

April 28, 1964

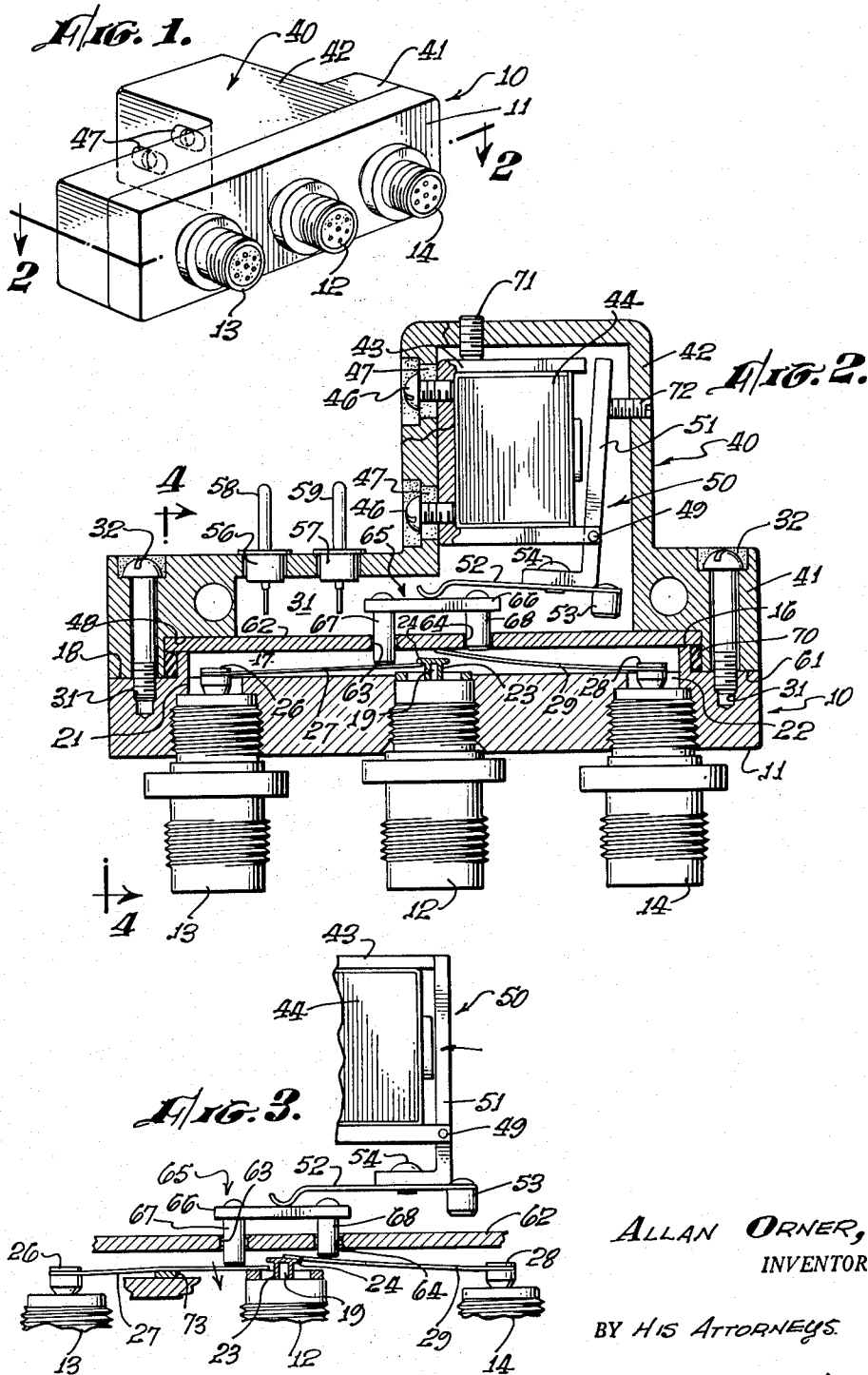
A. ORNER

3,131,268

ELECTROMAGNETIC COAXIAL SWITCH

Filed March 14, 1962

2 Sheets-Sheet 1



ALLAN ORNER,
INVENTOR.

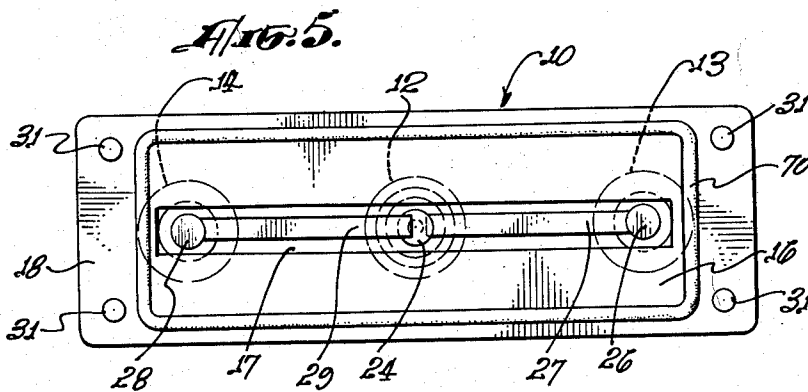
BY HIS ATTORNEYS.

Spensley & Horn.

Filed March 14, 1962

ELECTROMAGNETIC COAXIAL SWITCH

2 Sheets--Sheet 2



Spensley & Horn.

1

3,131,268

ELECTROMAGNETIC COAXIAL SWITCH
Allan Orner, Los Angeles, Calif., assignor to Electronic
Specialty Company, Los Angeles, Calif., a corporation
of California

Filed Mar. 14, 1962, Ser. No. 179,553
10 Claims. (Cl. 200-104)

This invention relates generally to electrical switches, and more particularly to coaxial switches utilizing two contact arms.

High frequency coaxial switches are well known in the art for selectively passing R.F. energy from an input coaxial connector to either one of two output coaxial connectors. In such switches, it is usually desired to short-circuit the unused output coaxial connector to electrically isolate it from the adjacent operating connectors, especially at very high radio frequencies where the wave lengths of the R.F. energy involved are of the order of magnitude of the physical dimensions of the switch components. It is extremely important, therefore, that such switches provide and maintain both a good impedance match between the various connectors and maximum isolation of the unused connector. Furthermore, for use in aircraft and missiles, the switch must be compact and light in weight, must require a minimum amount of power for actuation, and must maintain the electrical connections during the often encountered impact and high-G forces.

In an attempt to provide the foregoing enumerated characteristics, coaxial switches have been designed utilizing two leaf spring contact arms, one end of each contact arm being rigidly secured to an output connector and the free end of each contact arm positioned adjacent the input connector where each one can be selectively urged into electrical contact with the input connector. However, such prior art switches utilize two solenoids, each solenoid for actuation of a different one of the contact arms through means of a long push rod, thereby resulting in a relatively expensive, heavy and bulky switch. Due to the utilization of long push rods, the switch actuator mechanism is extremely susceptible to vibration since the mechanism cannot be properly dynamically balanced. In addition, such switches are extremely critical of adjustment and operable over only limited temperature ranges due to the variation in the length of the elongate push rods because of their temperature expansion characteristics. Because of the large physical size of the switch actuator mechanism, it exhibits mechanical resonance effects at relatively low frequencies, thereby rendering the switch less reliable under vibrational and acceleration forces.

Accordingly, it is an object of the present invention to provide improved electrical switches.

It is another object of the present invention to provide improved coaxial switches.

It is a further object of the present invention to provide improved coaxial switches utilizing two contact arms and a single solenoid for actuation of both of the arms.

It is yet another object of the present invention to provide extremely compact and light weight coaxial switches.

It is a still further object of the present invention to provide coaxial switches utilizing two contact arms, the switches providing reliable operation under extreme vibration and high-G forces.

It is another object of the present invention to provide coaxial switches utilizing two contact arms, the switches being capable of easy assemblage and convenient adjustment.

It is still another object of the present invention to

2

provide improved resonant line coaxial switches during the manufacture of which all soldered connections can be made prior to assemblage of the resonant line within the switch.

It is a still further object of the present invention to provide improved coaxial switches which can be adjusted without the necessity of disassembling the switch.

It is also an object of the present invention to provide improved coaxial switches capable of reliable operation under extreme environmental conditions.

The objects of the present invention are accomplished, in general, by a novel balanced actuator mechanism wherein both of the switch contact arms are actuated upon application of a single force to a self-adjusting push rod assembly. In a presently preferred embodiment of the present invention, an input coaxial connector and two output coaxial connectors are mounted to a switch housing and project into the housing, each of the output coaxial connectors having one end of an elongate leaf spring contact rigidly secured to its central inner electrode. The free end of one of the leaf spring contacts is normally urged by its resilience against the central inner electrode of the input coaxial connector while the free end of the other leaf spring contact is normally urged by its resilience into electrical contact with the switch housing at a point adjacent the central inner electrode of the input coaxial connector. A generally π -shaped push rod assembly, defining a base having two spaced apart parallel push rods extending therefrom, has the short push rods slidably mounted within the switch housing with the projecting ends of the push rods facing the free end of the leaf spring contacts and in alignment therewith. Upon application of a suitable force to the base portion of the push rod assembly, the force being directed toward the input coaxial connector, the push rod assembly is moved toward the input coaxial connector whereupon one of the push rods moves the free end of one of the spring contacts away from the central inner electrode of the input coaxial connector and into electrical contact with the housing and the other push rod moves the other leaf spring contact into electrical contact with the central inner electrode of the input coaxial connector. Due to the slidable mounting of the push rod assembly by the push rods, together with maintenance of sufficient tolerance between the push rods and the surfaces against which they slide, the push rod assembly is capable of a certain degree of rocking to thereby render the push rod assembly self-adjusting. This self-adjusting feature of the push rod assembly also enables a make-before-break type of switch action, if desired, merely by utilizing one leaf spring contact of greater resilience than the other leaf spring contact, since upon actuation of the weaker spring contact an increased actuating force will be automatically applied to the other push rod for actuation of the stronger spring contact. More important is the fact that the self-adjusting feature of the push rod assembly obviates the necessity of maintaining extremely close production tolerances and the heretofore extreme criticality of switch adjustment.

The novel features which are believed to be characteristic of the present invention, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings, in which the invention is illustrated by way of example. It is to be expressly understood, however, that this description and the drawings are for the purposes of illustration and description only, and that the true spirit and the scope of the invention is defined by the accompanying claims.

In the drawing:

FIGURE 1 is a perspective view of a coaxial switch

in accordance with a presently preferred embodiment of the invention;

FIGURE 2 is an enlarged view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a partial view of FIGURE 2 indicating the switch in an actuated condition;

FIGURE 4 is a view taken along the line 4—4 of FIGURE 2; and

FIGURE 5 is a rear view in elevation of a face plate assembly as utilized in the assembly of FIGURE 2.

Referring now to the drawing, in FIGURE 1, there is shown a perspective view of a coaxial switch in accordance with a presently preferred embodiment of the invention. The switch is contained within a housing 40 to which is mounted a face plate 10, both the housing 40 and the face plate 10 being constructed of metal or other suitable electrically conductive material. The face plate 10 has a planar front surface 11 with three threaded apertures therein into which are mounted an input coaxial connector 12 and output coaxial connectors 13 and 14. As can be seen in FIGURES 2, 4 and 5, the rear surface of the face plate 10 defines a central planar surface portion 16, having a rectangular slot 17 therein, and surrounded by a recessed planar edge surface portion 18. The input coaxial connector 12 is mounted deep within the face plate 10 so that its central inner electrode 19 projects into the slot 17. An aperture 21 communicates between the slot 17 and the threaded aperture into which the output coaxial connector 13 is inserted, with the central inner electrode of the coaxial connector 13 approximately flush with the base of the slot 17. An aperture 22 communicates between the slot 17 and the threaded aperture into which the output coaxial connector 14 is inserted, with the central inner electrode of the coaxial connector 14 approximately flush with the base of the slot 17. A ferrule 23 is mounted to the projecting central inner electrode 19 of the input coaxial connector 12 within the slot 17, the ferrule 23 having a circular transverse flange 24 thereon. Mounted to the tip of the central inner electrode of the output coaxial connector 13 by a metallic cap 26 is an elongate leaf spring contact 27, the length of the leaf spring contact 27 being such that the free end of the contact is proximate the ferrule 23 on the central inner electrode of the input coaxial connector 12. The inherent resilience of the leaf spring contact 27 urges its free end against the flange 24 on the ferrule 23, thereby completing electrical contact to the inner electrode 19. Mounted to the projecting tip of the inner central electrode of the output coaxial connector 14 by means of a metallic cap 28 is an elongate leaf spring contact 29 with the free end of the leaf spring contact 29 adjacent the flange 24 on the ferrule 23. The inherent resilience of the leaf spring contact 29 tends to maintain the free end of this leaf spring contact in spaced relationship from the flange 24. In the construction of the coaxial switch of the presently preferred embodiment, the coaxial connectors 12—14 are mounted to the face plate 10, together with the leaf spring contacts 27 and 29 to form a complete sub-assembly. Four threaded apertures 31 extend into the face plate 10 from its recessed edge surface portion 18 for the receptive engagement of mounting screws 32 for securing the face plate 10 to the housing 40.

The housing 40 generally defines a shallow portion 41 and a deeper portion 42. Mounted within the deeper portion 42 is a coil assembly including a coil core 43 and a bobbin wound coil 44. The coil core 43 is constructed of ferromagnetic material and is adjustably mounted within the housing 40 by means of screws 46 extending through horizontal slots 47 in the deeper portion 42 of the housing 40. The width of the slots 47 is only slightly larger than the diameter of the bodies of the screws 46 so that the heads of the screws 46 will bear against the surface of the housing 40.

Rotatably mounted to one end of the coil core 43 by

means of a pin 49 is an armature assembly 50. The armature assembly 50 consists of a generally L-shaped armature 51, an elongate leaf spring 52 and a balance weight 53. The elongate leaf spring 52 is mounted near one of its ends to the shorter leg portion of the armature 51 by suitable means such as rivets 54. The balance weight 53 is rigidly affixed to the end of the leaf spring 52 adjacent the armature 51. The mass of the balance weight 53 is chosen to statically and dynamically balance the armature assembly 50. A pair of feed-throughs 56 and 57, of suitable electrical insulating material, such as glass (to maintain a hermetic seal), extend through the wall of the housing 40. An electrical terminal 58 extends through the glass of feed-through 56 and projects into the shallow portion 41 of the housing 40. An electrical terminal 59 extends through the glass of feed-through 57 and projects into the shallow portion 41 of the housing 40. The electrical terminals 58 and 59 are sealed within the glass of feed-throughs 56 and 57, and the feed-throughs 56 and 57 are sealed to the surface of the housing 40. Suitable electrical leads, not shown, connect the electrical terminals 58 and 59 with the ends of the winding of the coil 44.

In the end surface 61 of the open end of the housing 40, there is defined a rectangular depression of a predetermined depth, the rectangular depression being slightly greater in size than the central rear surface 16 of the face plate 10. Mounted within this rectangular depression is a housing cover plate 62, the cover plate 62 completely filling the rectangular depression in the face 61. Centrally located in the cover plate 62 are two spaced apart cylindrical apertures 63 and 64. A generally π -shaped push rod assembly 65, defining a base portion 66 and two spaced apart push rods 67 and 68 extending therefrom has the push rods 67 and 68 slidably mounted within the apertures 63 and 64 with the projecting ends of the push rods 67 and 68 extending through the cover plate 62. The base portion 66 of the push rod assembly 65 and the projecting push rods 67 and 68 are of Zytel nylon or other suitable electrical insulating material. The apertures 63 and 64 in the cover plate 62 are of a predetermined diameter larger than the diameter of the push rods 67 and 68 and the apertures have beveled edges. The tolerance between the push rods 67 and 68 and the apertures 63 and 64 enables a certain degree of rocking motion by the push rod assembly 65 during normal operation, this rocking motion providing a self-adjusting feature as will be explained hereinbelow.

During the construction of the illustrated coaxial switch, the coil 44, the coil core 43 and the armature assembly 50 are assembled as a unit and the mass of the balance weight 53 adjusted to statically and dynamically balance the armature assembly 50. The coil and armature assembly is inserted into the deeper portion 42 of the housing 40 and there adjustably secured by the mounting screws 46. The coil 44 is then wired by electrical leads, not shown, to the electrical terminals 58 and 59 and secured thereto by soldering. The push rod assembly 65 is then assembled to the cover plate 62 by insertion of the push rods 67 and 68 into the apertures 63 and 64, and the cover plate 62 then positioned in abutment with a shoulder defined by a recessed surface portion 48 within the face 61 of the housing 40. A suitable sealing ring 70, such as a neoprene O-ring, for example, is placed around the periphery of the central rear surface 16 of the face plate 10 and the face plate then mounted to the housing 40 with the central rear surface 16 abutting against the cover plate 62 and with the edge surface portion 18 of the face plate 10 in abutment with the face 61 of the housing 40. The screws 32 are inserted through suitable apertured apertures extending through the shallow portion 41 of the housing 40 and threadably mated with the apertures 31 in the surface 18 of the face plate 10. The sealing ring 70 is compressed during the assembly and tightening of the screws 32 to provide a

pressure-tight seal between the face plate 10 and the housing 40.

Upon assemblage of the face plate 10 to the housing 40, a resonant line section is formed by the slot 17, the slot being sealed by the surface of the cover plate 62. The dimensions of the slot 17 are such that a suitable strip line will be formed at the contemplated operating frequencies. Thus, the leaf spring contacts 27 and 29 are operated entirely within a strip line.

Adjustment of the switch 10 is relatively simple. The mounting screws 46 are loosened slightly to enable movement of the coil core 43 to the extent that the screws 46 are movable within the slots 47. The coil 44 is energized by connection of a suitable source of operating potential to the electrical connectors 58 and 59 to cause the armature 51 to be rotated in a counterclockwise direction and drawn into contact with the ends of the coil core 43, this position being shown in FIGURE 3. Rotation of the armature 51 causes the push rod assembly 65 to be urged toward the cover plate 10. In the energized condition, an adjusting screw 71, extending through the rear surface of the housing 40, is screwed inwardly to urge the coil core 43 toward the face plate 10 until the leaf spring contact 27 is in physical and electrical contact with the surrounding outer electrode of the input coaxial electrode 12 and the free end of the leaf spring contact 29 is in physical and electrical contact with the ferrule 23 mounted to the tip of the central inner electrode 19 of the input coaxial connector 12. These conditions can be conveniently indicated by a connection of ohmmeters between the central inner electrode of the coaxial connector 13 and the face plate 10 and between the central inner electrodes of the coaxial connectors 12 and 14. The adjusting screw 71 is then screwed in still further a predetermined amount to provide the desired contact pressure by bowing or over-deflection of the leaf spring 52 in the armature assembly 50. The screws 46 are then tightened to lock the coil and core in this position and the slots 47 then sealed with non-flowing epoxy.

The coil 44 is then de-energized, thereby allowing the spring restoring force of the leaf spring contacts 27 and 29, together with the spring restoring force of the leaf spring 52, to urge the push rod assembly 65 against the leaf spring 52 to cause clockwise rotation of the armature assembly 50 to the position shown in FIGURE 2. An adjusting screw 72, threadably inserted through the side wall of the deeper portion 42 of the housing 40 is then unscrewed until the free end of the leaf spring contact 29 makes physical and electrical contact with the cover plate 62 and the free end of the leaf spring contact 27 makes physical and electrical contact with the flange 24 on the ferrule 23. Again, ohmmeters may be utilized to provide the desired indication. The adjusting screw 72 is then further backed off an additional predetermined amount to provide the desired contact pressure in accordance with the natural resilience of the leaf spring contacts 27 and 29. The adjusting screw 72 is then sealed in this position through the application of non-flowing epoxy.

The adjusting screw 71 is then completely withdrawn and suitable vacuum pumping apparatus connected to the threaded aperture for the screw 71 and the interior of the housing then evacuated and subsequently a desired atmosphere, such as a nitrogen atmosphere, is created within the interior of the housing. The aperture is then sealed with epoxy and the switch then ready for operation. During the mounting of the coaxial connectors 12-14 to the face plate 10 a plurality of the connector threads are coated with non-flowing epoxy to thereby provide the desired pressure-tight seal.

The illustrated embodiment of FIGURE 2 is for a break-before-make type of switching operation, the leaf spring contacts 27 and 29 being of approximately equal resiliency and the push rod 67 being longer than the push rod 68. Upon energization of the coil 44, movement of the push rod assembly 65 will cause the push

rod 67 to move the free end of the leaf spring contact 27 away from the flange 24 slightly before the push rod 68 urges the free end of the leaf spring contact 29 into contact with the flange 24. For proper switch action, the resiliencies of the leaf spring contacts 27 and 29 need not be identical nor need be within certain critical specifications. For example, if the leaf spring contact 29 is of slightly greater resiliency than that of the leaf spring contact 27, when the linear motion of the push rod 67 is arrested by the free end of the leaf spring contact 27 bearing against the outer electrode of the input coaxial connector 12 the push rod assembly 65 will rock in a clockwise direction to thereby increase the force urging the push rod 68 toward the coaxial connector 12 and so cause movement of the free end of the leaf spring contact 29 into physical and electrical contact with the flange 24 on the ferrule 23. In practice, the diameters of the apertures 63 and 64 are adjusted to provide sufficient tolerance to allow rocking of the push rod assembly 35 through an arc of approximately 18° in either direction from its rest position.

The switch of FIGURE 2 can be converted from a break-before-make type of switching operation to a make-before-break type of operation merely by the addition of a small block 73 as shown in FIGURE 3. The block 73 is mounted to the face plate 10 within the block 17 and in alignment with the leaf spring contact 27. The block 73 is in contact with the central portion of the leaf spring contact 27 when the switch is in the de-energized position. The block 73 is of a suitable electrical insulating material, such as nylon, for example, in order to prevent continual short circuiting of the contact 27 to the face plate 10. Due to the presence of the block 73, a much greater force is needed to urge the free end of the leaf spring contact 27 away from the underside of the flange 24 on the ferrule 23. Hence, upon energization of the coil 44, the initial movement of the push rod assembly 65 will be a rocking one in the clockwise direction and movement of the push rod 68 toward the input coaxial connector 12 to urge the free end of the leaf spring contact 29 away from the cover plate 16 and into contact with the flange 24 on the ferrule 23. At this point, the push rod assembly 65 then rocks in the counterclockwise direction to effectively transfer the majority of this force to the push rod 67 to thereby cause movement of the free end of the leaf spring contact 27 away from the flange 27 and into contact with the outer electrode of the coaxial electrode 12. The presence of the block 73 shortens the effective length of the leaf spring contact 27 to greatly increase its apparent stiffness. Of course, the same result could be achieved by utilizing a leaf spring contact 27 of much greater natural stiffness than that of the leaf spring contact 29.

Thus, there has been described an improved coaxial switch wherein a single solenoid is used to actuate two leaf spring contact arms through a novel self-adjusting push rod assembly. The actuator mechanism is both statically and dynamically balanced and eliminates the heretofore utilized extremely long push rods. Although the illustrated embodiment discloses a type of switch operation wherein one contact is switched from ground to an output electrode while the other contact is being switched from the output electrode to ground, it is readily apparent that the concepts of the present invention are equally applicable to any type of switching arrangement wherein the elongate leaf spring contacts are moved between predetermined positions, either simultaneously or one before the other. The predetermined switch positions may result in the leaf springs being in physical contact with electrical terminals or may provide the desired switching function without physically contacting electrical terminals, such as by movement through a magnetic field, for example. Furthermore, the leaf springs may or may not make electrical contact at both switch positions, i.e. the switches may be single-throw, double-throw, or combinations thereof. Thus, movement of each leaf spring be-

tween the predetermined positions may result in the making or breaking of an electrical contact or both a making and a breaking in any particular desired order. Hence, when herein referring to the movement of the leaf spring contacts between predetermined positions, the word "between" is intended to refer to movements in either direction and is intended to encompass any desired intermediate positions.

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. In an electrical switch: first and second electrical terminals; first and second elongate leaf spring contacts, said first elongate contact being rigidly secured at one end to said first electrical terminal and having its free end adapted for movement between first and second predetermined positions, said second elongate contact being rigidly secured at one end to said second electrical terminal and having its free end adapted for movement between third and fourth predetermined positions; a plate disposed adjacent said electrical terminal and in predetermined spaced relationship therewith, said plate defining two spaced apart apertures extending through its thickness dimension, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof; a generally π -shaped push rod assembly defining a base having first and second spaced apart push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said plate, said push rod assembly being positioned with its push rod projecting through the apertures in said plate toward said first and second leaf spring contacts, said push rods having a uniform cross sectional configuration of such dimension to provide a predetermined tolerance between the push rods and the apertures through which they extend; and, means for selectively applying a predetermined force to the base of said push rod assembly to move said push rod assembly in a predetermined direction to cause said first push rod to move the free end of said first elongate contact between said first and second predetermined positions and to cause said second push rod to move the free end of said second elongate contact between said third and fourth predetermined positions, unitary means for selectively moving the free end of said first elongate contact between said first and second positions and the free end of said second elongate contact between said third and fourth positions.

2. In an electrical switch: first and second and third electrical terminals; a first elongate leaf spring contact rigidly secured at one end to said first electrical terminal and with its free end extending toward said third electrical terminal and adapted for movement between a first predetermined position in physical and electrical contact with said third electrical terminal and a second predetermined position spaced away from said third electrical terminal; a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end extending toward said third electrical terminal and adapted for movement between a third predetermined position in spaced relationship from said third electrical terminal and a fourth predetermined position in physical and electrical contact with said third electrical terminal; a plate disposed adjacent said electrical terminal and in predetermined spaced relationship therewith, said plate defining two spaced apart apertures extending through its thickness dimension, one of said apertures being in alignment with said first elongate leaf spring con-

tact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof; a generally π -shaped push rod assembly defining a base having first and second spaced apart push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said plate, said push rod assembly being positioned with its push rod projecting through the apertures in said plate toward said first and second leaf spring contacts, said push rods having a uniform cross sectional configuration of such dimension to provide a predetermined tolerance between the push rods and the apertures through which they extend; and, means for selectively applying a predetermined force to the base of said push rod assembly to move said push rod assembly in a predetermined direction to cause said first push rod to move the free end of said first elongate contact between said first and second predetermined positions and to cause said second push rods to move the free end of said second elongate contact between said third and fourth predetermined positions.

3. An electrical switch comprising, in combination:

- (a) a switch face plate;
- (b) first, second and third electrical terminals mounted to said face plate and electrically insulated from each other;
- (c) a first elongate leaf spring contact rigidly secured at one end to said first electrical terminal and with its free end extending toward said third electrical terminal and adapted for movement between a first predetermined position in physical and electrical contact with said third electrical terminal and a second predetermined position spaced away from said third electrical terminal;
- (d) a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end extending toward said third electrical terminal and adapted for movement between a third predetermined position in spaced relationship from said third electrical terminal and a fourth predetermined position in physical and electrical contact with said third electrical terminal;
- (e) a cover plate secured to said face plate adjacent said electrical terminal and in predetermined spaced relationship therewith, said cover plate defining two spaced apart apertures extending through its thickness dimension, one of said apertures being in alignment with said elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
- (f) a generally π -shaped push rod assembly defining a base having first and second spaced apart push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said cover plate, said push rod assembly being positioned with its push rods projecting through the apertures in said cover plate toward said first and second leaf spring contacts, said push rods having a uniform cross section configuration of such dimensions to provide a predetermined tolerance between the push rods and the apertures through which they extend; and,
- (g) means for selectively applying a predetermined force to the base of said push rod assembly to move said push rod assembly in a predetermined direction to cause the first push rod to move the free end of said first elongate contact between said first and second predetermined positions and to cause said second push rod to move the free end of said second elongate contact between said third and fourth predetermined position.

4. An electrical switch comprising, in combination:

- (a) a switch face plate;

- (b) first, second and third electrical terminals mounted to said face plate and electrically insulated from each other;
 - (c) a first elongate leaf-spring contact rigidly secured at one end to said first electrical terminal and with its free end normally urged by its resilience against said third electrical terminal and in electrical contact therewith, said first leaf spring contact being so oriented with respect to said first and third electrical terminals that a sufficient force of predetermined direction applied to said first leaf spring contact will cause movement of the free end of first leaf spring contact from said third electrical terminal to interrupt its electrical connection therewith;
 - (d) a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end normally maintained by its resilience a predetermined distance from said third electrical terminal, said second leaf spring contact being so oriented with respect to said second and third electrical terminals that a sufficient force of said predetermined direction applied to said second leaf spring contact will move the free end of said second leaf spring contact into physical and electrical contact with said third electrical terminal;
 - (e) a cover plate secured to said face plate adjacent said electrical terminals and in predetermined spaced relationship therewith, said cover plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
 - (f) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said cover plate, the diameter of said push rods being a predetermined amount less than the diameter of said cylindrical apertures, said push rod assembly being positioned with its push rods projecting through the apertures in said cover plate toward said first and second leaf spring contacts; and,
 - (g) means for selectively applying a predetermined force to the base of said push rod assembly to move said push rod assembly in said predetermined direction toward said leaf spring contacts to cause said first push rod to move the free end of said first elongate contact away from said third electrical terminal and to cause said second push rod to move the free end of said second elongate contact into electrical contact with said third electrical terminal.
5. An electrical switch comprising, in combination:
- (a) a switch housing defining a chamber therein;
 - (b) first, second and third electrical terminals mounted to said switch housing and electrically insulated therefrom and projecting into the chamber within said housing;
 - (c) a first elongate leaf spring contact rigidly secured at one end to said first electrical terminal and with its free end normally urged by its resilience against said third electrical terminal and in electrical contact therewith, said first leaf spring contact being so oriented with respect to said first and third electrical terminals that a sufficient force of predetermined direction applied to said first leaf spring contact will move the free end of said first leaf spring contact from said third electrical terminal to thereby interrupt electrical contact therewith;
 - (d) a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end normally maintained by its resili-

- ience a predetermined distance from said third electrical terminal, said second leaf spring contact being so oriented with respect to said second and third electrical terminals that a sufficient force of said predetermined direction applied to said second leaf spring contact will move the free end of said second leaf spring contact into physical and electrical contact with said third electrical terminal;
 - (e) a plate mounted within said housing adjacent said electrical terminals and in predetermined spaced relationship therewith, said plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
 - (f) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said plate, the diameter of said push rods being a predetermined amount less than the diameter of said cylindrical apertures, said push rod assembly being positioned with its push rods extending through the apertures in said plate and projecting therefrom toward said first and second leaf spring contacts; and,
 - (g) means for selectively applying a predetermined force to the base of said push rod assembly to move said push rod assembly in said predetermined direction toward said leaf spring contacts to cause said first push rod to move the free end of said first elongate contact away from said third electrical terminal and to cause said second push rod to move the free end of said second elongate contact into electrical contact with said third electrical terminal.
6. An electrical switch comprising, in combination:
- (a) a switch housing defining a chamber therein;
 - (b) first, second and third electrical terminals mounted to said switch housing and electrically insulated therefrom and projecting into the chamber within said housing;
 - (c) a first elongate leaf spring contact rigidly secured at one end to said first electrical terminal and with its free end normally urged by its resilience against said third electrical terminal and in electrical contact therewith, said first leaf spring contact being so oriented with respect to said first and third electrical terminals that a sufficient force of predetermined direction applied to said first leaf spring contact will move the free end of said first leaf spring contact from said third electrical terminal to thereby interrupt electrical contact therewith;
 - (d) a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end normally maintained by its resilience a predetermined distance from said third electrical terminal, said second leaf spring contact being so oriented with respect to said second and third electrical terminals that a sufficient force of said predetermined direction applied to said second leaf spring contact will move the free end of said second leaf spring contact into physical and electrical contact with said third electrical terminal;
 - (e) a plate mounted within said housing adjacent said electrical terminals and in predetermined spaced relationship therewith, said plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof

- and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
- (f) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said plate, the diameter of said push rods being a predetermined amount less than the diameter of said cylindrical apertures, said push rod assembly being positioned with its push rods extending through the apertures in said plate and projecting therefrom toward said first and second leaf spring contacts; and,
- (g) electromagnetic actuating means mounted within said housing, said electromagnetic actuating means consisting of a coil core of magnetic material having a wire coil wound thereon and a generally L-shaped armature having first and second leg portions at substantially right angles to each other, said armature being rotatably mounted for angular movement of said first leg portion toward said coil core in response to the magnetic field created by the passage of an electrical current through said coil, said second leg portion being of a predetermined resiliency, said second leg portion being in contact with said base of said push rod assembly and so positioned with respect thereto that upon energization of said coil and the resultant rotary movement of said armature said push rod assembly will be urged in said predetermined direction toward said leaf spring contacts with sufficient force to cause said first push rod to move the free end of said first elongate contact to interrupt its electrical contact with said third electrical terminal and to cause said second push rod to move the free end of said second elongate contact into electrical contact with said third electrical terminal.
7. A coaxial switch comprising, in combination:
- (a) a switch housing defining an aperture extending inwardly from a predetermined surface thereof;
- (b) a face plate detachably mounted to said predetermined surface to thereby seal the aperture within said housing;
- (c) an input coaxial connector and first and second output coaxial connectors mounted to the exterior surface of said face plate with the central electrodes of said coaxial connectors projecting into the aperture within said housing;
- (d) a first elongate leaf spring contact of a predetermined resiliency, said first leaf spring contact being rigidly secured at one end to the central electrode of said first output coaxial connector and with its free end normally urged by its resiliency against the central electrode of said input coaxial connector and in electrical contact therewith, the free end of said leaf spring contact being movable away from the central electrode of said input coaxial connector and toward said face plate;
- (e) a second elongate leaf spring contact of a predetermined resiliency, said second leaf spring contact being rigidly secured at one end to the central electrode of said second output coaxial connector and with its free end proximate the central electrode of said input coaxial connector and normally maintained by its resiliency in spaced relationship from said central electrode of said input coaxial connector, the free end of said second elongate leaf spring contact being in alignment with the central electrode of said input coaxial connector for contact therewith upon movement of said second contact toward said face plate;
- (f) a cover plate mounted within the aperture in said housing in parallel alignment with said face plate and spaced therefrom a predetermined distance, said cover plate defining two spaced apart cylindrical apertures extending through its thickness dimension,

- said central apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
- (g) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods coinciding with the spacing of said apertures in said cover plate, the diameter of said push rods being a predetermined amount less than the diameter of said apertures in said cover plate, said push rod assembly being positioned within the aperture in said housing with said push rods extending through the apertures in said cover plate and projecting toward the leaf spring contacts; and,
- (h) electromagnetic actuating means mounted within said housing for selectively applying a predetermined force to the base of said push rod assembly to urge said push rod assembly toward said leaf spring contacts with a predetermined force so that said first push rod will be urged against said first leaf spring contact to move its free end away from the central electrode of said input coaxial connector and into electrical contact with said face plate and to urge said second push rod against said second elongate contact to move its free end into electrical contact with the central electrode of said input coaxial connector.
8. An electrical switch comprising, in combination:
- (a) a switch housing defining a chamber therein;
- (b) first, second and third electrical terminals mounted to said switch housing and electrically insulated therefrom and projecting into the chamber within said housing;
- (c) a first elongate leaf spring contact rigidly secured at one end to said first electrical terminal and with its free end normally urged by its resiliency against said third electrical terminal and in electrical contact therewith, said first leaf spring contact being so oriented with respect to said first and third electrical terminals that a sufficient force of predetermined direction applied to said first leaf spring contact will move the free end of said first leaf spring contact from said third electrical terminal to thereby interrupt electrical contact therewith;
- (d) a second elongate leaf spring contact rigidly secured at one end to said second electrical terminal and with its free end normally maintained by its resiliency a predetermined distance from said third electrical terminal, said second leaf spring contact being so oriented with respect to said second and third electrical terminals that a sufficient force of said predetermined direction applied to said second leaf spring contact will move the free end of said second leaf spring contact into physical and electrical contact with said third electrical terminal;
- (e) a plate mounted within said housing adjacent said electrical terminals and in predetermined spaced relationship therewith, said plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
- (f) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods corresponding with the spacing of said apertures in said plate, the

diameter of said push rods being a predetermined amount less than the diameter of said cylindrical apertures, said push rod assembly being positioned with its push rods extending through the apertures in said plate and projecting therefrom toward said first and second leaf spring contacts; and,

(g) electromagnetic actuating means mounted within said housing, said electromagnetic actuating means consisting of a coil core of magnetic material having a wire coil wound thereon and a generally L-shaped armature assembly having first and second leg portions at substantially right angles to each other, said armature assembly being rotatably mounted for angular movement of said first leg portion toward said coil core in response to the magnetic field created by the passage of an electrical current through said coil, said second leg portion being of a predetermined resiliency, said second leg portion having a counterweight attached thereto to statically and dynamically balance said armature assembly, said second leg portion being in contact with said base of said push rod assembly and so positioned with respect thereto that upon energization of said coil and the resultant rotary movement of said armature said push rod assembly will be urged in said predetermined direction toward said leaf spring contacts with sufficient force to cause said first push rod to move the free end of said first elongate contact to interrupt its electrical contact with said third electrical terminal and to cause said second push rod to move the free end of said second elongate contact into electrical contact with said third electrical terminal.

9. A coaxial switch comprising, in combination:

(a) a switch housing defining an aperture extending inwardly from a predetermined surface thereof;

(b) a face plate detachably mounted to said predetermined surface to thereby seal the aperture within said housing;

(c) an input coaxial connector and first and second output coaxial connectors mounted to the exterior surface of said face plate with the central electrodes of said coaxial connectors projecting into the aperture within said housing;

(d) a first elongate leaf spring contact of a predetermined resiliency, said first leaf spring contact being rigidly secured at one end to the central electrode of said first output coaxial connector and with its free end normally urged by its resilience against the central electrode of said input coaxial connector and in electrical contact therewith, the free end of said leaf spring contact being movable away from the central electrode of said input coaxial connector and toward said face plate;

(e) a second elongate leaf spring contact of a predetermined resiliency, said second leaf spring contact being rigidly secured at one end to the central electrode of said second output coaxial connector and with its free end proximate the central electrode of said input coaxial connector and normally maintained by its resiliency in spaced relationship from said central electrode of said input coaxial connector, the free end of said second elongate leaf spring contact being in alignment with the central electrode of said input coaxial connector for contact therewith upon movement of said second contact toward said face plate;

(f) a cover plate mounted within the aperture in said housing in parallel alignment with said face plate and spaced therefrom a predetermined distance, said cover plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said central apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring

contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;

(g) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods coinciding with the spacing of said apertures in said cover plate, the diameter of said push rods being a predetermined amount less than the diameter of said apertures in said cover plate, said push rod assembly being positioned within the aperture in said housing with said push rods extending through the apertures in said cover plate and projecting toward the leaf spring contacts; and,

(h) electromagnetic actuating means mounted within the aperture in said housing, said electromagnetic actuating means consisting of a coil core of magnetic material having a wire coil wound thereon and a generally L-shaped armature assembly having first and second leg portions at substantially right angles to each other, said armature assembly being rotatably mounted for angular movement of said first leg portion toward said coil core in response to the magnetic field created by the passage of an electrical current through said coil, said second leg portion being of a predetermined resiliency, said second leg portion having a counterweight mounted thereto to statically and dynamically balance said armature assembly, said second leg portion being in contact with said base of said push rod assembly and so positioned with respect thereto that upon energization of said coil and the resultant rotary movement of said armature assembly said push rod assembly will be urged in said predetermined direction toward said leaf spring contacts with sufficient force to cause said first push rod to move the free end of said first elongate contact away from the central electrode of said input coaxial connector and into electrical contact with said face plate and to urge said second push rod against said second elongate contact to move its free end into electrical contact with the central electrode of said input coaxial connector.

10. A coaxial switch comprising, in combination:

(a) a switch housing defining an aperture extending inwardly from a predetermined surface thereof;

(b) a face plate detachably mounted to said predetermined surface to thereby seal the aperture in said housing, the inner surface of said face plate defining an elongate rectangular slot of predetermined dimensions;

(c) an input coaxial connector and first and second output coaxial connectors mounted to the exterior surface of said face plate with the central electrodes of said coaxial connectors projecting into the slot in the interior surface of the face plate;

(d) a first elongate leaf spring contact of a predetermined resiliency, said first leaf spring contact being rigidly secured at one end to the central electrode of said first output coaxial connector and with its free end normally urged by its resilience against the central electrode of said input coaxial connector and in electrical contact therewith, the free end of said leaf spring contact being movable away from the central electrode of said input coaxial connector and toward said face plate;

(e) a second elongate leaf spring contact of a predetermined resiliency, said second leaf spring contact being rigidly secured at one end to the central electrode of said second output coaxial connector and with its free end proximate the central electrode of said input coaxial connector and normally maintained by its resilience in spaced relationship from said central electrode of said input coaxial connector, the free end of said second elongate leaf spring con-

tact being in alignment with the central electrode of said input coaxial connector for contact therewith upon movement of said second contact toward said face plate;

- (f) a cover plate mounted within the aperture in said housing in parallel alignment with said face plate and spaced therefrom a predetermined distance, said cover plate defining two spaced apart cylindrical apertures extending through its thickness dimension, said central apertures having beveled edges and being of a predetermined diameter, one of said apertures being in alignment with said first elongate leaf spring contact near said free end thereof and the other of said apertures being in alignment with said second elongate leaf spring contact near said free end thereof;
- (g) a generally π -shaped push rod assembly defining a base having first and second spaced apart cylindrical push rods of predetermined lengths extending therefrom, the spacing of said push rods coinciding with the spacing of said apertures in said cover plate, the diameter of said push rods being a predetermined amount less than the diameter of said apertures in said cover plate, said push rod assembly being positioned within the aperture in said housing with said push rods extending through the apertures in said cover plate and projecting toward the leaf spring contacts; and,
- (h) electromagnetic actuating means mounted within the aperture in said housing, said electromagnetic actuating means consisting of a coil core of magnetic material having a wire coil wound thereon and a generally L-shaped armature assembly having first

and second leg portions at substantially right angles to each other, said armature assembly being rotatably mounted for angular movement of said first leg portion toward said coil core in response to the magnetic field created by the passage of an electrical current through said coil, said second leg portion being of a predetermined resiliency, said second leg portion having a counterweight mounted thereto to statically and dynamically balance said armature assembly, said second leg portion being in contact with said base of said push rod assembly and so positioned with respect thereto that upon energization of said coil and the resultant rotary movement of said armature assembly said push rod assembly will be urged in said predetermined direction toward said leaf spring contacts with sufficient force to cause said first push rod to move the free end of said first elongate contact away from the central electrode of said input coaxial connector and into electrical contact with said face plate and to urge said second push rod against said second elongate contact to move its free end into electrical contact with the central electrode of said input coaxial connector.

References Cited in the file of this patent

UNITED STATES PATENTS

2,749,396	Horman et al.	June 5, 1956
2,859,311	Concelman	Nov. 4, 1958
2,926,318	Lanciot	Feb. 23, 1960
2,958,053	Concelman	Oct. 25, 1960
2,997,669	Charles	Aug. 23, 1961
3,050,603	Concelman	Aug. 21, 1962