang encapsulated switch assembly embodying the present invention;

FIG. 2 is a perspective view of a capsule contact assembly with leads connected to the switch segments and contact foil;

FIG. 3 is an exploded view of the components of the capsule contact assembly; and

FIG. 4 is a fragmentary sectional view on an enlarged scale showing how the flexural contact laminate is caused to contact an underlying switch segment by means of a rotatable pressure piece.

Referring now to FIG. 1, there is shown a 2-gang encapsulated switch assembly which comprises two identical switch housings 2 and 2A connected in tandem with a third housing 4 which contains a detent indexing mechanism identified generally at 6. These housings may be made of plastic or of metal as, for example, anodized aluminum. The housings are connected together by clamps 8 and 10. These clamps are of conventional split ring construction and are well known to persons skilled in the art.

Since the two switch units are identical, only the switch unit contained within housing 2 will be described in detail. Corresponding elements of the switch contained within the housing 2A are identified by like numbers followed by the letter A.

The housing 2 has an end wall 14 which is provided with an axial extension 16 and a central bore 18. The inner cylindrical surface of the housing 2 is lined with insulation 22. The insulation 22 may be applied in the form of a coating, but preferably it is in the form of a sleeve which is cemented in place. Disposed within the insulating lining 22 and abutting the end wall 14 is a cylindrical spacer sleeve 24. Engaging the spacer sleeve 24 is a capsule contact assembly identified generally at 26. This capsule contact assembly is held against the spacer 24 by a second cylindrical spacer sleeve 28. The spacer sleeves 24 and 28 may both be adhesively secured to the lining 22. Alternatively, only the spacer 28 need be secured to the lining 22.

Connected to the capsule contact assembly 26 and extending through suitable openings formed in the wall of the housing 2 is a plurality of connecting leads identified generally at 32 in FIG. 1. These leads are connected to different terminals 36 provided on the outside of the housing. The terminals 36 are attached to the housing in a conventional fashion. Both the form of these terminals and the manner in which they are attached to the housing forms no part of the present invention.

Rotatably disposed within central bore 18 of the housing is a shaft 40. This shaft is provided with a pair of peripheral grooves which receive C-rings 42 and 44. C-ring 42 engages the end face of extension 16 and C-ring 44 engages the end face of the wall 14, thereby cooperating to prevent axial movement of shaft 40 while at the same time permitting it to rotate freely relative to the bearing surface which defines bore 18.

Attached to the inner end of the shaft 40 is an arm identified generally at 48. This arm has a central opening sized to receive the shaft 40 and is bifurcated on one side of the opening so as to provide two parallel fingers 50. (Only one finger 50 is visible in FIG. 1 due to the manner in which the section is taken.) The two fingers 50 are connected by a transversely extending screw 52. The head of the screw abuts one finger 50 and the other end of the screw is screwed into a tapped hole in the other finger 50. The screw operates to draw the two fingers together so as to clamp arm 48 onto shaft 40.

Arm 48 has at its free end a tapped hole in which is threaded a screw 56. Screw 56 functions to connect arm 48 with a driving arm of similar construction which is mounted on or otherwise connected to the next shaft in line in the gang. Thus, in FIG. 1, screw 56 connects with a drive arm 60 mounted on an operating shaft 62. The inner end 63 of shaft 62 is reduced in size and has a rectangular cross-section. The drive arm 60 is of bifurcated construction like arm 48, and it is clamped to shaft 62 through a compressible plastic adapter sleeve 65 having a cylindrical outer surface which is gripped by arm 60 and a rectangular center hole sized to make a friction fit with shaft 62 when the arm is clamped thereon by operation of its adjusting screw 66. Arm 48A of the second switch assembly is connected in a similar manner to a drive arm 60A attached to shaft 40. The drive arm 60 has a slot 64 whose width (measured perpendicular to the plane of FIG. 1) is just large enough to re-

ceive screw 56 without any perceptible play therebetween.

It is to be noted that housing 4 has an end wall 68 having a central hole 70 through which extends shaft 62. The end wall 68 also has an axial extension 72 which functions as a bearing for shaft 62 and is provided with exterior threads whereby it may be used to attach the entire assembly to a supporting panel. Shaft 62 has a peripheral groove in which is seated a C-ring 76 which abuts the axial extension 72 and thereby prevents the shaft from moving toward switch housing 2.

The detent mechanism 6 which is mounted within housing 4 is of conventional construction. Essentially it comprises a plate 80 which is secured in spaced parallel relation to end wall 68 and has a hole in which is movably disposed a ball 82. Affixed to the shaft 62 is an annular detent 86 which, as seen in FIG. 1, is of corrugated or wave-light construction. Detent 86 coacts with plate 80 to prevent shaft 62 from moving away from shaft 40. Although not shown, anti-friction means may be interposed between detent 86 and plate 80 so as to facilitate rotation of shaft 62. This form of construction is well known to persons skilled in the art. The corrugations of the detent are sized to accommodate a substantial portion of the ball 82. The ball is urged into the corrugations by a leaf spring assembly 88, and by virtue of engagement by ball 82 with one of the corrugations of detent 86, the shaft 62 is restrained against rotating at will. However, when the shaft has applied to it a suitable torque, the detent will cam the ball axially against spring 88 an amount sufficient to permit the shaft to index one corrugation, whereupon the ball will be forced by spring 88 into another corrugation of detent 86.

Arm 48 carries a pressure piece which comprises a small wheel or roller 90 rotatably mounted on a radially oriented pin 92 which is attached to one end of a spring metal support 94. The latter is bifurcated to fit around shaft 40 and to form two fingers which are secured to the corresponding fingers 50 of arm 48 in a suitable manner, as, for example, by pins 98. The spring metal support 94 urges wheel 90 against the capsule contact assembly 26. Although not shown, it is to be understood that roller 90 is coupled to pin 94 by a miniature roller or ball bearing which renders it substantially free wheeling.

Turning now to FIGS. 2, 3, and 4, the capsule contact assembly 26 comprises an annular switch disk 100 which is formed of a suitable relatively stiff insulating material. Formed on one surface of switch disk 100 is a plurality of conductive segments 102. Preferably these conductive segments are made of copper. The conductive segments are separated by radially extending grooves 104. In this connection, it is to be observed that the individual segments 102 are formed by first providing a full copper coating on one face thereof and by thereafter scribing the grooves 104. Overlying the conductive segments 102 are two concentric annular spacer elements or stand-off rings 108 and 110. Ring 108 is smaller than ring 110, being sized slightly larger than the inner diameter of switch disk 100. Ring 110 has a maximum outside diameter no greater than the outside diameter of switch disk 100. The two rings divide the switch segments 102 into relatively small terminal portions 112 and relatively large contact portions 114. The insulated wire leads 32 are electrically connected to the terminal portions 112.

Overlying and supported by rings 108 and 110 is a flexural contact laminate 118 which comprises a conductive inner layer 120 formed of a suitable material such as coin silver, gold foil, or beryllium copper plated with rhodium, and a resilient non-conductive outer layer 124 which preferably comprises woven fiberglass fabric impregnated with a plastic material such a tetrafluoroethylene, or a polyester film. The insulating outer layer 124 functions to strengthen the metallic inner layer against cracking under repeated flexing. The contact laminate 118, the rings 108 and 110, and the switch disk 100

are all cemented together, with the portion of the contact laminate between the two rings held in parallel spaced relation to the switch segments 102. In addition, in order to prevent the inner edge of the conductive layer 120 from engaging leads 32 and the terminal portions 112 of the switch segments, additional cement or potting compound (not shown) is applied in liberal quantities over the terminal portions 112 so as to insulate them and the ends of the leads 32 from the conductive inner layer 120. The conductive inner layer 120 is provided also with an inwardly extending tab 126 to which is secured a lead 32A which also is connected to one of the terminals 36. The outer layer 124 of the flexural contact laminate is engaged by the roller pressure piece 90, the latter traveling along a circular path which is halfway between stand-off rings 108 and 110.

Operation of the foregoing construction is as follows: Assuming that the terminals 36 for leads 32 and 32A are connected to individual circuits, when shaft 62 is rotated, the pressure piece 90 will cause different portions of the contact laminate to engage contact portions 114 of successive switch segments 102. Each depressed portion of the contact laminate will rapidly spring back out of contact with the underlying switch segment as the pressure exerted by pressure piece 90 is transferred to another portion of the laminate. As a consequence, successive leads 32 will be connected in turn to lead 32A, thereby successively switching different circuits.

It is to be noted that the leads 32 may be connected to the switch disk in a manner slightly different from the manner illustrated in FIG. 2. Thus, for example, the inner edge of the switch disk may be notched at each segment 102, for the purpose of accommodating the leads so that they will not protrude inward of the inner edge of the disk. The leads may be soldered in place in the notches. Alternatively, the leads 32 could be connected to the switch segments from the back side through holes formed in the disk. However, the illustrated construction is the preferred because of ease of manufacture.

It is to be noted also that it is not necessary to have a detent mechanism such as is shown at 6. By eliminating it, shaft 62 may be rotated at a uniform speed, thereby permitting the switch assembly to function as a continuously operating commutator switch.

It is to be noted that the foregoing switch construction has many advantages, the most noteable of which is its utility in an explosive atmosphere. The switch is especially suitable for use in explosive atmospheres for the reason that any spark which may occur between the contact layer 120 and one of the segments 102 will be contained wholly within the sealed off space between the switch disk 100 and the flexural contact laminate 118. Hence the presence of an explosive atmosphere within the housing is not dangerous.

A further advantage of the foregoing construction is that it lends itself well to ganging. At the same time, however, it is to be understood that each switch may be made as a separate entity. In this connection it is to be noted that the housing 2 may be provided with an end cover in place of the housing 4.

A further advantage is that two switches may be ganged for in-phase or out-of-phase switching, the phase relationship being varied by rotating one switch housing relative to the other or by rotating the capsule contact assemblies.

Another important advantage of the present invention resides in the fact that as the pressure piece 90 travels over the contact laminate, successive portions of the laminate will be pressed down into firm contact with the switch disk and then will rise again without hesitation as the pressure piece moves on. As a consequence, the output signal will be free of noise due to uneven or chattering switch connections.

Another advantage of the foregoing switch construction is that it lends itself to variation in the number of switch segments provided on the switch disk 100. The number

of terminals 36 can be varied without much difficulty so as to accommodate more or less switch segments.

Use of a roller-type pressure piece 90 is also advantageous. The roller exhibits little or no resistance to rotation and, as a consequence, little or no wear is caused on the upper surface of the contact laminate. In practice this construction has performed satisfactory through forty million shaft rotations.

Also advantageous is the fact that the capsule contact assembly need be supported only at its outer edge, although it may be supported at its inner edge also if so desired. Supporting only the outer edge simplifies the overall construction and makes it easier to assemble and disassemble the switch. It also makes it easier to fully fill the housing with a non-conductive and non-explosive fluid medium where so required.

Obviously, many modifications and variations of the present invention are possible in the light of the foregoing teachings. It is to be understood, therefore, that the invention is not limited in its application to the details of construction and arrangement of parts specifically described or illustrated, and that within the scope of the appended claims it may be practiced otherwise than as specifically described or illustrated.

What is claimed is:

1. A long-life rotary switch comprising a housing having an end wall and a shaft journaled in the end wall, an annular capsule contact assembly within the housing, means holding said capsule contact assembly in fixed spaced relation with said end wall, said capsule contact assembly held solely at its outer edge, said capsule contact assembly comprising (1) a rigid annular non-planar conductive switch disk having a plurality of conductive switch segements on one face thereof, and (2) a flexural annular contact laminate overlying one side of said switch disk in parallel spaced relation to the said switch segments, means securing the inner and outer edges of said contact laminate to the corresponding edges of said switch disc, said contact laminate comprising a conductive inner layer and a resilient non-conductive outer layer, a plurality of terminals on the outside of said housing, a plurality of leads disposed in the space between said capsule contact assembly and said end wall, said leads each connected at one end to one of said switch segments and at the other end to one of said terminals an additional lead connected at one end to said inner conductive layer of said contact laminate and at the other end to another of said terminals, said additional lead also disposed in the space between said capsule contact assembly and said end wall, and a pressure piece attached to said shaft and rotatable therewith, said pressure piece having a portion engaging said outer non-conductive layer of said contact laminate and moveable relative thereto for causing said contact laminate to engage each switch segment in turn as said shaft rotates.

2. A rotary switch as defined by claim 1 wherein said means for holding said capsule contact assembly includes a spacer sleeve secured to the interior of said housing and engaging said capsule contact assembly at its outer edge.

3. A rotary switch as defined by claim 2 wherein the outer edge of said capsule contact assembly is held by and between two spacer sleeves, one of said spacer sleeves engaging said end wall.

4. A switch as defined by claim 1 wherein said plurality of leads are connected to said switch segments at the inner edge of said capsule contact assembly.

5. A ganged switch construction comprising a plurality of substantially identical switch units, each switch unit comprising a housing having an end wall and a shaft journaled in said end wall, an annular capsule contact assembly within said housing, means holding said capsule contact assembly in fixed spaced relation with the end wall of said housing, said capsule contact assembly held solely at one edge, said capsule contact assembly comprising (1) a rigid non-conductive switch disc having a plurality of planar conductive switch segments on one face thereof and (2) a flexural contact laminate overlying and secured to the switch disc in parallel spaced relation to said switch segments, said contact laminate comprising a conductive inner layer and a resilient non-conductive outer layer, a plurality of terminals on the outside of said housing, a plurality of leads in said housing in the space between the end wall thereof and the capsule contact assembly disposed therein, each lead connected at one end to one of said switch segments and at the other end to one of said terminals, a pressure piece attached to said shaft and rotatable therewith, said pressure piece having a portion engaging the outer non-conductive layer of said contact laminate with a pressure sufficient to cause said contact laminate to engage one of said switch segments, said pressure piece movable with said shaft whereby to cause said contact laminate to engage each switch segment in turn as said shaft rotates; split ring clamp means connecting together the housings of said plurality of switch units, and means connecting together the shafts of said plurality of switch units whereby the pressure pieces thereof will move together.

6. A ganged switch construction as defined by claim 5 wherein said means connecting together said shafts is releasable to permit relative rotation of said shafts, whereby the switching of one unit may be varied in phase with the switching of another unit.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,170,047 February 16, 1965

William J. Mairs et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, lines 32 and 33, for "non-planar conductive" read -- non-conductive --; lines 33 and 34, for "conductive switch segements" read -- planar conductive switch segments --; same column 5, line 45, after "terminals" insert a comma.

Signed and sealed this 24th day of August 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

UNITED STATES PATENT OFFICE

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