Oct. 7, 1958 R. H. KOONTZ 2,855,471

STRIP-LINE SWITCHES

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FIG. 1.

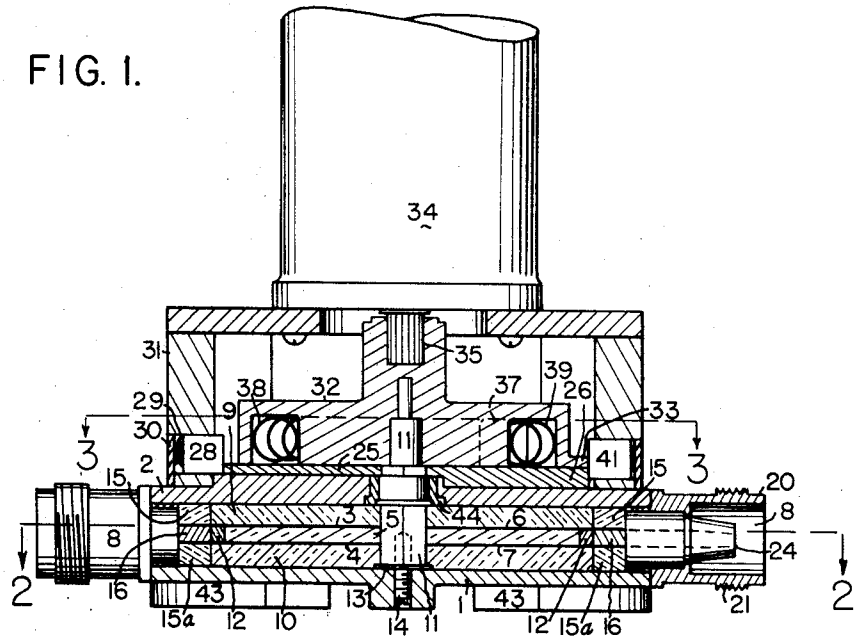
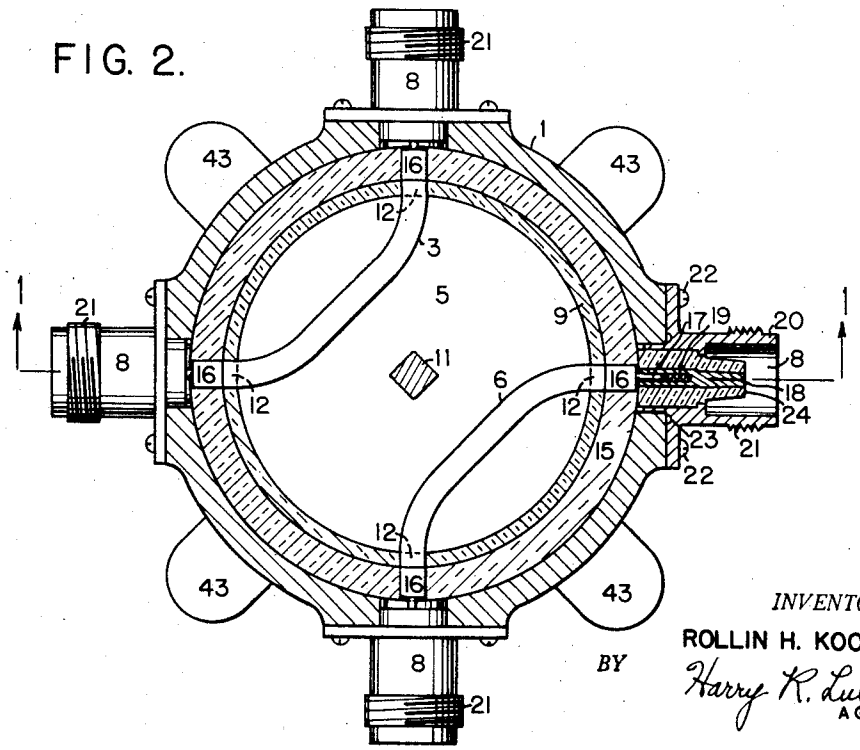


FIG. 2.



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FIG. 3.

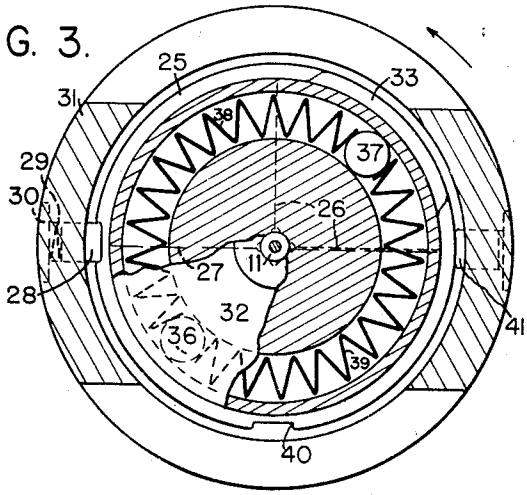


FIG. 4.

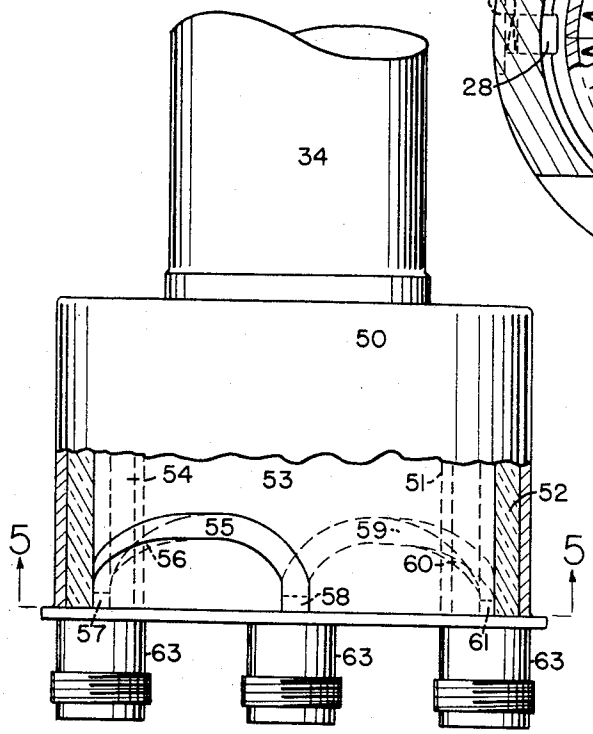
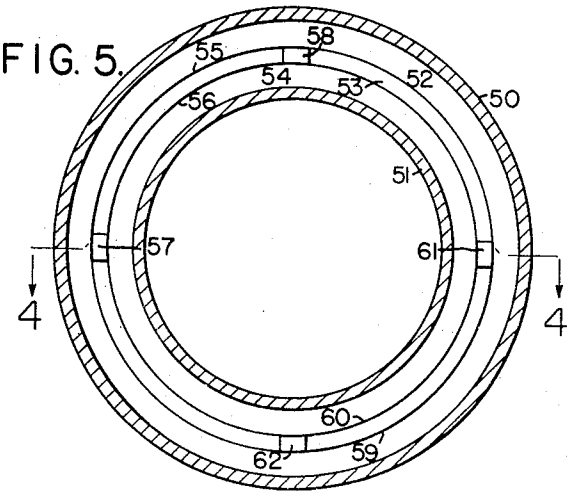


FIG. 5.



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STRIP-LINE SWITCHES

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Application June 19, 1957, Serial No. 666,631

18 Claims. (Cl. 200—5)

My invention relates to a high frequency electrical switch and particularly to a rotary switch for switching coaxial cables.

When it is required to switch radio frequency alternating current electrical energy having a frequency of hundreds or of thousands of megacycles extreme care is required to avoid discontinuities. Such defects have occurred in the devices of the prior art because both inner and outer conductors of the coaxial cable have been connected and disconnected. It is difficult to maintain a low resistance joint at the junctions of the outer conductors. Other prior switches have introduced discontinuities because of nonsymmetrical current flow in portions of the outer conductor within the switch and because of sharp turns in the coaxial conductor path.

Prior devices have also been relatively large, heavy and have had movable members of large inertia requiring large forces to operate. Such configurations have resulted from an attempt to retain the conventional coaxial conductor through the switch, and/or by breaking contact with both the inner and the outer conductors to accomplish switching.

Coaxial switches are often used in aeronautical vehicles and in missiles. In such the switches are invariably remote controlled. Should the remote control mechanism fail for any reason devices of the prior art would have disconnected the circuit or circuits switched and the equipment involved rendered useless. A switch in which this fault cannot occur is obviously of great value.

According to my invention I provide a switch of the coaxial type in which the structure of the outer conductor remains connected and symmetrical regardless of the switch position. Also, at least one coaxial circuit remains connected to the equipment involved regardless of failure of the actuating mechanism during the switching cycle or at any other time.

Briefly, I accomplish this by conveying the radio frequency signal to be switched through the movable part of the switch by means of a strip-line inner conductor between two stationary ground planes. The latter are integral parts of the structure that includes the external conductors of the coaxial cables leading to and from the switch. I am able to accomplish a fail-safe structure by a rotary latch-spring-cam combination interposed between the actuator and the switching rotor. The latter does not move from a given initial position until the actuator mechanism has completed the motion required to bring the succeeding switch elements into contact, after which the energy stored in the spring actually completes the transfer.

An object of my invention is to provide a radio frequency switch having a minimum number of contacts.

Another object is to provide such a switch in which uniformity of impedance is attained and easily maintained.

Another object is to provide a rotary switch actuated in a fail-safe manner.

Another object is to provide a coaxial type switch in

which positive alignment of the coaxial elements is insured at the cessation of each actuation.

Another object is to provide a radio frequency switch having a rotor of small inertia.

Another object is to provide such a switch that is small, light weight, requires a small force for actuation and which may be pressurized.

Another object is to provide a radio frequency switch that is easily and inexpensively manufactured in quantity to uniform characteristics.

Other objects of my invention will become apparent upon reading the following detailed specification and upon examining the accompanying drawings, in which:

Fig. 1 shows an elevation view of my switch, partly in section,

Fig. 2 shows a plan sectional view thereof, particularly of the rotor and the relation of the electrical switching thereof to the surrounding housing,

Fig. 3 shows another plan sectional view thereof, particularly of the fail-safe actuating mechanism,

Fig. 4 shows an elevation view of an alternate embodiment of my switch, partly in section, and

Fig. 5 shows a plan sectional view of the alternate embodiment, particularly of the rotor thereof.

In Fig. 1 numeral **1** represents the lower half of the housing. This element also provides the lower ground plane for the strip-line of the rotor. Numeral **2** represents the upper half of the housing and provides the upper ground plane. The conductors of the rotor are upper strip **3** and lower strip **4** and second upper strip **6** and second lower strip **7**. These are cemented to the sides of inner rotor insulator plate **5**. Each pair of strips provides connection between two coaxial circuits.

The conventional coaxial cable consists of coaxially disposed inner and outer cylindrical conductors, the outer conductor being hollow and the inner one coaxially disposed within it. An equivalent conductive arragement consists of a strip of some thickness disposed between two extensive ground planes. This is the structure recited above.

In radio frequency practice it is known that only the surfaces of conductors are required for current conduction. Consequently, the thin strips **3** and **4**, for instance, spaced one above the other constitute the strip of "some thickness." These coact electrically with the inner surfaces of the housings **1** and **2**. The mode of propagation is the same as in coaxial lines, the "transverse-electromagnetic" mode, often abbreviated "TEM". Although the two pairs of strips **3**, **4** and **6**, **7** are within the same ground plane enclosure **1**, **2**, thereinbetween there is negligible energy transference or "cross-talk" between the two. The fields of each pair of strips do not extend much beyond the distance equal to one ground plane separation on either side thereof. As shown in Fig. 2, the spacing between the two pairs of strips is two and one-half times the width thereof. The gradual arcuate shape of the strips, i. e., **3** and **6**, is to be noted as contributing to a uniform impedance structure. This is quite the opposite of extremely sharp corner bends of numerous devices of the prior art.

The relative dimensions shown in Figs. 1 and 2 give a characteristic impedance of 50 ohms, matching the cylindrical type of coaxial line of the same impedance connected to connector **8**, etc. in the use of the switch. Should a higher impedance be required, the spacing between the pairs of strips **3**, **4** and **6**, **7** is reduced as well as the transverse width of each, while the spacing between the ground planes is increased. For a lower impedance the relations between these parameters, or some of them, are altered in the opposite direction.

The above-described electrical aspects of my invention

are realized in the following manner. Above inner rotor insulator plate 5 is upper rotor insulator 9 and below the same is lower rotor insulator 10. These are similar to plate 5, but are thicker and have surrounding lips, as shown at 9 in Fig. 2. These enclose plate 5 and abut at the lips to provide a cement joint. All are broached with a square central hole for shaft 11.

I prefer to fabricate the rotor by forming piece 5 to the finished dimensions shown. Strips 3, 4 and 6, 7 are formed of a good metal conductor having a thickness of a few thousandths of an inch, such as copper, with or without silver plating. The ends of each pair are bridged by metallic rotor tabs of beryllium copper. These are the contacts of the rotor conductors and engage companion contacts insulatingly attached to the stationary housings. Tabs 12 are either silver soldered or soft soldered to the conductor strips.

Suitable slots are provided in the surrounding lips of both the upper and lower rotor insulators at quarter circumference points to accommodate tabs 12. The inner surfaces of these insulators are also formed to size but the periphery and the thickness are left oversize. Inner plate 5, the strips and the inner surfaces of the insulators are covered with a thin film of a suitable epoxy cement known to the trade. The parts are assembled and pressured to fit with only a thin film of epoxy remaining between the surfaces, after which the assembly is baked for an hour at the temperature of boiling water. For the insulator parts 5, 9 and 10 bonderized Teflon is preferred because of a desirable combination of good high frequency insulating and fabricating properties.

Shaft 11 is then inserted in the square hole and a metal retainer 13 is pressed into the bottom of the shaft to hold the rotor to the shaft and also to provide a cup for cone bearing 14. The outer dimensions of insulators 9 and 10 are then machined true to the shaft to finished sizes.

Surrounding the rotor insulators with only a few thousandths of an inch clearance are dielectric rings 15 and 15*a*. These are also preferably of Teflon and like the insulators are slotted at quarter circumference points to accommodate stationary contacts 16. These are preferably of beryllium copper, have the same frontal contact area as the rotor tabs 12, and are formed with cylindrical extensions 17 which fit into holes in inner coaxial fitting 18. A small compression spring 19 urges the stationary contacts toward the rotor tabs to insure good electrical contact.

Inner fitting 18 is fastened into connector dielectric 24, which in turn is fastened into connector body 20. The latter is provided with external threads 21 for attaching known coaxial cable connectors and is itself attached to the housings by screws 22. An O ring 23 provides a gas tight joint to afford pressurizing.

We now turn to the mechanical actuating aspects of the switch. These are more particularly shown in Figs. 1 and 3. It will be understood that a switch of this type may fail in actuation, but if the failure still allows one or the other connection of the radio frequency circuits to be retained the system as a whole is at least half operative. Not only may the switch fail but the electric power for actuation may also fail, with the same consequences if during the period of actuation. Because any failure affecting actuation is more likely to occur during actuation than not, a radio frequency system switched by devices of the prior art with all the switch contacts out of contact during actuation is quite likely to make the system entirely inoperative. The seriousness of such failures in regard to safety of life and/or maintenance of control involved in aeronautics and missile operation is apparent. Consequently, the "fail-connected" aspect of my invention is an important coactive factor with the light weight and low inertia aspects of the construction. All are particularly valuable in this kind of application.

In Fig. 1 the previously described insulated rotor is surmounted by a metallic rotor plate 25. This plate has a downwardly extending quadrant on the right hand side of Fig. 1 identified by numeral 26 and in Fig. 3 by the dotted lines marking the extent of quadrant 26. This coacts as a stop with an opposite raised portion of upper housing 2 extending entirely across a diameter. The latter occupies the forward half of the upper housing, in Fig. 3 bounded by dashed line 27. Since both boundaries 26 and 27 are machined surfaces it is seen that plate 25 will make accurately a quarter turn, and no more. Also, this sturdy means of limiting the angular motion remains precise throughout the life of the switch.

A latch, or catch, 28 will be noted at the left of both Figs. 1 and 3. In the latter figure particularly it is seen that this engages in a corresponding slot in plate 25. The latch is a hollow square element and compression spring 29 nested therein urges the latch toward the periphery of plate 25. A cover plate 30 allows the latch to be inserted in motor mounting ring 31 during assembly. In the position shown in the figures the switch is locked in one operating position.

In operation, this condition is altered by suitable rotation of cup plate 32. This cup plate is relatively independent of the previously described rotative structure. It is free to rotate on the two upper round portions of shaft 11. It has a cam portion 33 extending to a sufficiently large radius to push catch 28 backward, when and if rotated sufficiently to reach the same as a matter of circumferential position.

Such rotation is provided by actuator motor 34, of Fig. 1. The latter engages the cup plate through splined shaft 35. The cup plate is provided with a boss 36 and rotor plate 25 with a similar boss 37. Between these two bosses and nested in a circular slot in the cup plate are two fairly flexible compression springs 38 and 39. This gives an elastic or resilient coupling between the two rotative elements.

To ascertain the operation, assume that the motor rotates the cup plate counter-clockwise, according to the arrow in Fig. 3. Spring 38 is then very considerably compressed. Spring 39 is extended to its uncompressed length but does not enter into the mechanical operation at this time. When rotation in excess of a half turn has been accomplished, cam 33 bears against latch 28 and after a little more travel presses the latter back sufficiently to release plate 25. At this, plate 25 immediately snaps around a quarter turn because of the now considerable energy stored in spring 38.

It will then be noted that notch 40 is no longer in the position shown in Fig. 3, but a quarter turn counter-clockwise and engaging latch 41. The switching has been most rapidly and positively completed. Motor actuator 34 is provided with limit switches internally that deenergize the motor after a half turn of shaft 35 has been executed, according to the known construction of such devices. The next possible actuation is in the reverse direction and is accomplished by energizing the motor in the opposite direction, characteristically by reversing the polarity of the electrical energy operating the same by a suitable switch. When this is done, the reverse action of compressing spring 39, unlatching by rotation of the cam, rotation of the switch rotor proper, and relatching takes place.

In this way it is seen how desirable objects of my invention are attained.

In Fig. 3 the electrical connectors 8, etc. lying considerably below the section plane chosen have been omitted for sake of clarity in showing the mechanical fail-safe elements. In Fig. 2 and the lower part of Fig. 1 four feet 43 are shown as integral with the lower housing 1. These are for attaching the switch to other equipment, etc. of which it is a part.

For the housings, metal plates, etc. Duralumin is a preferred material. Such pieces may be given a "hard

coat" by known processes such as anodizing and may be dry lubricated by similar known means. In the top housing a bearing bronze bushing 44 is preferably inserted to give the known desirable wearing qualities of a steel shaft in bronze bearings.

The switch illustrated is capable of handling radio frequency powers of four kilowatts peak, or an average power of one kilowatt at frequencies up to a thousand megacycles with a standing wave ratio of 1.1 or better.

With lapped surfaces between the top and bottom housings, lapped bearings and compound-sealed connectors my switch will retain atmospheric pressure for considerable periods of time in rarified atmospheres, so as to retain essentially one atmosphere of pressure regardless of flight conditions.

An alternate embodiment of my switch is shown in Figs. 4 and 5. This may be characterized as a cylindrical embodiment whereas the original embodiment was planar. In effect, the parallel ground "planes" have been wrapped into coaxial cylindrical surfaces and the planar rotor has become a hollow cylinder disposed therebetween.

In Figs. 4 and 5 the outer case **50** serves also as the outer grounded conductive surface. Electrically connected thereto and concentric therewith is inner grounded surface **51**. Between these two are outer Teflon insulator rotor cylinder **52**, center Teflon cylinder **53**, and inner Teflon cylinder **54**. In a manner analogous to that previously described, pairs of strips are caused to adhere to center cylinder **53**. The gradual curvature of the strips is approximately the same as shown in Fig. 2, but since the strips of this embodiment are wrapped around a portion of a cylinder they appear differently in Fig. 4. Outer conductive strip **55** is the only one of the four that appears in full view in Fig. 4. The extremities of the section in this view are along a diameter as shown in Fig. 5, but then the section surface passes around the outer surface of center cylinder **53**. Behind strip **55** a portion of companion strip **56** is seen dotted. Strip **55** solders to the outside of rotor contact **57**, while strip **56** solders to the inside of the same. The opposite end of strips **55** and **56** terminate in rotor contact **58**. In a similar manner strips **59** and **60** curve between rotor contacts **61** and **62** to the rear of the cylinders. It will be noted in this embodiment particularly that one pair of strips and the associated contacts can be formed from a solid piece of metal and pushed into place, eliminating soldering or welding in the part.

As before, the several rotor contacts make contact with stationary contacts. These are not shown in Fig. 4, being within the coaxial connectors **63**, of which there are four; the center two being one behind the other. The stationary contacts are like those, **16**, shown in Fig. 2 and contact with the rotor contacts when the switch is at rest.

It will be seen that, save for the gradual curve of the whole ground plane-rotor combination, the radio frequency impedance aspects of the alternate structure is the same as that of Figs. 1 and 2. The alternate embodiment is used where all the coaxial cables to be switched run in a given direction to and from the switch and where the radial connections of the cables according to Figs. 1 and 2 cannot be accommodated in the surrounding apparatus or environment. Each embodiment has particular uses.

The mechanical aspects of the embodiment of Fig. 4 are the same as those of Fig. 1, thus these have not again been detailed. As before, a quadrant plate, springs or equivalent resilient elements, motor cup plate, latches, and cam all surmount the high frequency electrical portion of the switch and coact with actuator 34 as has been explained.

Either embodiment is suitable for a number of uses in the radio frequency art; such as alternately connecting a transmitter and a receiver to one antenna, connecting either of these apparatus to different antennas for multiband operation, transferring two antenna from one to the other of two transmitters or two receivers, switching one transmitter from one to two loads with a power divider in one circuit, and by ganging one switch on top of another to accomplish these functions where double (balanced) coaxial cable feeds are employed, or for simultaneously switching a plurality of transmitters, receivers, etc. to different antennas and the like.

Certain other alternate constructions may be employed. In Fig. 1, instead of the inner portion and outer wall forming the annular slot wherein springs **38** and **39** are located being a part of cup plate **32** this formation may be made a part of the rotor plate just beneath. The manner of functioning is not altered, only the form of the elements for structural and fabrication purposes.

One advantage of my switch lies in the fact that the path through the switching portion lies completely within Teflon or equivalent insulation. In this way impedance discontinuities are avoided. In numerous switches of the prior art the coaxial path reverts from insulation to air-space a plurality of times.

It will be understood that my switch may be fabricated with six connectors and three arcuate conductors, eight connectors and four arcuate conductors, six connectors and two arcuate conductors, eight connectors and three arcuate conductors, and so on. For unusual applications, an odd number of connectors may be employed with conductors that do not make contact for all switch positions. Also, adjacent or particular connectors may be connected in parallel to switch one circuit to two other circuits with different positions of the switch rotor.

Still further modifications may be made in the size, proportions, shape and arrangement of the elements of my switch without departing from the scope of my invention.

Having thus fully described my invention and the manner in which it is to be practiced, I claim:

1. A rotary switch comprising plural equidistantly spaced ground surfaces, flat strip conductors rotatively disposed equidistantly between, wholly within the boundaries of and insulated from said ground surfaces, stationary contacts, means to resiliently rotate said rotatively disposed conductors such that said conductors have mechanical equilibrium only when said conductors and said stationary contacts are in contact.

2. A rotary coaxial cable switch comprising two equidistantly spaced stationary outer conductor elements, rotative means having rectangular strip conductors equidistantly disposed wholly between said outer conductor elements, stationary contacts, circumferential means deformable to rotate said rotative means elastically attached thereto such that said rotative means is in a mechanically stable position only when said conductors and said stationary contacts are in contact.

3. A switch comprising two equidistantly separated ground planes, rotative means having flat conductors equidistantly disposed wholly between said ground planes, plural stationary contacts, circumferentially disposed compressive means to rotate said rotative means for connecting each end of said conductors to different said stationary contacts, said rotative means having mechanical stability only when said conductors and said stationary contacts are in electrical contact.

4. A switch of the coaxial type comprising two spaced ground plane elements, an insulated rotor disposed between said elements, flat conductive strips equidistant from said elements within said rotor, contacts at the extremities of said strips equally spaced upon an exterior surface of said rotor, stationary contacts carried by and insulated from said ground plane elements to engage the contacts upon said rotor, means to revolve said rotor including annular resilient coupling means between said means to revolve and said rotor related to retain contact between pairs of rotor and stationary contacts.

until said resilient coupling means is compressed an amount in excess of the distance between one stationary contact and another, motion to the other said position then being powered by the release of potential energy of said resilient coupling means, the mechanism thus having mechanical stability only when contact is made between the contacts of said rotor and said stationary contacts.

5. A rotary switch of the coaxial type comprising two spaced stationary outer conductor elements, an insulated rotor disposed between said elements, arcuate conductive strips within said rotor flatly disposed with respect to said elements, contacts connected to the ends of said strips equally spaced around an edge of said rotor, stationary contacts carried by and insulated from said outer conductor elements spaced to engage the contacts upon said rotor, means to revolve said rotor, circumferentially disposed elastic means to couple said rotor and said means to revolve said rotor, said elastic means and said rotor related to retain contact between pairs of rotor and stationary contacts until said elastic means is stressed an amount corresponding to more than the distance between one rotary contact position and another, motion to the other said position then being powered by the release of potential energy of said elastic means, to the end that the rotor has mechanical stability only when said rotor and said stationary contacts are engaged.

6. A rotary switch of the coaxial type comprising two spaced stationary ground plane housing elements, an insulated rotor disposed between said elements, two arcuate rectangular conductive strips within said rotor, contacts connected to the ends of said strips positioned upon an exterior surface of said rotor at each quarter circumference, four stationary contacts carried by and insulated from said housing elements spaced to engage the contacts upon said rotor, means to revolve said rotor including an annularly disposed spring, said spring and said rotor related to retain contacts upon said rotor and stationary contacts in contact until said spring is compressed an amount corresponding to more than the distance between one rotary position and another, rotation of said rotor to the said other position then being accomplished by the release of potential energy of said spring, so that the mechanism has mechanical stability only when contact is made between said rotor contacts and said stationary contacts.

7. Means for altering connection between coaxial electrical connective means having plural spaced conductors comprising equi-spaced conductive surfaces, rotatable means between said surfaces, conductors equispaced from and insulated from said surfaces carried by said rotatable means, said conductors terminating upon a portion of said rotatable means away from said surfaces, at least one of said spaced conductors of each of said connective means disposed to electrically contact a termination of the conductors of said rotatable means, at least one of said plural spaced conductors of each of said connective means connected to said spaced conductive surfaces, means-to-rotate said rotatable means, circumferential mechanical energy storage means intermediate said means-to-rotate and said rotatable means, immobilizing means coactive with said rotatable means, release means coactive with said means-to-rotate, said immobilizing means and said release means related to allow rotation of said means-to-rotate before said release means acts to remove the influence of said immobilizing means upon said rotatable means, said circumferential mechanical energy storage means intermediate thereafter rotating said rotatable means to effect switching between said connective means.

8. Switching means for altering connection between cables lying in a single surface having plural spaced conductors comprising spaced conductive surfaces, rotatable means between said surfaces having insulated strip conductors, said conductors terminating upon an area of said rotatable means away from said surfaces, terminals connected to at least one of said spaced conductors of each of said cables disposed to electrically contact the conductors of said rotatable means, at least one of said plural spaced conductors of each of said cables connected to said spaced conductive surfaces to form an equivalent of the one said plural spaced conductor, means-to-rotate said rotatable means, means to couple said means-to-rotate to said rotatable means, immobilizing means coactive with said rotatable means, release means coactive with said means-to-rotate, said immobilizing means and said release means related to allow rotation of said means-to-rotate farther than the distance required to effect switching between said cables before said release means acts to remove the influence of said immobilizing means upon said rotatable means, said means to couple thereafter rotating said rotatable means to effect switching between said cables; the recited structure adapted to prevent said rotatable means from assuming a position unconnecting all said cables upon a failure of said means-to-rotate subsequent to actuation thereof and prior to the actuation of said release means.

9. A rotatable switching means for altering connection between cables lying in one surface having plural spaced conductors comprising at least two spaced conductive surfaces, rotatable means between said surfaces having strip conductors insulated from and equidistant from said surfaces, said conductors terminating upon an area of said rotatable means away from said surfaces, terminals connected to one of said spaced conductors of each said cables disposed to electrically contact the terminations of the conductors of said rotatable means, at least one of said plural spaced conductors of each of said cables connected to at least two of said spaced conductive surfaces, means to rotate said rotatable means, compliant means to couple said means to rotate said rotatable means, immobilizing means coactive with said rotatable means, release means coactive with said means to rotate, said immobilizing means and said release means related to allow rotation of said means to rotate farther than the distance required to effect switching between said cables before said release means acts to remove the influence of said immobilizing means upon said rotatable means, said compliant means thereafter rotating said rotatable means to effect switching between cables, the recited structure adapted to prevent failure of contact between at least some of said cables upon a failure of said means to rotate subsequent to actuation thereof and prior to actuation of said release means.

10. A rotary switch of the coaxial transfer type comprising two stationary uniformly spaced ground surfaces, an insulated rotor disposed between said surfaces, two pairs of spaced arcuate conductive strips within said rotor, rotor contacts disposed at quarter-circumference points around an edge of said rotor, said strips connecting adjacent said rotor contacts, four stationary contacts resiliently carried by and insulated from said housing spaced to simultaneously engage the four said rotor contacts, four coaxial type connectors, the inner conductor of each connected to a said stationary contact and the outer conductor of each connected to both ground surfaces, said rotor attached to a sector plate coactive with a projection upon one said ground surface on the side away from said rotor to allow only a quarter turn of said rotor, two arcuately disposed springs, a rotative motor plate, said sector plate resiliently coupled to said motor plate by said springs, two oppositely disposed catches to lock said sector plate for aligning said rotor contacts with said stationary contacts, a reversibly rotational actuator attached to said motor plate, a cam to unlock said sector plate when said actuator has turned said motor plate in excess of a quarter turn to change the relation of said stationary and said rotor contacts, said sector plate rapidly revolved a quarter turn by spring-stored energy when said sector plate is unlocked or

retaining the initial contact relation upon the failure of said actuator operation depending upon the rotative position of said motor plate at the time of failure to prevent loss of electrical contact between said rotor and stationary contacts because of said failure.

11. Means for switching electrical energy traversing cables having inner and outer conductors comprising two spaced ground planes, rotatable means between said ground planes, flat strip conductors within said rotatable means, the extremities of said conductors disposed around the periphery of said rotatable means, stationary contacts connected to the inner conductors of said cables and mounted to bear upon said extremities of said conductors, the outer conductors of said cables connected to both said ground planes, means to rotate said rotatable means, circumferential deformable means to couple said means to rotate to said rotatable means, means to secure said rotatable means, means to unsecure said rotatable means coactive with said means to rotate said rotatable means, said means to secure and said means to unsecure related to allow rotation of said means to rotate said rotatable means farther than the distance between said extremities of said conductors before said means to unsecure acts to unsecure said rotatable means, said means to couple affected by said rotation prior to unsecuring and thereafter to rotate said rotatable means from one contacting position to the next where said means to secure again secures said rotatable means; the recited structure preventing said rotatable means from coming to rest without electrical connection between said extremities of said conductors and said stationary contacts upon failure of said means to rotate affecting said means to couple.

12. Means for switching electrical energy traversing coaxial cables comprising two spaced stationary conductive planes, a rotatable insulated rotor between said conductive planes, gradually curved conductive strips within said rotor equi-spaced from said conductive planes, rotor contacts connected to the extremities of said strips and disposed around the periphery of said rotor, an even number of stationary contacts connected to the inner conductor of the same number of said coaxial cables and mounted to bear upon said rotor contacts, the outer conductor of each said coaxial cable connected to both said conductive planes, means-to-rotate said rotor, circumferential deformable means to couple said means-to-rotate to said rotor, plural latches coactive with said rotor, unlatching means coactive with said means-to-rotate, said latches and said unlatching means related to allow rotation of said means-to-rotate farther than the distance between two said rotor contacts before said unlatching means acts to unlatch at least one said latch holding said rotor, said deformable means deformed by said rotation prior to unlatching and in becoming undeformed thereafter to rotate said rotor from one stationary contact to another where at least one of said latches again holds said rotor; the recited structure adapted to prevent said rotor coming to rest devoid of electrical connection between said rotor and said stationary contacts upon deactivation of said means-to-rotate while deforming said deformable means.

13. Means for switching electrical energy traversing coaxial cables comprising two spaced stationary ground planes, a rotatable insulated rotor between said ground planes, arcuate conductive strips within said rotor equally distant from said ground planes, rotor contacts connected to the extremities of said strips and equally disposed around the periphery of said rotor, an even number of stationary contacts connected to the inner conductor of the same number of said coaxial cables and resiliently mounted to bear upon said rotor contacts, the outer conductor of each said coaxial cable connected to both said ground planes, means-to-rotate said rotor, annular elastically deformable means to mechanically couple said means-to-rotate to said rotor, plural latches coactive with said rotor, unlatching means related to said means-to-rotate said rotor, said latches and said unlatching means arranged to allow rotation of said means-to-rotate said rotor farther than the distance between two said rotor contacts before said unlatching means acts to unlatch a latch holding said rotor, said elastically deformable means deformed by said rotation prior to unlatching and in becoming undeformed thereafter to rotate said rotor rapidly from one stationary contact to the next where another of said latches again locks the rotor; the recited structure arranged to prevent the rotor from coming to rest without electrical connection between at least two said rotor and stationary contacts upon deactivation of said means-to-rotate said rotor during an activation cycle thereof.

14. A rotary switch of the coaxial transfer type comprising two stationary ground planes formed by mating halves of a housing, an insulated circular rotor within said housing, two pairs of spaced gradually curved arcuate conductive strips within said rotor lying in planes parallel to said ground planes, rotor contacts disposed at quarter-circumference points around the periphery of said rotor, said strips connected to adjacent said rotor contacts, four stationary contacts resiliently carried by and insulated from said housing spaced to simultaneously engage the four said rotor contacts, a coaxial type connector connected to each said stationary contact and attached conductively to said housing, said rotor attached to a quadrant plate coactive with a projection upon said housing to allow only a quarter turn of said rotor, two arcuately disposed springs, a rotative motor plate, said quadrant plate resiliently coupled to said motor plate by said springs, two oppositely disposed catches to lock said quadrant plate for aligning said rotor contacts and said stationary contacts, a reversible actuator to rotate said motor plate, a cam to unlock said quadrant plate when said actuator has turned said motor plate in excess of a quarter turn to change the relation of said stationary and said rotor contacts, said quadrant plate rapidly revolved a quarter turn by spring-stored energy when said quadrant plate is unlocked or retaining the initial contact relation upon the failure of said actuator depending upon the rotative position of said motor plate at the time of failure to prevent loss of electrical contact between said rotor and said stationary contacts because of said failure.

15. Means for switching electrical energy traversing cables having inner and outer conductors comprising spaced cylindrical ground surfaces, rotatable means between said surfaces, conductors within said rotatable means, the extremities of said conductors disposed around an end of said rotatable means, stationary contacts connected to the inner conductors of said cables and mounted to bear upon said extremities of said conductors, the outer conductors of said cables connected to both said ground surface, means to rotate said rotatable means, annular spring-like means to couple said means to rotate to said rotatable means, means to secure said rotatable means, means to unsecure said rotatable means coactive with said means to rotate said rotatable means, said means to secure and said means to unsecure related to allow rotation of said means to rotate said rotatable means farther than the distance between said stationary contacts before said means to unsecure acts to unsecure said rotatable means, said means to couple altered by said rotation prior to unsecuring and thereafter to rotate said rotatable means from one contacting position to the next where said means to secure again secures said rotatable means; the recited structure preventing said rotatable means from coming to rest without electrical connection between said extremities of said conductors and said stationary contacts upon failure of said means to rotate while alternating said means to couple.

16. Means for switching electrical energy traversing coaxial cables comprising two cylindrical conductive surfaces, a rotatable rotor between said surfaces and insulated therefrom, gradually curved conductive elements upon said rotor, rotor contacts connected to the ends of

said elements and disposed around an end of said rotor, an even number of stationary contacts connected to the inner conductor of the same number of said coaxial cables and mounted to bear upon said rotor contacts, the outer conductor of each said coaxial cable connected to both said cylindrical surfaces, means to rotate said rotor, annular deformable means to couple said means to rotate to said rotor, latching means coactive with said rotor, unlatching means coactive with said means to rotate said rotor, said latching means and said unlatching means related to allow rotation of said means to rotate said rotor farther than the distance between two said stationary contacts before said unlatching means acts to unlatch said latching means holding said rotor, said deformable means deformed by said rotation prior to unlatching and in becoming underformed thereafter to rotate said rotor rapidly from one stationary contact to another where said latching means again holds said rotor, the recited structure preventing the rotor from coming to rest without electrical connection between said rotor and said stationary contacts upon deactivation of said means to rotate while deforming said deformable means.

17. Means for switching electrical energy traversing coaxial cables comprising two spaced cylindrical conductive surfaces, a rotatable rotor between said surfaces and insulated therefrom, arcuate conductive strips in said rotor, rotor contacts connected to the extremities of said strips and equally spaced around only one end of said rotor, an even number of stationary contacts connected to the inner conductor of the same number of said coaxial cables and resiliently mounted to bear upon said rotor contacts, the outer conductor of each said coaxial cable connected to both said cylindrical surfaces, means to rotate said rotor, annular elastically deformable means to mechanically couple said means to rotate to said rotor, latching means coactive with said rotor, unlatching means coactive with said means to rotate said rotor, said latching means and said unlatching means related to allow rotation of said means to rotate said rotor farther than the distance between two said stationary contacts before said unlatching means acts to unlatch said latching means holding said rotor, said elastically deformable means deformed by said rotation prior to unlatching and in becoming undeformed thereafter to rotate said rotor rapidly from one stationary contact to the next where said latching means again holds said rotor, the recited structure preventing the rotor from coming to rest without electrical connection between at least two said rotor and stationary contacts upon deactivation of said means to rotate while deforming said deformable means.

18. A rotary switch of the coaxial transfer type comprising two stationary coaxially disposed cylindrical ground surfaces formed by housing elements, an insulated hollow cylindrical rotor within said housing, two pairs of spaced gradually curved thin arcuate conductive strips within said rotor equidistant from said surfaces, rotor contacts disposed at quarter-circumference points around one of said cylindrical rotor, said strips connecting adjacent said rotor contacts, four stationary contacts resiliently carried by and insulated from said housing spaced to simultaneously engage the four said rotor contacts, a coaxial type connector connected to each said stationary contact and attached to said housing, said rotor attached to a quadrant plate coactive with a projection upon said housing to allow only a quarter turn of said rotor, two arcuately disposed springs, a rotative motor plate, said sector plate resiliently coupled to said motor plate by said springs, two oppositely positioned catches to lock said quadrant plate for aligning said rotor contacts and said stationary contacts, a reversible actuator to rotate said motor plate, a cam to unlock said quadrant plate when said actuator has turned said motor plate in the order of a half turn to change the relation of said stationary and said rotor contacts, said quadrant plate rapidly revolved a quarter turn by spring-stored energy when said quadrant plate is unlocked or retained in the initial contact position upon failure of said actuator action depending upon the rotative position of said motor plate at the time of failure to prevent loss of electrical contact between said rotor and stationary contacts because of said failure.

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