ROTARY SWITCH HAVING IMPROVED CROSS-TALK AND MATCHING CHARACTERISTICS

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ROTARY SWITCH HAVING IMPROVED CROSS-TALK AND MATCHING CHARACTERISTICS

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The present invention relates to high frequency coaxial electrical switches for selectively connecting a first high frequency coaxial transmission line to individual ones of a pair of such lines and, in particular, concerns a rotary switch of the type shown in U.S. Patent 2,640,115.

It is a principal object of the present invention to improve the electrical characteristics of a coaxial switch of the general type shown in U.S. Patent 2,640,115 with respect to its cross-talk and impedance matching characteristics without any substantial increase in the complexity of the switch as to its fabrication or use.

It is a further object of the invention to provide a shield element in a rotary coaxial switch of the type contemplated herein, which switch employs an enclosed chamber into which an axial inner conductor and a pair of radially spaced inner conductors extend. The switch also employs a radial switch arm at all times connected to the axial inner conductor and alternate ones of the radial inner conductors to effect alternate switching operation. The improved cross-talk and matching characteristics are effected by the shield element suitably supported in the chamber between the inner conductors and which element is provided with a longitudinal slot to clear the switch arm for movement.

Further objects and advantages will become apparent from the following description of the invention taken in conjunction with the figures, in which:

FIG. 1 is an exploded elevational view partly in section of a switch employing the principles of the instant invention.

FIG. 2 is an end view in elevation of a portion of the assembled switch taken along line 2—2 of FIG. 1; and

FIG. 3 is an exploded view in perspective of the shielding element employed in the switch chamber in accordance with the principles of the invention. Reference is now made to the figures for an illustration of a switch 10 incorporating the principles of the invention. Switch 10 involves a solenoid motor 11 for actuating switching operation. Switch 10 includes a support or body comprising a cup shaped housing 12 having a stepped axial bore 13 in which a notched member 14 is seated upon assembly of switch 10. The left side of housing 12 is enclosed by an end wall 15 and the opposite and open end of bore 13 is enclosed by an end wall 16 provided by a cylindrical cover 17. These elements, housing 12, notched member 14 and cover 17, are all constructed of radially switch arm 37 is carried by insulator 41 and held therewith. Arm 37 is electrically isolated from the chamber walls by insulator 41. Upon assembly of switch 10, switch arm 37 is supported in chamber so that its lower portion is at all times in conductive contact against the rounded end of inner conductor 29. Switch arm 37 bridges the distance between alternate ones of the inner conductors 34, 35, whereby the upper portion of switch arm 37 extends radially to permit conductive connection with the sides of individual ones of inner conductors 34, 35. The upper end of arm 37 terminates within chamber 24 to avoid contact with chamber wall 23.

Movement of switch arm 37 from one to another of its two "make contact" positions about the axis of conductor 29 is effected by any well known device, such as solenoid motor 11. Solenoid 11 includes a rotatable shaft 42 having a radial key or pin 43. Upon assembly
of switch 10, pin 43 registers with a keyway 44 at the adjacent end of bearing member 40 to turn same. A flat coil spring 45 is operatively engaged to shaft 42. Spring 45 is mounted on solenoid 11 by clamp means 46. Shaft 42 is held in one rotatable position when solenoid 11 is de-energized whereby bearing member 40 is correspondingly positioned. This holds switch arm 37 in a first of its "make contact" positions, for example, as shown in FIG. 2, wherein its upper end is in contact with conductor 34 to couple the transmission lines connected to connectors 27, 30 together through switch 10. In this condition, connector 31 is inactive. Solenoid 11 may be energized by the application of suitable voltage potential to a pair of input terminals 47 and when energized causes shaft 42 to turn, whereby switch arm turns therewith to its second "make contact" position. Arm 37 now contacts conductor 35 to couple the transmission lines connected to connector 27, 31 whereas connector 30 is inactive. When solenoid 11 is again deenergized, spring 45 returns switch arm to the first "make contact" position. If desired, solenoid 11 may also include additional internal stop means to prevent swing arm from swinging beyond either of the "make contact" positions to avoid contact with walls 20, 21. Key 43 and the adjacent elements of solenoid 11, such as, spring 45 and clamp means 46, nest in bore 48 of cover 17 upon assembly of switch 10. The description of the rocking device or means for pivoting switch arm 37 from one to the other of its "make contact" positions, is briefly described here-in because it is not an element of the claimed improvements. It will be understood that other well known operating devices or manual operations may be used to alternate switch arm 37 from one to the other of its two "make contact" positions.

The principal of the invention involves supporting shield element means 49 in chamber 24. Shield means is illustrated in the figures as a pair of arcuate shield bodies 50, 51 made of electrically conducting material. Shield bodies 50, 51 have an axial width substantially equal to a. One end of each shield body is embedded in an individual chamber wall 20, 21 and soldered there to hold firmly the composite shield element 49 in desired position in chamber 24. Shield element 49 is substantially symmetrical with respect to the vertical radius as viewed in FIG. 2 upon assembly of bodies 50, 51 in chamber 24. In the elevational view of FIG. 2, the arcuate wall 49a defined by shield 49 lies in a circumferential plane substantially parallel to peripheral wall 23. Each shield body 50, 51 has a turned end 49b forming contiguous portions extending radially towards chamber 24 for member 49 extends between wall 23, but terminate close to wall 23. It will be noted that the circumferential plane 49a of shield 49 extends between wall 23 and conductor 29 and, in particular, above conductor 29 and below the ends of conductors 34, 35 to electrically shield the latter pair of conductors from conductor 29. The upturned shield ends 49b extend radially between walls 20, 21 and, in particular, mid-way between conductors 34, 35 so that essentially three component chambers are defined by shield 49, each for an individual one of the three inner conductors extending into chamber 24. Each shield body 50, 51 has an off-set slot 52 and upon assembly in chamber 24 the slots are aligned to form a circumferential closure 52 through which switch arm 37 passes, whereby arm 37 is cleared for movement from one to the other of its two "make contact" positions. In addition, shield 49 capacitively loads chamber 24 which improves the impedance match with the coaxial cables connected to switch 10. As understood in the art, cross-talk means picking up a signal in the inactive circuit which may be opened, grounded or resistor terminated as a result of a relatively imperfect isolation of such inactive circuits from the active circuitry. With respect to the operation of switch 10, it will be understood that the circumferential width b of switch arm 37 is less than the circumferential separation of shield portion 49b from walls 20, 21, respectively. Accordingly, when arm 37 is in its first "make contact" position as shown in FIG. 2, a portion of arm 37 above this arcuate portion 49a of shield 49 reaches into chamber portion 24a surrounding inactive conductor 35. In this position, the upper part of arm 37 is contained within chamber portion 24a surrounding the connected conductor 34. A reverse relationship exists when arm 37 is in its other "make contact" position, at which time the chamber portion 24a surrounding inactive conductor 34 does not contain any part of switch arm 37.

In order that electromagnetic wave energy propagate well in a coaxial transmission line, it should be characterized by a uniform capacitance and inductance per unit length. Consequently, under ideal conditions, switch 10 should have the same impedance per unit length as the cables to which switch 10 is attached. Switch 10 upon assembly will have a certain impedance between the inner conductor paths, for example conductors 29, 37 and 34 or 35, and the outer conductor paths, for example, 28, the outer conductor path in the absence of the use of shield 49, a relatively large gap exists between switch arm 37 and the outer conductor path in switch 10, such as wall 15, whereby the capacitance of switch 10 is relatively low. The insertion of shield 49 is designed to increase the capacitance per unit length of switch 10 to improve its matching characteristics, whereby switch 10 exhibits a better match with a 50 ohm line.

The slot dimension S (FIG. 3) plays a part in controlling the amount of shielding and also switch impedance. The shield effect is increased and capacitance of switch 10 is increased by making slot dimension S smaller, although it will be understood that this dimension must always be wide enough to pass switch arm 37 without contacting shield 49 to avoid shorting of arm 37. In addition, the shield dimension d, that is to say, the separation of its arcuate plane 49a from wall 23, may be increased to increase the capacitance of switch 10. Moreover, the thickness of the shield dimension t, if increased, will increase the capacitance between shield 49 and arm 37 and, hence will increase the capacitance of switch 10. By selecting suitable dimensions for S, d and t, an impedance per unit length for switch 10 may be established to effect improved impedance matching with the coaxial cables connected to switch 10, with respect to a switch employing the principles of the invention, it was found that upon terminating connector 27 with a 50 ohm line and both connectors 30, 31 are terminated with match loads, switch 10 provides an impedance match with the VSWR less than 1.2 from 0–1000 mc, whereas switch arm 37 is in either of its "make contact" positions. Cross-talk to a terminated connector 31 is better than 80 db down when switch was either of its "make contact" positions with the signal applied to connector 30 and connector 27 terminated with a match load.

In one embodiment, shield bodies 50, 51 were shaped from blanks of spring phosphorous bronze and formed to provide an arcuate plane 49a having a radius of about .328 inch for mounting in a chamber 24 having a radius of about .469 inch. The blank material was selected to provides a first, it effectively provides a characteristic impedance provided with a dimension S of about .062 inch for slot 52 to pass a switch arm 37 having a thickness of about .004 inch.

It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an electrical switch for selectively connecting a
first electromagnetic wave transmission line to individual ones of a pair of such lines, wherein said switch including a conductive body having an internal chamber defined by first and second opposed conductive walls joined at an apex at one end and being bridged by a peripheral conductive wall at an opposite end, said chamber also including a pair of parallel spaced conductive end walls, said first and second walls extending in respective planes orthogonal to said parallel end walls, a first coaxial connector for connection to the first transmission line and having an inner conductor extending into said chamber adjacent the chamber apex and along an axis normal to said parallel end walls, a pair of coaxial connectors for individual connection with said pair of transmission lines and having respective inner conductors extending radially into said chamber from said peripheral wall and between said first and second opposed walls, movable conductive switch means supported in said chamber for connecting said first inner conductor with alternate ones of said pair of inner conductors in response to switching movement from one to another of two positions, the combination comprising, an arcuate conductive shield element supported in stationary relationship in said chamber and making conductive connection with said chamber walls, said shield bridging the distance between said first and second opposed walls and lying in an arcuate plane uniformly spaced from said peripheral wall, the plane of said shield being located between said peripheral wall and said shield, said shield having a turned portion extending radially towards said peripheral wall and between individual ones of said pair of inner conductors so as to shield one electrically from the other, said shield having an arcuate slot of preselected width through which said switch means extend for clearing said switch means for movement from one to another of its two switching positions, the width dimension of said slot coextending in the same direction as the width dimension separating said parallel end walls, the degree of electrical shielding and effective capacitance of said chamber being a function of the size of said slot width, movement of said switch means to one or the other of its two switching positions effects the electrical connection between said first inner conductor and an individual one of said pair of inner conductors, whereas the other of said pair of inner conductors is inactive and electrically shielded from the connected inner conductors.

2. Apparatus as defined in claim 1, wherein one inner conductor of said pair is adjacent to said first wall and the other inner conductor of said pair is adjacent said second wall, the size of said switch means being less than the separation between the turned portion of said shield and said first and second walls, said switch means being confined entirely between said turned portion and the respective ones of said first and second walls when said switch means is in one or the other of its two positions.

3. Apparatus as defined in claim 2 wherein the effective capacitance of said switch is also a function of the distance between the plane of said shield and said peripheral wall and the radial thickness of said shield.

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