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C. LEFF ET AL

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SWITCHING DEVICE

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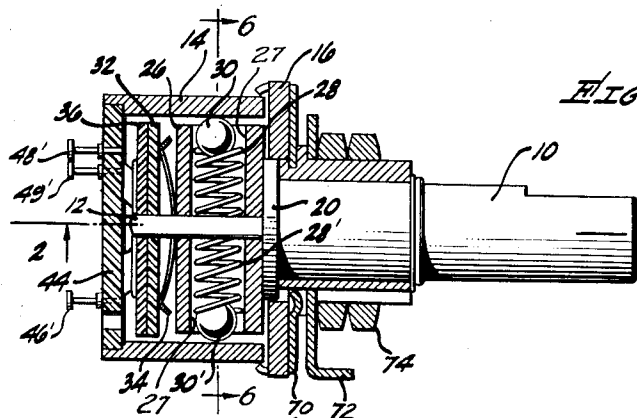


FIG. 1.

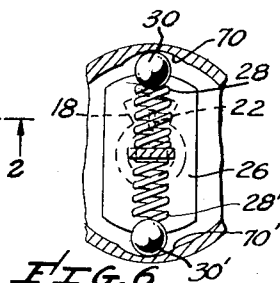


FIG. 6.

FIG. 3.

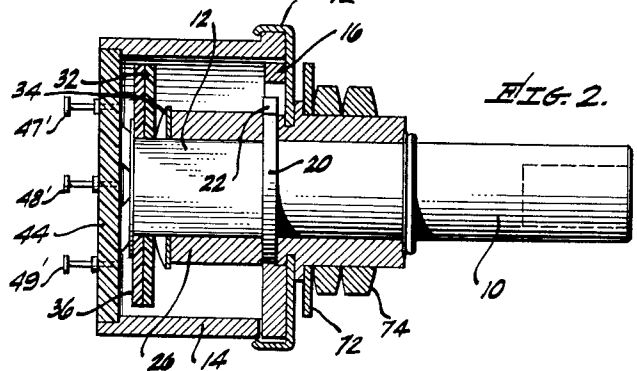


FIG. 2.

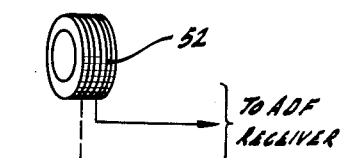
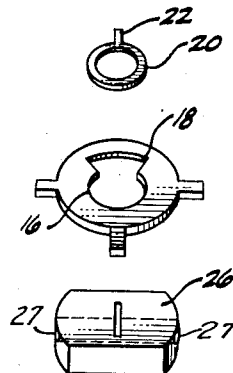


FIG. 5.

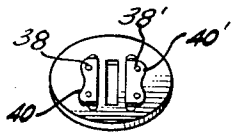
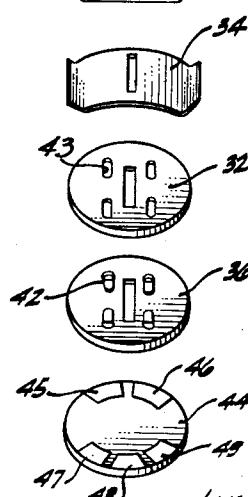


FIG. 4.



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SWITCHING DEVICE

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4 Claims. (Cl. 200—11)

This invention relates to switch devices and more particularly to an improvement in miniature switches of the type with which the operation of different electrical circuits are manually controlled.

Miniature switches have been developed in which contact surfaces to which terminals of separate electrical circuits are connected are mounted in tiers on a common rotatable shaft. The shaft carries spaced contact points which rotate therewith to make or break contact with associated contact surfaces and circuit terminals. Pains must be taken in assembling such a switch to position the contact surfaces and contact points so that particular circuits will be energized properly in predetermined positions of the shaft. Such precautions limit the speed at which switches having uniform characteristics can be produced. Further, where space is at a premium, such switches pose a serious problem.

It is an object of this invention to provide an improved miniature switch with which contact points and surfaces for terminals of different circuits do not have to be stacked in tiers as in prior art switching arrangements.

It is another object of this invention to provide an improved miniature switch with which terminals and contact points for selective control of different circuits are compactly arranged to satisfy minimum space requirements not possible with prior art switches.

It is another object of this invention to provide an improved miniature switch for selectively controlling the operation of separate electrical circuits, which comprise a minimum number of component parts of simple design and rugged construction, and which is capable of being produced in volume with uniformity of characteristics.

The above and other objects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawing, in which a preferred embodiment of the invention is illustrated by way of example. The scope of the invention is pointed out in the appended claims. In the drawing,

Fig. 1 is a sectional view of an improved miniature switching device in accordance with this invention;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is an exploded view of the parts of the device of Fig. 1;

Fig. 4 is a perspective view of one of the parts of Fig. 3 as seen from the reverse side thereof;

Fig. 5 is a schematic diagram illustrating the operation of the switching device of this invention in an electrical system, and

Fig. 6 is a partial sectional view taken along line 6—6 of Fig. 1.

Briefly, this invention provides a manually rotatable card with spaced contact points placed thereon, such card being resiliently urged against spaced wiping or contact surfaces for connection to the terminals of different electrical circuits. Rotation of the contact points in either direction effects direct connections between predetermined pairs of such contact surfaces,

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Referring to Figs. 1—4, a shaft 10 is provided with a rectangular extension 12 which projects into a housing 14. Mounted on the circular portion of the shaft adjacent extension 12 is a stop member 16 having an opening to receive shaft 10 and provided with an arcuate shaped cut-out 18, as indicated in Fig. 3. The central opening of member 16 is concentric with and of the same diameter as a ring 20 fixed to shaft 10 which has a lug or finger projection 22 extending into cut-out 18. The portions of member 16 defining the opposite edges of cut-out 18 are limit stops for lug 22; hence, rotation of shaft 10 is limited to an angle corresponding to the difference between the angle defined by the sides of cut-out 18 and the angle between the sides of lug 22.

Mounted on extension 12 adjacent stop member 16 is a rotor 26. A cylindrical opening 27 in rotor 26 extends transversely to the axis of extension 12. Springs 28, 28' are located in this opening on opposite sides of extension 12, and ball bearings 30, 30' are placed at the outer ends of the respective springs 28, 28' to be urged against the inner wall of housing 14. Thus, rotor 26 will rotate with shaft 10, with the ball bearings providing minimum friction; this arrangement also serves to prevent translational motion of the shaft when it is turned.

Spaced a short distance from rotor 26 is a wafer 32 of non-conductive or insulating material, and resilient means such as a flexed leaf spring member 34 is located between rotor 26 and wafer 32. It will be apparent that leaf spring 34 is merely illustrative of suitable resilient means; such means may also be an element of rubber or other non-metallic resilient material. Positioned below wafer 32 is a non-conductive support wafer 36 for supporting two pairs of contact points. Referring to Figs. 3 and 4, the contact points 38, 38' are provided in pairs on metallic leaves 40, 40' which have fingers or prongs 42, 42' extending through wafer 36 and bent so that their ends register against the opposite surface of wafer 36. Openings 43 are provided in wafer 32 in alignment with the prong ends to permit the adjacent surfaces of wafers 32 and 36 to be flush with each other. The pressure exerted by leaf spring 34 keeps the contact points urged against the top surface of a non-conductive insert 44 fixed in the end of housing 14. Insert 44 is provided with spaced contact or wiping surfaces which are preferably flush mounted thereon. In this connection, insert 44 preferably is of phenolic material and the contact surfaces are etched thereon; such etching may be accomplished by conventional processes, such as photo-etching techniques well known in the printing and printed circuit arts. In the example here illustrated, five contact surfaces 45, 46, 47, 48 and 49 are spaced about the insert 44. Respective contact terminals or pins 45', 46', 47', 48' and 49' are embedded in insert 44, each having one end in contact with a contact surface and its opposite end extending to the exterior of housing 14 for connection to a circuit terminal.

Utility of the above described switch is illustrated in Fig. 5, wherein a conventional two-phase motor 50 having reference and control windings (not shown) is mechanically coupled to a loop antenna 52 which receives signals from a radio station to be applied to an automatic direction finder (ADF) receiver (not shown). A transformer 54 has the ungrounded end of its primary winding 56 connected to the reference winding of motor 50. The ends of the secondary winding 58 are connected to terminals 47' and 49'; terminal 43' is connected to ground. Terminal 45' is connected to the positive terminal of a direct current (D.C.) supply source and terminal 46' is resistively coupled to the control winding of motor 50, as by a resistor 60. A capacitor 62 couples the control winding of motor 50 to the center-tap of secondary winding 58.

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In the above described switch arrangement there is a neutral position of the shaft wherein one pair of contact points provides a direct connection between contact surfaces 45 and 46, and hence terminals 45' and 46', and the contact points of the other pair are positioned in the spaces between the pairs of contact surfaces 47, 48 and 48, 49, whereby no direct connection is provided between either of these pairs of contact surfaces. In this connection, and referring to Fig. 6, when shaft 10 is positioned so that lug 22 is centered in cut-out 13, balls 30, 30' rest in the centers of diametrically opposite depressions 78, 78' in the inner wall of housing 14. Therefore, when shaft 10 is turned from this position, coaction of springs 28, 28' and ball bearings 30, 30' causes a contra-rotating force to be exerted on extension 12, whereby the shaft will return to its neutral position when released.

For clockwise rotation of shaft 10 a predetermined number of degrees from the neutral position, such as 5°, the direct connection between contact surfaces 45 and 46 will be maintained and a direct connection will be established between contact surfaces 47 and 48, i. e., between terminals 47' and 48'. In this position of the shaft, a direct current connection is established from the positive terminal of the D.-C. supply source through resistor 60 to the control winding of motor 50, and the lower half of secondary winding 58 is connected to ground. For a similar position of the shaft counter-clockwise from the neutral position, direct connections are provided between the pairs of contact surfaces 45, 46 and 48, 49, whereby the direct current connection from the supply source to the control winding is established and the upper half of secondary winding 58 is connected to ground.

When shaft 10 is turned clockwise the full amount, i. e., where lug 22 abuts member 16 at the edge of cut-out 13, one pair of contact points engages only contact surface 46, and contact points of the other pair provide a direct connection between the pair of contact surfaces 47, 48. In this position, there is a direct current connection from the positive terminal of the supply source to the control winding (not shown) of motor 50, and the lower half of secondary winding 58 is connected to ground. When the shaft is turned counter-clockwise the full amount, contact surfaces 48 and 49 are directly connected, whereby the upper half of secondary winding 58 is connected to ground and the direct current connection from the positive terminal of the supply source to the control winding is broken. The operation of the circuit, with A.-C. power being applied to primary winding 56, will now be described for each position of shaft 10.

In the neutral position of shaft 10, no power is applied to the control winding of motor 50; consequently the output shaft of the motor and antenna 52 are stationary. When shaft 10 is turned a small amount clockwise to connect the lower half of secondary winding 58 to ground, the application of the D.-C. voltage to the control winding provides a "drag" effect on the operation of motor 50 in a conventional manner, and the output shaft of the motor and antenna 52 will rotate slowly in a direction depending upon the phase of the A.-C. voltage applied through the lower half of secondary winding 58 and capacitor 62 to the control winding. In the corresponding counter-clockwise position of shaft 10 from the neutral position, the connection of the upper half of secondary winding 58 to ground causes a voltage of opposite phase to be applied to the control winding of the motor, whereby the output shaft of the motor and antenna 52 will rotate slowly in the opposite direction.

When shaft 10 is turned to its maximum limit in either direction to remove the D.-C. voltage from the control winding and to connect one-half of the secondary winding to ground, the drag effect on motor 50 is removed to permit the motor to rotate antenna 52 at a greater speed.

When shaft 10 is released, in any position, it will be returned to its neutral position.

From the foregoing, it can be seen that the rotation of

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antenna 52 can be made slow or fast, depending upon the position of shaft 10. The parts of the switch of this invention are so arranged that mistakes in assembly are reduced to a minimum. For example, the rotor 26 is a symmetrical element and would still be correctly positioned if, with respect to its position in Figs. 1 and 2, its ends were reversed and it was turned over. Similarly with wafer 32. Also, leaf spring 34 could be turned upside down from the position illustrated in Figs. 1-3, and the operation of the switch would be unaffected. The pairs of contact points are also symmetrically disposed with respect to the center of wafer 36, whereby they are positioned correctly so long as wafer 36 is placed on extension 12 with the contact points urged against the adjacent surface of insert 44.

As previously mentioned, the particular arrangement of contact surfaces could be different in number; further, it will be apparent that additional pairs of contact points could be utilized in conjunction with a greater number of contact surfaces. Obviously, too, a greater number of contact points could be provided on each metallic leaf, whereby adjacent contact points may be used to contact adjacent contact surfaces for one shaft position, and wider spaced contact points on the same leaf can be utilized to contact wider spaced contact surfaces in the same or a different position on the shaft. In other words, any desirable scheme can be followed in arranging contact points and contact surfaces so that direct connections between contact surfaces can be selectively established in accordance with shaft position. Furthermore, wafers and inserts having different contact and bearing surface schemes could be readily substituted for wafer 36 and insert 44 without disturbing other parts of the device. For this purpose, the inserts could be pressed into the end of housing 14 and suitably keyed for angular placement.

Referring again to Figs. 1 and 2, suitable means for holding the parts of the switch in assembled positions may be a cover plate 70 which is crimped at its edges to fit over member 16 and housing 14. A bracket 72 fitted over shaft 10 and secured against cover plate 70 by nuts 74 may be provided to be secured to a support. A knob (not shown) may be placed over the end of shaft 10 for operating the switch as above described.

From the foregoing, it will be apparent that this invention provides an improved manual control switch for selectively establishing and breaking contact between terminals for different circuits, wherein contact points are resiliently urged into contact with a bearing surface carrying spaced contact surfaces for such terminals, and wherein rotation of the contact points establishes and breaks contact between predetermined contact surfaces.

What is claimed is:

1. A switch comprising a housing, a rotatable shaft having one end projecting into said housing, an element of non-conductive material fixed to one end of said housing and having one surface thereof adjacent said one end of the shaft, spaced contact surfaces supported on said one surface of said element, a terminal pin for each contact surface extending through said element to said one surface, a support member mounted on said shaft, at least one metallic element affixed to said support member, at least one pair of spaced contact points on said metallic element, resilient means supported on said shaft for urging said support member toward said one surface of said element to constantly urge said contact points into engagement with said one surface, said support member being rotatable with said shaft to establish conductive connections between said contact points and predetermined pairs of said contact surfaces in predetermined positions of said shaft, said housing having a depression in the inner wall thereof, a spring support element supported on said shaft, a spring member, a spherical element, said spring member being supported by said spring support member to position said spherical element in

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said depression, limit stop means fixed to said housing, an element supported on said shaft and rotatable therewith to engage said limit stop means and thereby limit rotation of said shaft in either direction from a neutral position, said spherical element in the neutral position of said shaft being located in the center of said depression, and said spherical element upon rotation of said shaft from said neutral position effecting compression of said spring to establish a contra-rotating force effective upon release of said shaft to return said shaft to said neutral position.

2. In combination, a housing, an end plate for one end of said housing, said end plate being of non-conductive material, a plurality of spaced conductive surfaces affixed to the inner surface of said end plate, an externally accessible terminal pin for each conductive surface extending through said end plate to the conductive surface, a shaft having one end positioned adjacent the inner surface of said end plate and extending therefrom to the exterior of said housing, respective means supported by said shaft and said housing to limit rotation of said shaft, second means coupled to said shaft and said housing and effective in the absence of applied turning force to position said shaft in a neutral position intermediate the limits of rotation of said shafts, said second means being operable upon release of said shaft in any position other than the neutral position to cause said shaft to return to the neutral position, a plurality of conductive elements between spaced contact points, a non-conductive support member mounted on said shaft, said conductive elements being affixed to said support member, means for resiliently urging said support member toward said end plate to bias said contact points against inner surface thereof, and said support member being rotatable with said shaft to cause pairs of said contact points to establish direct current connections between predetermined conductive surfaces in predetermined positions of said shaft.

3. A rotary switching device comprising a housing, an end cap of non-conductive material for said housing, spaced contact surfaces affixed to the inner surface of said end cap, respective terminal pins for said contact surfaces extending through said end cap to the exterior of said housing, a shaft, an extension on said shaft, said extension projecting into said housing and having its end spaced from the inner surface of said end cap, a rotor

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element on said extension, said rotor element having openings on opposite sides of said extension and normal thereto, a compression spring in each of said openings, a ball bearing between the outer end of each spring and the inner wall of said housing, whereby each spring is compressed between said extension and its ball bearing and the ball bearings are continuously urged against said inner wall, said inner wall having at least one depression therein, one of said ball bearings resting in the center of said depression in a predetermined position of said shaft, whereby the spring associated with said one ball bearing is further compressed upon rotation of said shaft from said predetermined position to urge said shaft back to said predetermined position, cooperating means fixed to said shaft and said housing to limit rotation of said shaft in either direction from said predetermined position, a resilient member on said extension intermediate said rotor element and the end of said extension, a wafer of non-conductive material on said extension intermediate said resilient member and the end of said extension, at least one conductive element having spaced contact points affixed to the surface of said wafer adjacent the end of said extension, said resilient member constantly urging said wafer toward the inner surface of said end cap to cause said contact points to be maintained in engagement with said inner surface, and said wafer being rotatable with said shaft to establish direct connections between said contact points and predetermined contact surfaces in predetermined positions of said shaft.

4. The switching device defined in claim 3, wherein said cooperating means includes a disc surrounding said shaft and fixed to said housing, said disc having an arcuate opening extending from said shaft, a ring concentric with said disc secured to said shaft, said ring having a lug projection extending into said arcuate opening, and said lug in said predetermined position of said shaft being located in the center of said arcuate opening.

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