March 11, 1958 D. H. LANCTOT 2,826,746

CO-AXIAL SWITCH

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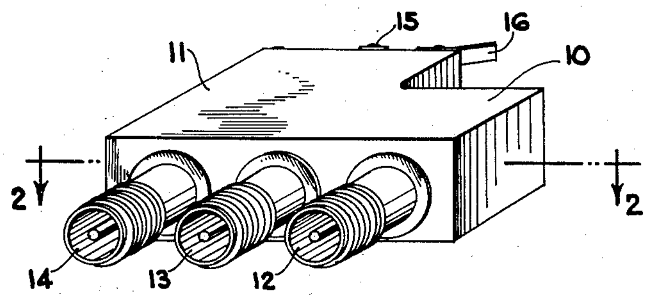


Fig. 1

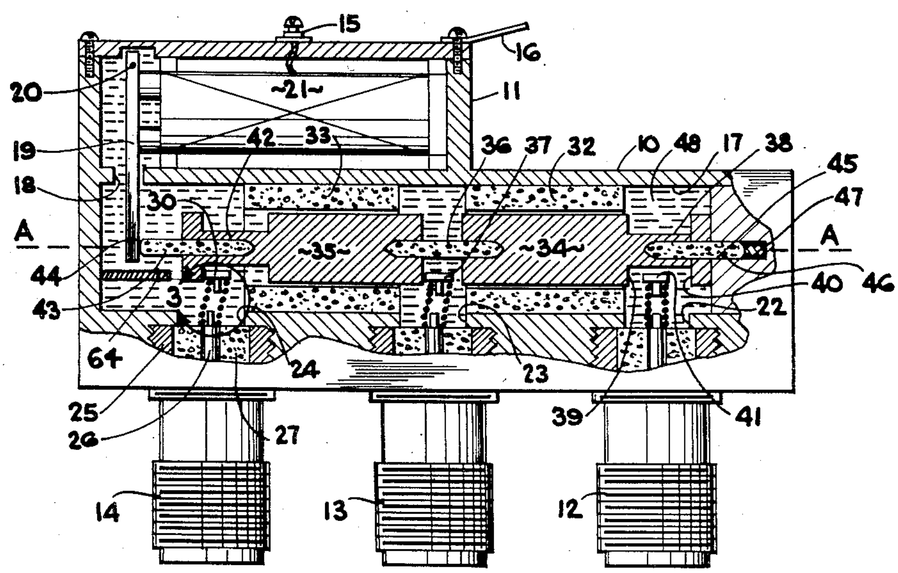


Fig. 2

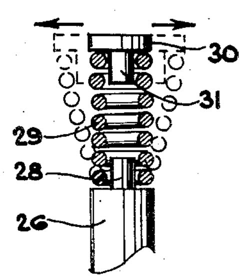


Fig. 3

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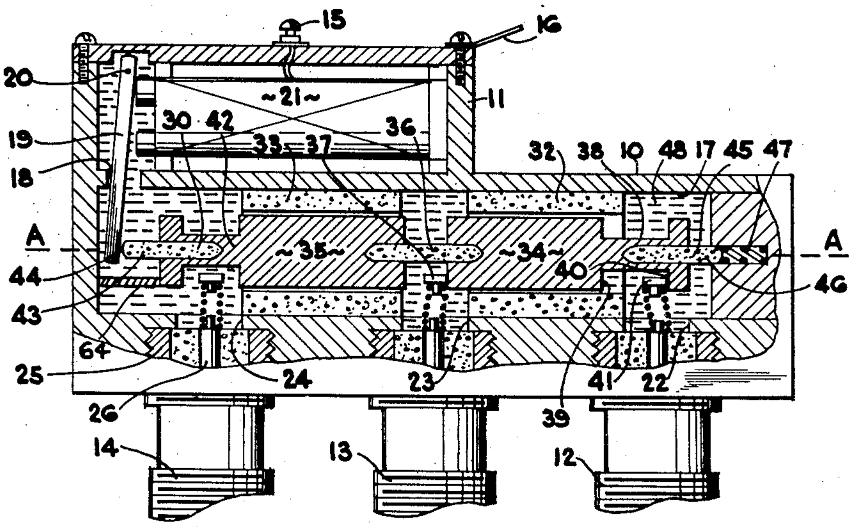


FIG. 4

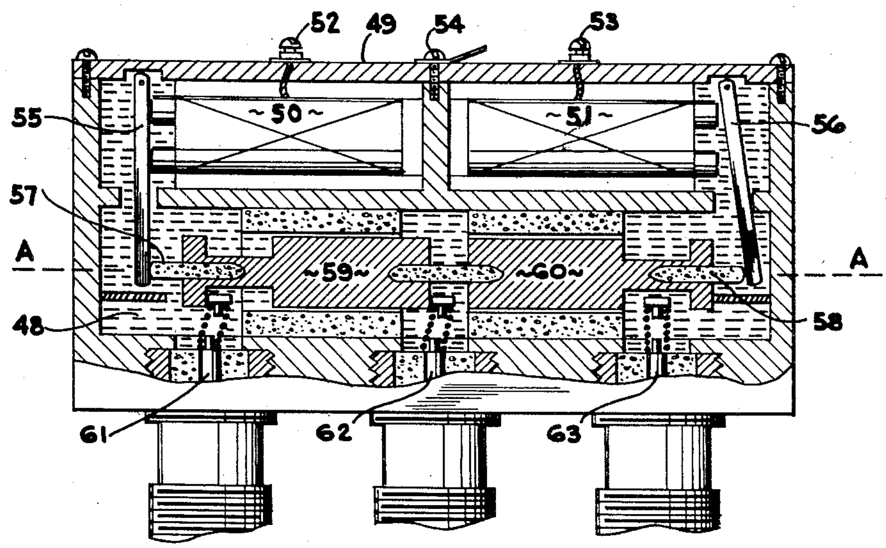


FIG. 5

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# United States Patent Office

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## CO-AXIAL SWITCH

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8 Claims. (Cl. 333—97)

This invention relates generally to broad-band radio frequency switches and more particularly to a T-type high power co-axial switch for passing R.-F. energy from an input co-axial connector to either one of two output co-axial connectors.

Many different types of co-axial switches are in wide use at the present time. Of the known types of broad-band switches capable of operating at high power levels of the order of a kilowatt, for example, the problems of proper heat dissipation and reliable electrical connections between the switching contacts are extremely important. The heating problem is particularly acute adjacent the points of electrical contact since it is ordinarily difficult to conduct the heat away from the contact points to the surface of the switch casing for proper dissipation through radiation. With regard to the problem of reliable electrical connections between the inner conductors of the co-axial connectors, most switches employ a wiping action between the connector contacts in order to take advantage of the self-cleaning effect. Nevertheless, over an extended period of operation in which the same surfaces are continuously wiping together, the spacing, and thus contact pressure and resistance can change considerably between the contacts. As a consequence, close tolerances are mandatory in the construction of high grade present day switches resulting in a relatively costly product.

Other problems associated with high power co-axial type switches involve proper dimensioning of the switch components to insure a proper impedance match between the various connectors and maximum isolation from cross talk between a disconnected connector and an operating connector.

A desirable feature in co-axial switches of the type electrically operated from a remote point is to make the mechanical switching movement as small as possible whereby minimum electrical power is necessary to operate the switch and the switching action itself can be made extremely rapid. It is also desirable to have all of the connectors face in the same direction to facilitate mounting of the switch.

Bearing the above in mind, one object of the present invention is to provide a vastly improved high power, broad-band co-axial switch designed to provide for maximum heat dissipation, particularly from regions surrounding the switch contact points.

Another equally important object is to provide a co-axial switch incorporating novel contact means co-operating with a novel switching arrangement wherein both wiping action and new contact surfaces are constantly exposed, whereby reliable electrical connections may be effected over an extremely long period of time without the necessity of observing close tolerances in the construction of the switch.

Still other objects of this invention are to provide a high powered T-type switch for passing R.-F. energy from an input co-axial connector to either one of two output co-axial connectors in which a proper impedance match between the various connectors is assured, maximum isolation exists between an operated and unoperated connector, and the actual mechanical movement for effecting a switching operation is relatively small so that extremely rapid switching between the input co-axial connector and either one of the output co-axial connectors may be realized.



Another object is to provide a co-axial switch so designed that all of the various co-axial connectors face in one direction whereby mounting and connecting of the switch is facilitated.

These and other objects and advantages of this invention are attained by providing a metallic casing having an internal longitudinal cylindrical passage therein. A center and two outside parallel, transversely directed, bore openings pass through one side of the casing and terminate in the longitudinal passage. The center bore is arranged to receive an input co-axial connector whereas the two outside bore openings are arranged to receive respectively, two output co-axial connectors. Novel flexible type contact means are connected to the inner conductors of the co-axial connectors respectively, and extend transversely into the longitudinal cylindrical passage terminating short of the central longitudinal axis thereof.

Within the longitudinal cylindrical passage, there are provided a pair of aligned elongated cylindrical conductor bars slidable within insulative bearing sleeves and maintained in spaced, axial alignment by an insulating member whereby the adjacent ends of the conductor bars form annular opposing contact surfaces arranged to engage in wiping action either side of the flexible contact means associated with the inner conductor of the input co-axial connector. The opposing annular contact surfaces provide a relatively large area for making contact with this flexible contact means. The outer ends of each of the conductor bars are provided with reduced diameter portions to define further opposing annular contact shoulders co-operating with the flexible contact means associated with the inner conductors of each of the outer co-axial connectors. The conductor bars are symmetrical about the central longitudinal axis of the passage and are free to rotate about this axis whereby new contact surfaces are constantly exposed to the flexible contact means associated with each of the co-axial connectors. The conductor bars are also free to slide longitudinally in response to energization of an actuating means whereby connections may be made between the input co-axial connector contact means and either one of the two output co-axial connector contact means depending upon which longitudinal direction the conductor bars are moved.

The metallic casing and passages are filled with a polymer oil which may comprise, for example, a polymer of chlorotrifluoroethylene. This oil serves several purposes, among which are a lubricant, a heat dissipation means, an arc quenching means at the contacts whereby high power may be passed between the various connections, and also as a di-electric providing a uniform di-electric constant with the sleeves.

The actuating means preferably comprises a simple solenoid coil for moving the conductor bars in a longitudinal direction. Because of the lubricating effect of the oil between the conductor bars and the insulative bearing sleeves, and the relatively small movement necessary to effect a switching operation, very little energy is required to power the solenoid and the switch may be operated extremely rapidly.

A better understanding of the various features and advantages of this invention will be had by referring to the accompanying drawings, in which:

Figure 1 is a perspective view of one embodiment of the co-axial switch of this invention;

Figure 2 is an enlarged cross section taken in the direction of the arrows 2—2 of Figure 1, showing the switch components in a first position;

Figure 3 is an enlarged elevational view of the switch contact means enclosed within the circular arrow 3 of Figure 2;

Figure 4 is a cross sectional view similar to Figure 2 illustrating the switch components in a second position; and,

Figure 5 is a cross sectional view of a modified embodiment of the switch.

Referring first to Figure 1, the switch is shown as comprising a metallic casing 10 having a rearwardly extending portion 11. Along a front face of the casing 10 there are provided three co-axial connectors 12, 13 and 14. Preferably, the center connector 13 serves as an input co-axial connector while the two outside connectors 12 and 14 serve as output co-axial connectors. The switch components within the casing 10 are arranged to be actuated by electrical means connected to terminals 15 and 16 at the rear of the casing. Operation of the switch serves to pass R.-F. energy between the center co-axial connector 13 and either one of the output co-axial connectors 12 and 14. From the physical arrangement illustrated in Figure 1, it will be evident that the various co-axial connectors all face in the same direction so that the switch may be easily mounted and connected.

Referring to Figure 2, the main casing portion 10 of the switch is provided with an internal longitudinal cylindrical bore 17 provided at its upper left hand end with a small opening 18. An armature 19, pivoted at 20 and arranged to be actuated by a conventional solenoid type coil 21, in the rearwardly extending casing portion 11, passes through the opening 18 as shown. Power for operating the solenoid coil 21 is passed into the terminal 15 to terminal 16 which may be grounded to the casing.

Also, communicating with the longitudinal cylindrical passage 17 are three parallel transverse bore openings 22, 23 and 24 passing through the front face of the casing 10. As will be evident from Figure 2, these bores are arranged to receive, respectively, the co-axial connectors 12, 13 and 14. Each of these co-axial connectors and associated flexible contact means are identical and, therefore, detailed description of one will suffice for all.

Referring to the co-axial connector 14, for example, the outer conductor 25 is secured in the bore 24 by screw threads. The inner conductor 26 of the connector is co-axially held in spaced relation with respect to the outer conductor 25 by a suitable di-electric 27. The extreme end of the inner conductor 26 is provided with a flexible contact means shown in greater detail in Figure 3 as including a small stem 28 supporting a coiled spring 29. The upper end of the coiled spring 29 terminates in a disc-like contact 30 having a reduced diameter stem 31 receivable within the upper portion of the spring 29 with a friction fit. The spring 29 is of highly conductive material so that a continuous electrical connection is maintained between the contact 30 and the inner conductor 26. It will be evident from this physical arrangement, that the contact 30 may flex to one side or the other of the vertical axis as indicated by the arrow and dotted line positions. The spring 29 is provided merely for enabling this flexure type movement and usually the individual coils of the spring are in contact; that is, very little elongation or compression of the spring takes place.

Referring again to Figure 2, it will be noted that within the cylindrical longitudinal passage 17 there are provided a pair of longitudinally aligned insulative sleeve members 32 and 33. These sleeve members are respectively arranged to receive a pair of elongated cylindrical conductor bars 34 and 35 having their adjacent ends held in axially spaced relationship by an insulating rod 36.



As will be clear from Figure 2, the spacing between the adjacent ends of the conductor bars is sufficiently wide to accommodate the flexible contact 37 associated with the inner conductor of the input co-axial connector 13, this flexible contact extending transversely towards the central longitudinal axis A—A of the passage 17. The arrangement is such that the peripheral edge of the disc-like contact 37 will engage one or the other of the annular opposing end surfaces of the conductor bars 34 and 35 depending on the longitudinal position of these conductor bars.

The far end of the conductor bar 34 is provided with a reduced diameter portion 38 providing opposing annular contact shoulders 39 and 40. One or the other of these shoulders is arranged to be engaged by one side or the other of the periphery of the disc-like contact 41 associated with the inner conductor of the output co-axial connector 12, again depending upon the longitudinal position of the conductor bar 34 within the sleeve 32. Similarly, the far end of the conductor bar 35 is provided with a reduced diameter portion 42 providing similar opposing contact shoulders, one or the other of which is arranged to be engaged by the flexible contact 30 associated with the inner conductor of the output co-axial connector 14. A small insulative push rod 43 extends from the end of the conductor bar 35 into engagement with the armature 19 as indicated at 44. A similar insulative push rod 45 extends from the far end of the other conductor bar 34 into a receiving bore 46 at the right hand end of the casing 10 to engage a small resilient compression spring 47 within the bore. The interior of the longitudinal passage 17 and casing is filled with a polymer oil as indicated by the dashed lines 48.

The operation of the switch wil be evident from the above description. In Figure 2, the solenoid coil 21 is shown in energized position wherein the armature 19, through the medium of the push rod 43, has longitudinally moved the conductor bars 35 and 34 to the right. This position of the conductor bars 34 and 35 within the cylindrical passage 17 is such that the flexible contact 30 associated with the output co-axial connector 14 is in engagement with the left hand shoulder of the reduced diameter portion 42 of the conductor bar 35 and the flexible contact 37 is in engagement with the annular end surface of the conductor bar 35. Thus, an electrical connection is effected between the output co-axial connector 14 through the contact 30, conductor bar 35, and contact 37 to the input co-axial connector 13. The flexible contact 41 associated with the output co-axial connector 12, however, is not in engagement with either of the opposing annular shoulders 39 and 41 and thus is not connected into the circuit.

Upon de-energization of the solenoid coil 21, the push rod 43 is released and the small coiled spring 47 in the bore 46 at the right hand end of the casing 10 urges the push rod 45 and conductor bars 34 and 35 longitudinally to the left, as viewed in Figure 2, to assume the positions illustrated in Figure 4. This movement will cause the armature 19 to rotate about the pivot point 20 in a clockwise direction through the medium of the push rod 43.

In the de-energized position shown in Figure 4, the input co-axial connector 13 is now connected to the output co-axial connector 12 through engagement of the contact 37 with the annular end surface of the conductor bar 34 and engagement of the contact 41 with the opposing annular shoulder 40. The inner conductor of the output co-axial connector 14 is now free of engagement with any portion of the conductor bar 35 and is therefore, out of the circuit.

When the solenoid coil 21 is again energized, the armature 19 will be drawn to closed position to again move the conductor bars 34 and 35 longtiudinally to the right to again compress the spring 47 and disconnect the output co-axial connector 12 from the input so-axial connector 13 and connect the input co-axial connector 13 to the output co-axial connector 14.

From both Figures 2 and 4, the symmetry of the conductor bars 34 and 35 with respect to the central longitudinal axis A—A of the passage 17 will be evident. The design is such that these conductor bars 34 and 35 may rotate within the sleeves 32 and 33 about the axis A—A so that new annular contact surfaces are constantly being exposed for engagement with the various flexible disc-like contacts 30, 37 and 41. Further, the inner surface of the passage 17 serves as the outer electrical conductor of the connecting co-axial portion whereas the conductor bars 34 and 35 serve as the inner co-axial conductor, the dimensioning of these elements and the dielectric constant of the sleeves 32 and 33 being given values such as to maintain a proper impedance match between the various connectors and connecting portions within the passage 17. The provision of the oil 48 not only serves as a lubricant for facilitating both rotative and longitudinal movement of the conductor bars 34 and 35 through the sleeves 32 and 33, but additionally serves to quench any sparking that may occur between the various contacts and the annular contact surfaces of the conductor bars. This oil further serves as a di-electric and conductive heat dissipation means whereby heat resulting from high power level energy transfer between the contacts and conductor bars is conducted to the casing 10 through the oil and radiated from the outer surface of the casing.

The construction of the various flexible contacts as illustrated in detail in Figure 3 is an important feature of this invention in that the ability of the contact to flex insures a wiping action between the peripheral edge of the disc-type contact and the annular opposing surfaces associated with the conductor bars 34 and 35. Thus, as the conductor bar first engages a contact and subsequently continues to move in the same direction to flex the supporting spring 29, a wiping action inherently takes place. The degree of flexure is sufficient so that close tolerances in the manufacture of the passage 17, bores 22, 23 and 24, and the conductor bars, is not essential.

As a result of the free floating of the conductor bars 34 and 35 and the simple engagement of the push rods 43 and 45 by the armature 19 and the return spring 47, rotation of the bars about the axis A—A as described may occur in a random manner whereby the fresh contact surfaces are constantly being exposed. This provision of relatively large contact surfaces successively employed for making electrical contact is extremely important in that the reliability of maintaining a good electrical connection is greatly increased.

It will also be evident from the above design that relatively little mechanical movement of the conductor bars 34 and 35 is necessary to effect a switching from one coaxial output connector to the other. In addition to this relatively small mechanical movement, the provision of the bearing sleeves 32 and 33 and lubricating characteristics of the oil enable longitudinal movement of the conductor bars between one switching position and a second switching position to be effected relatively easily and with only a small amount of power. Therefore, only a very little energy is required to operate the solenoid 21. A further consequence of the small mechanical movement for effecting the switching, as well as the ease of such movement, is the ability of the switch to be operated at an extremely rapid rate whereby it may adequately serve as an antenna lobing switch.

In Figure 5 there is shown a modified embodiment of the switch in which a rectangular type casing 49 is employed for housing two solenoid type coils 50 and 51 with associated energizing terminals 52 and 53 and a center ground terminal 54. As shown in Figure 4, each of the coils 50 and 51 has associated armatures 55 and 56 for engaging push rods 57 and 58 respectively positioned at the far ends of conductor bars 59 and 60. The conductor bars 59 and 60 are identical to the conductor bars 35 and 34 of Figures 2 and 4, the armature 56 associated with the solenoid coil 51 simply replacing the action of the coil spring 47. The remaining components of the switch in Figure 5 are also similar to the components of the switch illustrated in Figures 2 and 4, the inner conductors 61, 62 and 63 of the co-axial connectors respectively being arranged to be sequentially connected depending upon the longitudinal position of the conductor bars 59 and 60.



In the operation of the device of Figure 5, the energization of the solenoid coil 50 by energy applied between the terminal 52 and ground 54 will move the conductor bars 59 and 60 to the right whereby the inner conductor 61 is connected to the inner conductor 62. De-energization of the solenoid coil 50 and energization of the solenoid coil 51 will move the conductor bars 59 and 60 longitudinally to the left whereby the inner conductor 63 will be connected to the inner conductor 62 and the inner conductor 61 will be open. The provision of the second solenoid coil 51 provides a positive action for rapid lobing operations. Further, the provision of the second solenoid coil 51 in place of a return spring enables the armatures 55 and 56 to be spring biased to a neutral position, if desired, whereby should electrical power fail, the conductor bars will assume a center position whereby the associated contacts of all three inner conductors 61, 62 and 63 are out of engagement with the conductor bars 59 and 60 and a "fail-safe" arrangement is provided.

It will be noted in Figure 2 that the right hand end of the conductor bar 34 grounds against the metallic end plug of the passage 17 when the switch is in energized position. This shorting out of the conductor bar 34 to ground represents an electrical block to R.-F. energy and further isolates the output connector 12 when in disconnect position. Similarly, a small metallic stub 64 is provided at the left hand end of the passage 17 in Figures 2 and 4 to ground out the left hand conductor rod 35 when the switch is in de-energized position as shown in Figure 4.

It is also possible to decrease the distance between the opposing annular shoulders of the reduced diameter portions 38 and 42 of the conductor bars 34 and 35 so that the inner conductor of the disconnected co-axial connector will be ground to the casing through the conductor bar thereby insuring complete isolation between the connected and disconnected portions of the switch.

Various other modifications within the scope and spirit of the present invention will occur to those skilled in the art. The invention is, therefore, not to be thought of as limited to the particular switch embodiments set forth for illustrative purposes.

What is claimed is:

1. A co-axial switch comprising: two output coaxial connectors; an input co-axial connector; a metallic support holding the outer conductors of said co-axial connectors in physical and electrical engagement; the inner conductors of said output co-axial connectors and the inner conductor of said input co-axial connector extending transversely of and terminating in ends adjacent to a rectilinear axis; spaced, axially aligned conductor bars adapted to move back and forth along said axis; said conductor bars having reduced diameter portions defining annular opposing contact surfaces; flexible contact means secured to said ends and extending into said reduced diameter portions between said opposing contact surfaces adapted to make electrical connection with said opposing contact surfaces to connect the inner conductor of said input co-axial connector and either one of the inner conductors of said output co-axial connectors; and an annular insulating means surrounding said conductor

bars and supporting said conductor bars for axial rotation about said rectilinear axis whereby fresh contact surface portions on said annular opposing surfaces are brought into position upon rotation of said conductor bars to make said electrical connection.

2. A co-axial switch comprising: a metallic casing having an internal longitudinal cylindrical passage, one exterior side of said casing having central and two outside parallel transverse bore openings passing through one side of said casing and terminating in said longitudinal passage; an input co-axial connector receivable in said central bore; two output co-axial connectors receivable respectively in said two outside bores; flexible contact means connected to the inner conductor of each of said co-axial connectors and extending transversely into said longitudinal cylindrical passage terminating short of the longitudinal axis of said cylindrical passage; a pair of longitudinally aligned insulative sleeves disposed in said passage; a pair of elongated cylindrical conductor bars slidable in said sleeves respectively; and insulative member, the adjacent ends of said bars being held in longitudinal alignment and insulated from each other by said insulative member, said flexible contact means connected to the inner conductor of said input co-axial connector extending between said adjacent ends, the outer ends of said conductor bars having reduced diameter portions defining opposing annular contact shoulders, the flexible contact means connected to the inner conductors of said output co-axial connectors extending between said opposing annular shoulders respectively; and actuating means for moving said conductor bars longitudinally through said sleeves whereby said input co-axial connector is connected to one of said output co-axial connectors through one of said conductor bars when said conductor bars are actuated to move in one direction through said sleeves, and disconnected from said one output co-axial connector and connected to the other of said output co-axial connectors when said conductor bars are actuated to move in an opposite direction.

3. A switch according to claim 2, in which said longitudinal cylindrical passage, said sleeves, and said conductor bars are dimensioned such that an impedance match is maintained between said input co-axial connector and either one of said output co-axial connectors.

4. A switch according to claim 2, in which said flexible contact means each comprise a disc shaped contact head having a peripheral contact surface for engaging one of the opposing annular contact surfaces associated with said conductor bars; and a coiled conductive spring secured between said head and the inner conductor of the associated co-axial connector, the axis of said coiled spring extending normally in alignment with said inner conductor transversely into said passage, whereby said head may laterally flex to provide a wiping engagement with said one of the opposing annular contact surfaces.

5. A switch according to claim 2 in which said longitudinal passage is filled with oil whereby heat generated adjacent said contact means is conducted to the surface of said casing.

6. A switch according to claim 2, in which said sleeves and conductor bars are symmetrical with respect to said longitudinal axis whereby said conductor bars are free to rotate about said axis to expose fresh opposing annular contact surfaces.

7. A switch according to claim 2, in which said actuating means comprises an electromagnet having an armature projecting into said longitudinal passage; an insulative push rod having one end secured to one of said conductor bars and its other end engaged by said armature; an additional insulative push rod secured to the other of said conductor bars; a return spring at the opposite end of said passage adapted to engage in opposing relationship to said armature said additional push rod whereby energization of said solenoid moves said conductor bars in said one direction and de-energization of said solenoid frees said conductor bars for movement in said opposite direction by said return spring.

8. A switch according to claim 2, in which said actuating means comprises a pair of electromagnets having armatures extending respectively into opposite ends of said longitudinal passage; and insulative push rods disposed between said armatures and the far ends of said conductor bars respectively whereby energization of one of said electromagnets moves said conductor bars in said one direction and de-energization of said one of said electromagnets and energization of the other of said electromagnets moves said conductor bars in said opposite direction.

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# CERTIFICATE OF CORRECTION

Patent No. 2,826,746 Donald H. Lanctot March 11, 1958

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

In the grant, lines 2 and 11, and in the heading to the printed specification, lines 3 and 4, name of assignee, for "Electromation Co." read -- Electronic Specialty Co. --.

Signed and sealed this 17th day of June 1958.

(SEAL)

Attest:

KARL H. AXLINE

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Commissioner of Patents

UNITED STATES PATENT OFFICE

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