June 16, 1953 C. A. HAULMAN ET AL 2,642,495

COAXIAL TRANSMISSION LINE SWITCH

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FIG. 1

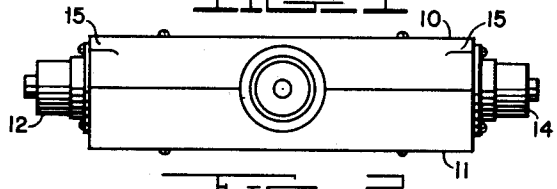


FIG. 2

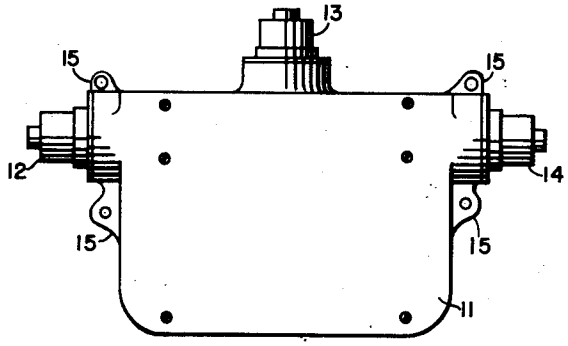


FIG. 4

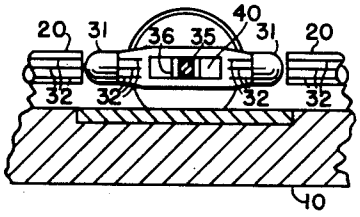


FIG. 5

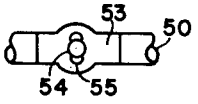
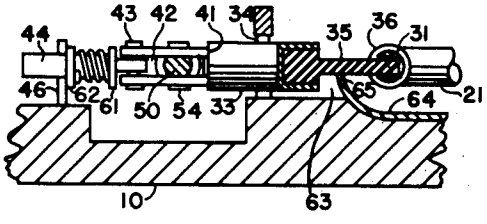


FIG. 6



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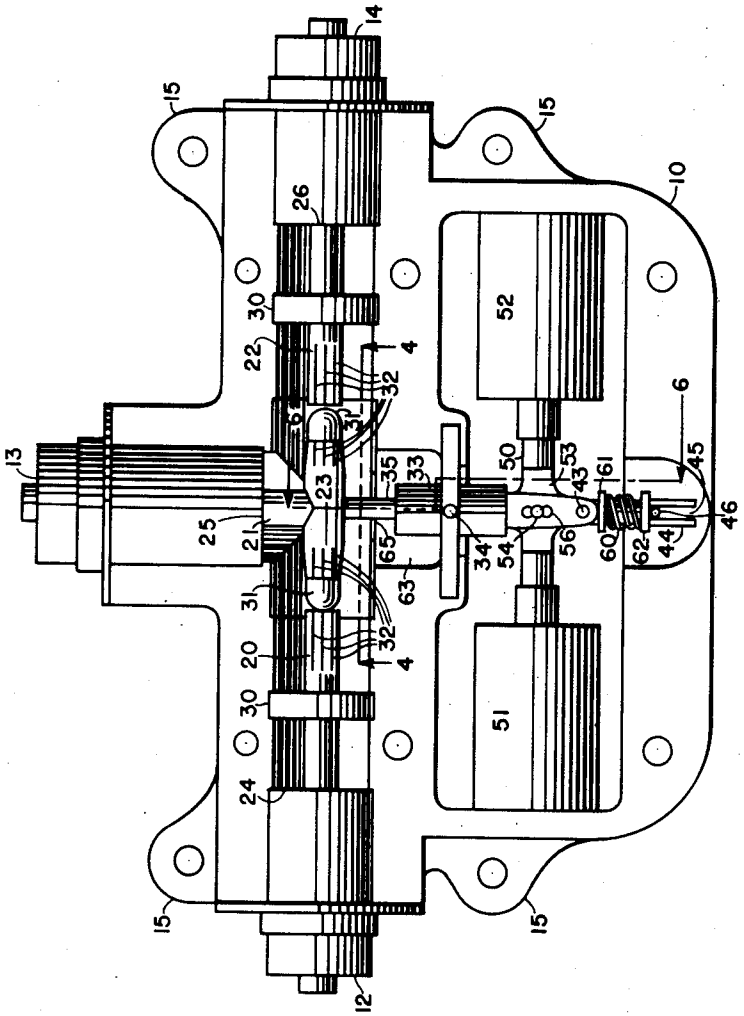
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FIG. 3



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COAXIAL TRANSMISSION LINE SWITCH

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4 Claims. (Cl. 178—44)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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This application is a continuation of application Serial No. 580,053, filed February 27, 1945, for Coaxial Transmission Line Switch.

This invention relates to a switch for directing energy from a coaxial transmission line into either of two associated similar coaxial transmission lines.

In transmission systems employing connected transmission lines having different characteristics a major problem is encountered in maintaining constant surge impedance of the line throughout the junction between the different transmission lines in order to prevent energy losses due to reflection. The same problem is encountered when connecting transmission lines having similar characteristics through a switching means. Transmission line switching devices have been provided heretofore operable to form a connection between one transmission line and either of two other transmission lines. However, the prior devices are not constructed in a manner so that constant surge impedance is maintained between connected lines throughout the switch. In particular, the prior devices do not include means for eliminating the effect of the unconnected line on the surge impedance of the connected lines, which effect inherently exists since the lines are necessarily mounted in close proximity within the switching device. Moreover, due to the construction of the switch actuating mechanism the prior devices include a cavity, which is large with respect to the external cross-sectional dimensions of the transmission lines, for enclosing such mechanism and into which the transmission lines extend. Compensating means, such as adjustable capacitors, are provided in an attempt to compensate for the abrupt and severe capacity variations between connected lines due to the cavity, however, such compensating means are not satisfactory in maintaining constant surge impedance throughout the switch, for either position of operation thereof, especially when the device is employed for transferring ultra-high frequency energy.

Accordingly, it is an object of the present invention to provide a novel switch for connecting a transmission line to either of two similar transmission lines, having a substantially constant surge impedance.

A further object is to provide a novel switch having the foregoing characteristics including an inherently low percentage of reflection and associated energy loss.

Another object is to provide a coaxial transmission line switch in which the capacity per unit

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length between inner and outer conductors is maintained substantially constant throughout the switch.

Other objects and features of the present invention will appear more fully hereinafter from consideration of the following detailed description in connection with the accompanying drawings which disclose one embodiment of the invention. It is to be expressly understood, however, that the drawings are designed for the purpose of illustration only and are not to be construed as a definition of the limits of the invention, reference for the latter purpose being had to the appended claims.

In the drawings, wherein similar reference characters denote similar elements through the several views:

Fig. 1 is a diagrammatic illustration of the top view of a transmission line switch constructed in accordance with the principles of the present invention;

Fig. 2 is a side view of the switch disclosed in Fig. 1;

Fig. 3 is a side view of the switch disclosed in Fig. 1 with the front cover removed therefrom;

Fig. 4 is a sectional illustration along the line 4—4 of Fig. 3;

Fig. 5 is a detailed illustration of one of the elements included in the device shown in Fig. 3, and

Fig. 6 is a sectional illustration along the offset section lines 6—6 of Fig. 3.

With reference more particularly to Figs. 1 and 2 of the drawings, a transmission line switch constructed in accordance with the principles of the present invention is disclosed therein including a substantially rectangular housing 10 provided with a front cover plate 11. Three coaxial transmission lines 12, 13 and 14, each including inner and outer conductors, are shown entering the housing 10 from the left, top and right, respectively, as viewed in Fig. 2. The transmission lines 12, 13 and 14 may constitute connection members to which extended coaxial transmission lines are adapted to be joined. The housing 10 has tabs 15 secured thereto for use in mounting the switch on a support.

As shown in Fig. 3, the inner conductors of the coaxial lines 12 and 14 extend into the housing 10 in axial alignment, and the inner conductor 21 of the coaxial line 13 extends into the housing 10 at right angles with respect to the inner conductors of lines 12 and 14. The extended inner conductors of the coaxial lines 12 and 14 terminate in conductors 20 and 22 respectively, while

the inner conductor of the coaxial line 13 terminates in tubular conductor 23 mounted perpendicular thereto in axial alignment with the conductors 20 and 22. The outer conductors of the coaxial lines 12, 13 and 14 terminate at planes 24, 25 and 26 respectively. From planes 24, 25 and 26 throughout the interior of the switch the outer conductors of the coaxial lines are formed by the figuration of the housing 10. As shown, the extended inner conductors 20, 21 and 22 are symmetrically surrounded by cylindrical walls formed in the housing 10 having diameters equal to the inner diameters of the outer conductors of coaxial lines 12, 13 and 14. Polystyrene discs 30 are provided for supporting the conductors 20 and 22.

In order to selectively establish contact between coaxial line 13 and either of coaxial lines 12 and 14 a movable switch member 31 is mounted for sliding movements inside the tubular conductor 23. The member 31 may consist of a short length of chrome-plated steel rod suitably rounded at each end as shown in Figs. 3 and 4. By reciprocation of the member 31, to the right or left as viewed in Fig. 3 of the drawings, relative to the tubular conductor 23, the inner conductor 21 of the line 13 may be connected to either the conductor 20 or the conductor 22. The conductors 20 and 22 are hollow at the terminated ends thereof for reception of the end of the member 31, and notches 32 are cut axially in the conductors 20, 22 and 23 to form spring fingers normally urged inwardly to maintain firm electrical and mechanical contact with the sliding member 31.

An electro-magnetically operated toggle mechanism is provided for actuating in the switch member 31 in a manner described heretofore. As shown in Figs. 3 through 6, the switch member 31 is actuated in the tubular conductor 23 by a finger 35 constructed of insulating material. The finger 35 extends from a cylindrical rod 33 pivotably mounted by a pin 34. The finger 35 has a square cross-section for operative engagement in square slot 36 provided in the member 31. To allow back and forth movement of the finger 35, as the member 31 is actuated, one side of the tubular conductor 23 is provided with a rectangular slot 40. The rod 33 includes an extension 41 of substantially square cross-section at the end thereof opposite the finger 35. The extension 41 is provided with an open, longitudinal slot 42 for receiving one end of a toggle member 44 pivotably secured to the end of the extension 41 by means of pivot member 43. The toggle member 44 includes a slot 45 at the other end thereof for pivotably engaging a stationary pin 46 secured to the housing 10. The ends of a plunger 50 positioned transversely through the slot 42, are respectively secured to the armatures, not shown, of actuating solenoids 51 and 52. The plunger 50 includes an intermediate section 53 which comprises a pair of parallel surfaces to allow operation in the slot 42. A pin 54 is positioned to engage an elongated hole 55 in the section 53 and an elongated hole 56 is provided in the extension 41 to provide an operating connection between the rod 33 and the plunger 50. Toggle spring 60 is compressed between a shoulder 61 on the toggle member 44 and a washer 62 bearing against the pin 46 to provide a snap action in the oscillating movement of the rod 33 about the pin 34 upon energization of the armatures 51 or 52. For ease of description the mechanism for actuating the switch member 31 is shown in the midposition of operation. It will be obvious that such position will never be maintained during operation as the switch due to the toggle action of the spring 60. The mid-position shown in the drawings will be attained only momentarily as the mechanism passes from one extreme position to the other.

As mentioned heretofore, the switch provided by the present invention is constructed in such a manner as to maintain continuity of the outer conductors of the coaxial lines through the housing 10. For ease of manufacture however, a cavity 63, which accommodates the rod 33 and the finger 35, may be provided in the housing 10 as a continuation of the outer conductor of the coaxial line 13. In order to close the opening thus formed, a sleeve 64, having a longitudinal slot 65 for the passage of the finger 35, is inserted in the housing 10 to maintain a continuous cylindrical wall therein between the planes 24 and 26.

In operation, one of the solenoids, for example the solenoid 51, is energized, pulling the plunger 50 to the left as viewed in Fig. 3. Such movement of the plunger 50 produces clockwise rotation of the rod 33 above the pivot 34, and forces the member 31 into engagement with the conductor 22 of the line 14. The spring 60 then functions to bias the plunger 50 to the left so that the solenoid 51 may be de-energized without terminating the electrical and mechanical contact between the member 31 and the conductor 22. Similarly, energization of the solenoid 52 will cause the line 33 to snap in a counterclockwise direction to establish an electrical and mechanical connection between the member 31 and the conductor 20.

It is to be expressly understood that when the member 31 is moved into engagement with one of the conductors 20 or 22, for example the conductor 20, the right-hand end of the member 31 extends into the tubular conductor 23, and the distance between the common inner conductor 23 and the un-connected inner conductor 22 is maintained equal to the distance between the inner conductors and the outer conductors of the coaxial lines. This relationship maintains the capacity per unit length of the coaxial lines substantially constant so that substantially constant surge impedance is maintained throughout the switch, thus reducing energy losses due to mismatch and reflection.

There is thus provided by the present invention novel switch means for switching one transmission line to either of two associated transmission lines, with the novel means so characterized as to maintain substantially constant capacity per unit length of lines throughout the switch, and hence substantially constant surge impedance throughout the switch, for either position of operation thereof. Specifically, the foregoing is accomplished by providing a switch housing having cylindrical passages therein which function as the outer conductors of the transmission lines through the switch, with such passages having continuous surfaces corresponding to the inner surfaces of the outer conductors, and by providing a novel arrangement for forming the desired connection between the inner conductors of the transmission lines wherein the inner conductor of the un-connected transmission line is maintained spaced from the inner conductors of the remaining transmission lines by a distance equal to the space between the inner and outer conductors of each of the trans-

mission lines. Furthermore, it is to be expressly understood that the novel switch provided herein may be readily sealed without effecting operation thereof for ease of adaptation to such applications as under-water use and for employment in the vicinity of explosives or other chemical substances.

Although only one embodiment of the present invention has been disclosed and described herein it is to be expressly understood that various changes and substitutions may be made therein without departing from the spirit of the invention as well understood by those skilled in the art, for example, two switch units embodying the principles of the present invention may be placed side by side producing a double pole, double throw transmission line switch, and that one of the solenoids may be removed and replaced by spring under tension to bias the switch to normally maintain a connection between two of the three transmission lines. Reference, therefore, will be had to the appended claims for a definition of the limits of the invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A switch comprising two coaxial transmission lines having outer conductors joined in a substantially unbroken connection and having inner conductors terminated in spaced relationship, a third coaxial transmission line having an outer conductor joining said first two outer conductors and including a hollow inner conductor in spaced relation between the termination of said first two inner conductors, a connector slidable within said hollow inner conductor and movable to contact selectively either of said first two inner conductors, and a non-conducting member operable to actuate said connector.

2. In a transmission line switching device, a housing, two coaxial transmission lines oppositely positioned in said housing along a common axis and having the inner conductors thereof terminated within said housing in spaced relationship, a third coaxial transmission line positioned in said housing with the inner conductor thereof terminated within said housing in spaced relation with the inner conductors of said two lines and perpendicular to said axis, a switch carrying member secured in perpendicular relationship to the terminated end of the inner conductor of said third line along said axis, a switch member carried by said switch carrying member for establishing a connection between the inner conductor of said third line and the inner conductors of either of said two lines, means to actuate said switch member, and means including said housing forming a substantially continuous surface having dimensions equal to the inner dimensions of the outer conductors of said two and said third lines between the outer conductors of said two and said third lines throughout said housing.

3. A coaxial transmission line switch comprising a housing, three coaxial transmission lines having inner and outer conductors, said lines having their outer conductors joined by the housing and so arranged that two of said lines are oppositely disposed on a common axis with the third line terminated between the ends of said two lines, a movable member for connecting either of said two lines to said third line, said movable member being in the form of a section of inner conductor slidably mounted on the end of the inner conductor of said third line in electrical contact therewith and constrained to slide transversely of the third line along the common axis of the two oppositely disposed conductors, the length of said movable member being substantially equal to the distance between the inner conductors of said two lines minus the distance between the inner and outer conductors, thereby maintaining the capacity per unit length of said connected lines substantially constant, and means for actuating said movable member.

4. A switch comprising two coaxial transmission line coupling elements having outer conductors joined in a substantially unbroken connection and having inner conductors terminating in spaced relationship, a third coaxial transmission line coupling element having an outer conductor in substantially unbroken connection with the two outer conductors and comprising a hollow inner conductor spaced between said first two inner conductors, a reciprocally movable conductor contained within said hollow conductor and movable to contact either of said first two inner conductors selectively, and a non-conducting actuating member operable to move said movable conductor.

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