June 30, 1970 J. P. DOERING, JR., ET AL 3,518,389

ROTOR ASSEMBLY FOR INTEGRAL ELECTRICAL SWITCH

Filed March 14, 1968 3 Sheets-Sheet 1

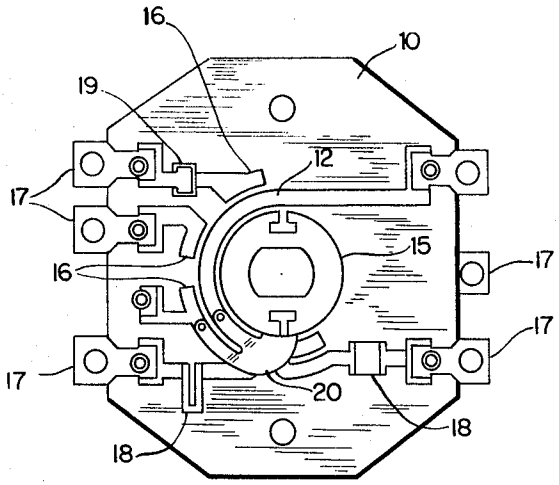

FIG. 1

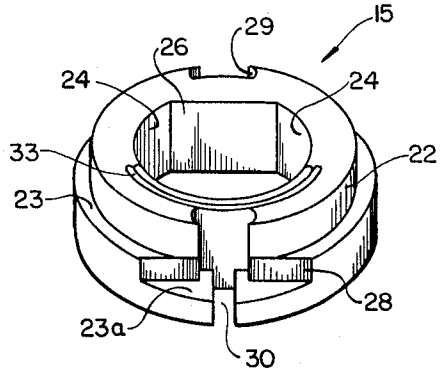

FIG. 2

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ROTOR ASSEMBLY FOR INTEGRAL ELECTRICAL SWITCH

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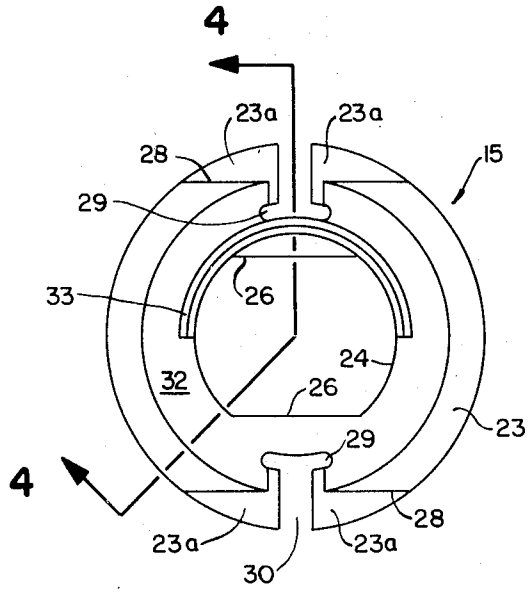

FIG. 3

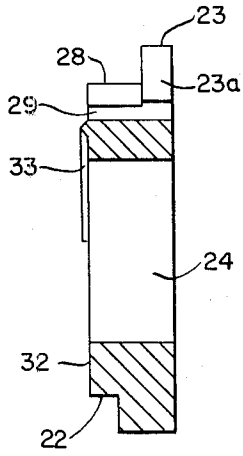

FIG. 4

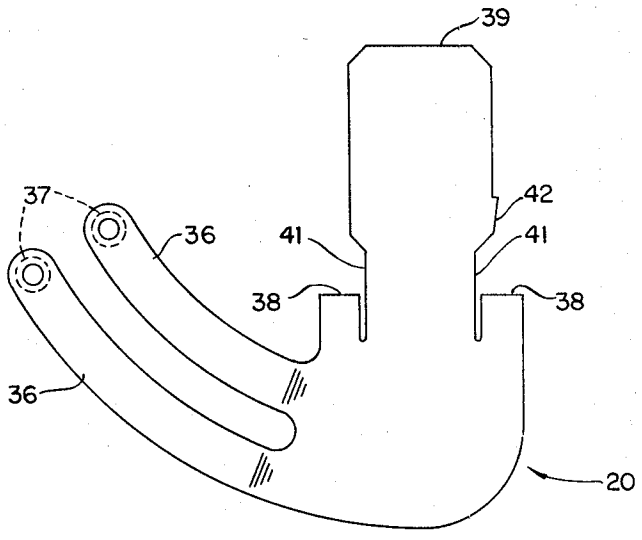

FIG. 5

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ROTOR ASSEMBLY FOR INTEGRAL ELECTRICAL SWITCH

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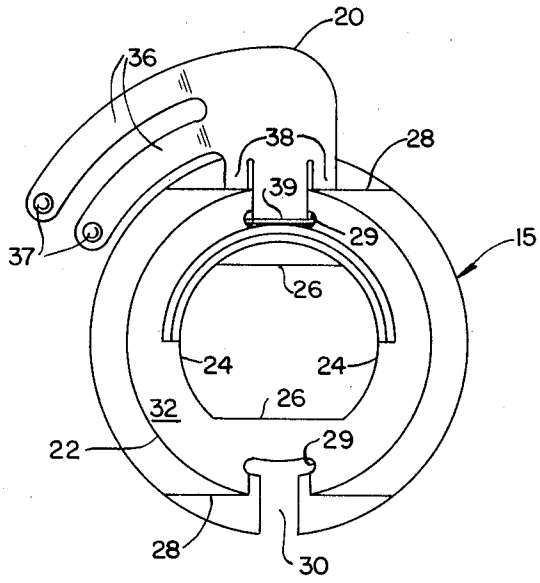

FIG. 6

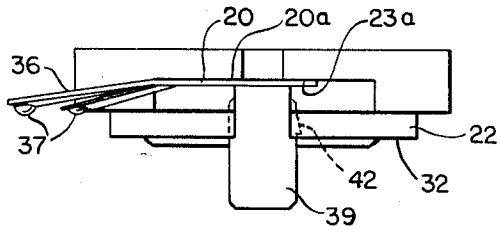

FIG. 7

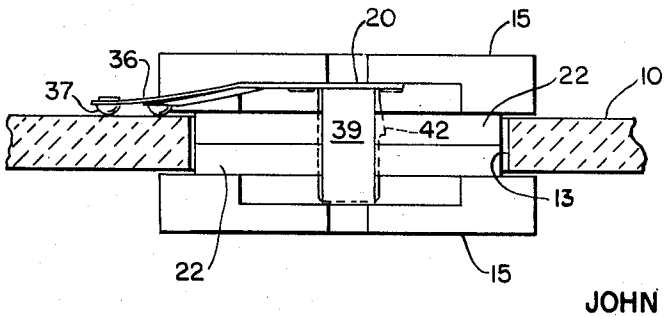

FIG. 8

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3,518,389

ROTOR ASSEMBLY FOR INTEGRAL ELECTRICAL SWITCH

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Int. Cl. H01h 3/00
U.S. Cl. 200—166 5 Claims

ABSTRACT OF THE DISCLOSURE

An integral rotary switch including a high temperature resistant nonconductive base member in the form of a thin wafer having oppositely disposed flat surfaces and an aperture therethrough. A plurality of switch contact pads are formed on at least one surface of the base member in an array disposed around the aperture. Each pad is electrically connected to an electrical network deposited on the surface of the base member. A rotor and switch contact assembly is mounted through the aperture and includes a pair of rotor parts each having a cylindrically shaped hub section and a flange section. The hub sections of the rotor parts are positioned into the aperture from opposite sides of the base member so that the ends of the respective hub sections are in abutting relation and attached to form an integral rotor adapted to rotate within the aperture. A contact member is supported on the rotor and includes at least one outwardly extending arm resiliently biased into contact with a surface of the base and adapted to traverse an arcuate path on the surface of the base and sequentially contact the switch pads.

A switching device of the type in which the rotor assembly of the present invention is particularly well adapted is disclosed in patent application Ser. No. 673,399, entitled Integral Electrical Switch and Circuit Module, filed Oct. 6, 1967, in the name of Stanley Schneider, and assigned to the same assignee as the present invention.

The above mentioned application relates to an integral rotary switch and circuit network in the form of an electrically nonconductive base member, or thin wafer, having an electrical network deposited or otherwise attached thereon and including a plurality of switch pads arranged on the surface of the wafer in a predetermined path to be engaged by a conductive wiper carried by an operating member. The operating member must be attached to and locked in place for movement with respect to the surface of the base. The rotor assembly of the present invention forms an improved operating member which may be easily mounted for rotation within an aperture formed in the base and may support one or more conductive wipers for rotation in an arcuate path on the surface of the base.

Accordingly, it is the object of the present invention to provide an improved rotor and contact assembly which may be assembled through an aperture formed in the base for supporting one or more conductive wipers adapted to traverse an arcuate path on the surface of the base.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of these and further aspects of the invention, reference may be had to the accompanying drawings in which:

FIG. 1 is a plan view illustrating a base having deposited on the surface thereof an electrical switching network and employing the rotor of the present invention;

FIG. 2 is a greatly enlarged perspective view of one of the two mating rotor parts adapted to form a rotor member according to the invention;

FIG. 3 is an enlarged plan view of a rotor part;

FIG. 4 is a cross-sectional view taken substantially along line 4—4 of FIG. 3;

FIG. 5 is a plan view of a conductive contact member shown in its originally stamped form before the support tab is bent with respect to the body of the contact member;

FIG. 6 is an end view similar to that of FIG. 3 with the contact member assembled into one of the rotor parts;

FIG. 7 is an elevation view further illustrating the assembly of the contact member into a slot formed in a rotor part; and

FIG. 8 is an elevation view showing the base member in cross-section and illustrating the assembly of the rotor parts through the aperture and with the contact member supported thereon.

Referring now to FIG. 1, there is shown a somewhat schematic embodiment of the invention in which the switch device includes a base member or wafer **10** substantially in the form of an octagon. The disc or base member **10** may be formed of a nonconductive material, such as a filled nylon or other plastic, or may be formed of a nonconductive high temperature resistant material, such as a ceramic material of alumina, steatite, or the like. At least one surface of the base member or wafer is flat and supports an electrically conductive circuit network and the associated switching components which may be bonded to the base member or otherwise applied in any manner well known in the art, such as by vaporization techniques. In the illustrated embodiment of FIG. 1, there is deposited on the surface of the base member **10** an electrically conductive slip ring **12**, formed in an arcuate path around an aperture **13** (see FIG. 8) formed through the base member. Within the aperture **13** there is positioned a rotor **15** which is mounted through the aperture for rotational movement therein.

Radially outward from the aperture and outwardly of the slip ring, in the disclosed embodiment of the invention, there are provided a plurality of contact switch pads **16**. Pads **16** may connect with terminals, such as terminal members **17** supported along the edges of the base member, or may electrically connect with various points in the electrical circuit network also deposited on the surface of the base member. As will be seen in FIG. 1, portions of the electrical circuit network also are connected to terminals **17** which are to be electrically connected with other electrical components associated with the device to which the switch is attached.

In the illustrated embodiment, the electrical network includes resistors **18**, a capacitor **19** and may include other electrical components, which may be either deposited on the surface of the base member **10** or otherwise mechanically attached thereto. One particular type of resistance material which may readily lend itself to adaptation to a ceramic substrate for a switch device is a cermet material of the type described in Pat. No. 2,950,995, Place et al. entitled Electrical Resistance Element, or Pat. No. 2,950,996, Place et al. entitled Electrical Resistance Material and Method of Making Same, which patents are assigned to Beckman Instruments, Inc., the assignee of the present application. After cermet resistance materials are deposited on the base member, they may be tailored in order to alter or achieve the desired resistance value or capacitance values required for the electrical circuit network.

Directly attached to the rotor **15** for rotation therewith is an electrically conductive contact member **20** including at least one conductive contact or wiper arms adapted to traverse an arcuate path along the surface of the base member **100**. In the embodiment shown, the contact member **20** is provided with a pair of wiper arms one of which traverses the deposited collector ring **12** and the other, which engages in sequence the switching pads **16** during rotation of the rotor member **15**.

As will now be explained, the present invention deals with the structure of the rotor member and the associated conductive contact or wiper **20** supported by the rotor member. As will be understood by reference to FIGS. 2, 3, 4 and 8, the rotor of the switching device includes a pair of rotor parts each of which is adapted to be assembled into the aperture **13** (see FIG. 8) from opposite sides of the base member or wafer. The rotor part is generally identified by the reference numeral **15** and is preferably molded or otherwise fabricated of a thermoplastic material or other suitable nonconductive easily molded material.

As may be seen in FIG. 2, the rotor part is preferably formed cylindrical in shape with a first or hub section **22** extending outwardly from a flange section or larger diameter section **23**, the hub section **22** is of a diameter adapted to fit within the aperture **13** formed in a substrate or base member **10** and the flange section **23** is of a diameter larger than the hub section and overlies at least a portion of the surface of the base member **10**. While, in the preferred embodiment, the flange section **23** is shown to be cylindrical, it is not essential that it be round or cylindrical and it may take on any number of other shapes. Axially disposed through the rotor part is a shaft opening **24**, which may preferably be provided with a pair of flats **26** adapted to receive a suitably shaped drive shaft for driving or rotating the rotor when assembled into position on the base member.

In the embodiment shown, there are two flat sections **28** formed or milled 180° apart across the outer surface of the flanged section **23**. The flat sections **28** are employed for supporting a pair of stabilizing tabs in a manner which will be explained hereinafter. The flat sections **28** are each interrupted by a slot **30** formed through the rotor part. As may be seen in FIG. 3, the slot **30** takes on a generally T-shaped configuration which diminishes in size in the region of the flat section **28** formed on the flanged section of the part. As may be seen in FIG. 3, the diminishing section of the T-shaped slot **30** forms a pair of tabs **23***a* in the region where the flat **28** is formed on the outwardly extending flanged section **23**. Tabs **23***a* form an abutment against which the upper surface of the contact member **20** rests when assembled onto the rotor.

On the exposed surface or inner end **32** of the hub section **22** there is formed a substantially semi-circular upraised shoulder or concentrator, which is employed in the preferred embodiment, for the purpose of attaching two mating rotor parts together. In this embodiment of the invention the upraised concentrator **33** has a triangular shaped cross-section, as will best be seen in FIG. 4. Concentrators **33** are preferably made semi-circular around the circumference of the shaft opening and are slightly less than 180° in extent. When two mating rotor parts are assembled, as shown in FIG. 8, the concentrators (which may not be seen in FIG. 8) are arranged so that the concentrators on the respective parts abut against the flat surfaces **32** on the end of the hub sections of the respective mating part. During assembly, the two mating concentrators **33** on the adjacent parts are fused to the surfaces **32** of the respective mating parts by the application of an external energy source, such as an ultrasonic welding source. By the application of a small pressure and a vibratory motion sufficient energy is generated between the concentrator shoulder **32** and the flat surface **33** to fuse the concentrator to the flat surface. It will be understood that other energy concentrator shapes are applicable and that the concentrator does not necessarily have to be semi-circular in extent. Also, other means may be employed for attaching the ends of the respective rotor parts, such as an epoxy cement or screws extending through the respective parts.

As will be seen in FIG. 8, the rotor member is formed by a pair of rotor parts **15** assembled through the aperture **13** of the bae member. Supported on these rotors may be one or more electrically conductive contact members **20**. As may best be seen in FIG. 5, the contact member may preferably be formed of a stamped part from an electrically conductive spring material, such as beryllium-copper alloy plated with gold or of another highly conductive spring-like material. The contact includes at least one contact-bearing arm **36**, or arms **36** having precious metal contacts **37** on the outer end thereof which may be spot welded or otherwise attached to the tips of the arms **36**. The arms **36** are biased or bent downwardly at an angle from the plane of the body of the contact member so that they abut on the surface of the base member **10** when the rotor is assembled thereon.

The contact member includes a retainer tab **39** bent at substantially right angles to the body of the contact member **20** as will best be seen in FIG. 7. The retaining tab **39** is inserted into the slot **29** of the rotor part so that the upper surface **20***a* of the contact member abuts against the tab sections **23***a* of the outwardly extending flange section **23**. The relieved or necked down portions **41** of the contact member (see FIG. 5) permit the contact member to be inserted into the substantially T-shaped slot without interference. The support tab **39** is provided with a barb-like projection **42** which digs or bites into the side of the slot **29** to retain the retaining tab **39** within the slotted portion of the rotor part. As may be seen in FIG. **7**, when the contact member **20** is inserted into one rotor part a large portion of the tab **39** extends beyond the surface **32** of the hub section **22**.

During the stamping operation, the contact member **20** is also provided with a pair of stabilizing tabs **38** (see FIG. 6). Tabs **38** abut against the flat sections **28** of the rotor part, when the support tab **39** is inserted into the slot **29** and help support the contact member **20** on the rotor after assembly.

In FIG. 7 it will be seen that the tab section **39** of the contact member **20** protrudes beyond the end **32** of the hub section **22**. This portion of the tab section **39** provides a seat for the mating rotor part which is positioned thereover. As may be seen in FIG. 8, when the mating rotor part is positioned over the support tab **39**, the tab **39** extends at least partially through T-shaped slots of the two respectively positioned rotor parts with the ends or hub sections thereof arranged in abutting relation. As stated previously, the concentrator shoulders (which are shown as fused in FIG. 8) are positioned so that each arcuate ridge engages a flat surface **32** on the opposite surface of the respective hub section.

After these parts are assembled with their respective hubs extending into the aperture **13** and with the contact member **20** in position, the assembly is placed in an ultrasonic welding apparatus which essentially applies pressure and vibratory motion to flatten out the concentrator shoulders **33** thereby fusing the end surfaces of the rotor parts together. The two rotor parts are thereby joined together to form an integral rotor assembly, which is free to rotate within the aperture **13** formed in the base member. The resilient contact arms of the respective contact members, supported within the slots of the rotor member, are biased into contact with the surface or surfaces of the base member. On rotation of the rotor one conductive arm **36** traverses over the conductive collector track **12** and the other arm **36** engages the respective switch pads **16**.

It should be noted that the number of slots **29** and flat sections **28** formed on the respective portions of the rotor parts is only limited by the total dimensions of the parts. While, in the example disclosed, only two slots are shown

it is possible to arrange several slots and flatted sections around the respective members and each of these may be provided with a conductive contact or wiper. It should also be pointed out that switch contact members **20** may be inserted on opposite sides of the substrate within respective slots formed in the mating rotor parts to electrically engage switching elements on both sides of the base member **10**. Furthermore, switch contact members may be connected electrically to other switch contact members on either the same side or on opposite sides of the rotor.

After the rotor has been positioned and the respective parts have been attached one to the other, either by sonic welding as described above or by means of a cement or other well known attaching means, the unit may be provided with a drive shaft (not shown) or may be "ganged" together with a number of other switching units and provided with a common drive shaft through the respective shaft openings **24** formed therein. While the hub sections **22** are, in the disclosed embodiment of the invention, made approximately one-half the thickness of the substrate or base member **10**, it is obvious that one of these hubs may be made substantially less in axial length than the other. It is preferable, for reasons of economy, to make both rotor parts identical.

While in accordance with the patent statutes there has been described what is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A rotor and contact assembly for a switch device formed of a nonconductive base having a circular aperture therethrough, the base also having switch contact pads disposed in a annular array on the surface thereof around the aperture, said rotor and contact assembly comprising:

first and second mating rotor parts formed of a nonconductive plastic material, each rotor part including a cylindrical hub section and a flange section, each of said hub sections adapted to extend into the aperture from opposite sides of the base for rotation therein and having the ends of said hub sections in abutting relation, each of the rotor parts having its flange section disposed adjacent an opposite surface of said base;

means rigidly attaching said first hub section to said second hub section comprising at least one raised concentrator shoulder on the abutting end of one of said hub sections, said raised concentrator shoulder fused by an externally applied energy source forming a bond between the abutting ends of said mating hub sections; and

at least one electrically conductive contact member supported on said rotor and including at least one resilient arm biased in a direction toward the surface of the base, said arm carrying a switch contact engaging the surface of said base and adapted to traverse an arcuate path into electrical contact with the switch contact pads during rotation of said rotor.

2. The rotor and contact assembly defined in claim **1** in which said means for rigidly attaching said first hub section to said second hub section comprises a semicircular upraised concentrator shoulder formed on each of the abutting ends of said hub sections, said concentrator shoulder on each rotor part having a triangular shaped cross-section, said concentrator shoulder of each respective rotor part fused to the surface of the abutting rotor hub of said opposite rotor part by means of said externally applied energy source.

3. A rotor and contact assembly for a switch device formed of a nonconductive base having a circular aperture therethrough, the base also having switch contact pads disposed in an annular array on the surface thereof around the aperture, said rotor and contact assembly comprising:

first and second mating rotor parts formed of a nonconductive material, each rotor part including a cylindrical hub section and a flange section, each of said hub sections adapted to extend into the aperture from opposite sides of the base for rotation therein and having the ends of said hub section in abutting relation, each of said rotor parts having its flange section disposed adjacent an opposite surface of said base, each of said rotor parts provided with a substantially T-shaped slot formed in an axial direction through at least said hub sections of said respective rotor parts, said T-shaped slots of said respective rotor parts being in alignment;

means rigidly attaching said first hub section to said second hub section thereby forming an integral rotor positioned for rotation within the aperture; and

at least one electrically conductive contact member including at least one outwardly extending resilient arm and a support tab arranged substantially normal to said outwardly extending arm, said support tab being positioned within said T-shaped slot in said rotor with the upper surface of said outwardly extending arm disposed beneath the lower surface of said flange section of said rotor part, said resilient arm biased in a direction toward the surface of said base and carrying a switch contact engaging the surface of said base and adapted to traverse an arcuate path on said base to contact said switch contact pads during rotation of said rotor.

4. An electrical switch comprising:

a high temperature resistant, nonconductive base member in the form of a thin wafer having an aperture therethrough;

a plurality of switch contact pads disposed on said base in an arcuate array around said aperture;

an electrical circuit network supported on said base member including terminal means adapted to connect said electrical circuit network into an external electrical circuit and conductive connectors extending from said switch pads to respective points in said electrical circuit network;

a rotor disposed in said aperture through said base, said rotor comprising:

first and second mating rotor parts formed of a nonconductive material, each rotor part including a cylindrical hub section and a flange section, each of said hub sections disposed in said aperture from opposite sides of said base with the ends of said hub sections in abutting relation, said flange sections of said rotor parts positioned respectively adjacent opposite surfaces of said base;

means rigidly attaching said first hub section to said second hub section thereby forming an integral rotor within said aperture;

a slot formed in said rotor hub sections and arranged substantially axially with respect to said hub sections disposed through said aperture, said slot communicating with the surface of said hub sections and being of a substantially T-shaped cross-section with the narrow portion of said T communicating with the surface of said hub sections within said aperture;

at least one electrically conductive contact member having at least one resilient arm and a support flange arranged substantially normal to said outwardly extending arm, said support flange of said contact member disposed in said slots formed in said abutting rotor parts of said rotor and having said conductive arm positioned beneath the surface of said flange section of one of said rotor parts, said arm of said contact member carrying a switch contact adapted to traverse an arcuate path on the surface

of said base thereby to contact said switch pads during rotation of said rotor.

5. The switch device defined in claim 4 in which each of said rotor parts is provided with an axial opening therethrough adapted to receive a drive shaft for rotating said rotor.

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HERMAN O. JONES, Primary Examiner

U.S. Cl. X.R.

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