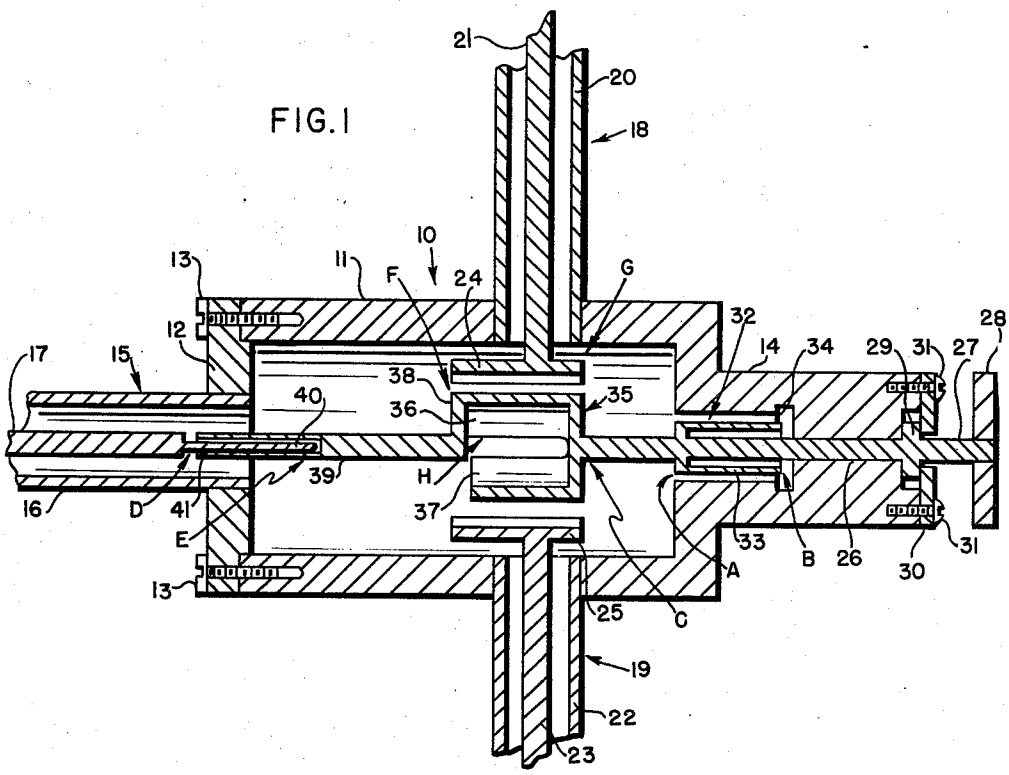
May 29, 1951 R. C. RAYMOND 2,555,154

RADIO FREQUENCY SWITCHING DEVICE

Filed Nov. 27, 1945

FIG. 1



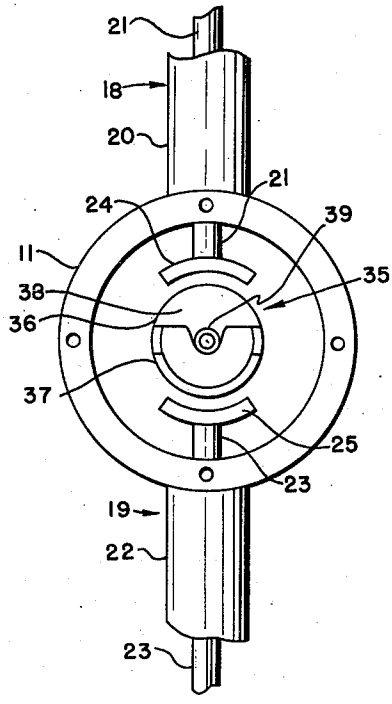


FIG. 2

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RADIO-FREQUENCY SWITCHING DEVICE

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5 Claims. (Cl. 178—44)

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This invention relates to electrical switches. More particularly it relates to a coaxial transmission line switch suitable for use over a narrow frequency range in the high radio frequency region.

In the use of apparatus employing elements operating at high radio frequencies it is often desirable to have simple switching means operable manually or otherwise which, while functioning as simply and directly as conventional switches, will not adversely affect the performance of the radio frequency system in which they are employed. In particular it is desirable that such switches should not attenuate the energy passing through them and that they should not permit crossover of radio frequency energy by inductive or capacitive coupling between the used and unused portions of the switches.

None of the prior art devices are free from these disadvantages. One prior art expedient has been the use of quickly detachable connectors permitting the connection of different alternate radio frequency transmission lines to the same receptacle. Another expedient has been the use of conventional switches selected for quality and for low shunt capacity, in shielded portions of the apparatus in which they are used. The first has the shortcoming that it does not provide means for rapid switching or means that could be adapted for mechanical or automatic operation. Conventional switches have been found to have these undesirable characteristics of attenuation and crossover of energy.

It is an object of this invention to provide a switch for coaxial transmission lines in which only negligible energy crossover and attenuation occur.

It is also an object of this invention to provide a switch for coaxial transmission lines based on the transmission line theory that when a length of line one-quarter wavelength long is terminated in a high impedance compared with its characteristic impedance, the impedance seen at the input is low compared with its characteristic impedance and when such a line is terminated in a low impedance compared with its characteristic impedance, the impedance seen at the input end is high compared with its characteristic impedance.

It is a further object of the present invention

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to provide a switch for coaxial transmission lines in which the energy can be switched from one line to another or divided between a plurality of lines.

Generally, this invention comprises a conductive housing physically and electrically connected to the outer conductor of an input coaxial line and the outer conductors of output coaxial lines, which housing encloses a rotatable conductive cage electrically connected to the inner conductor of the input coaxial line and selectively capacitively coupled to one or more inner conductors of a plurality of output coaxial lines with shielding to prevent coupling to the unused output lines.

Other objects, features, an advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the following description of the invention taken in connection with the accompanying drawings in which:

Fig. 1 is a cross-section of a switch constructed in accordance with the principles of this invention; and

Fig. 2 is an end view of the embodiment shown in Fig. 1, with the end plate removed.

Referring now more particularly to Fig. 1, conductive housing 10 includes a hollow portion 11, which is preferably cylindrical in shape, closed at the input end by end plate 12 held in place by any suitable means such as screws 13, 13. The other end of portion 11 terminates in a portion 14 of reduced size. Input coaxial line consisting of outer conductor 16 and inner conductor 17 has its outer conductor 16 fastened into the center of end plate 12 and electrically connected to it by any suitable means such as by soldering or brazing.

One output coaxial line 18 consisting of outer conductor 20 and inner conductor 21 is mechanically and electrically connected by any suitable means to the side of portion 11. A second output coaxial line 19 consisting of outer conductor 22 and inner conductor 23 is similarly connected to the side of portion 11 generally opposite the place where coaxial line 18 is connected.

Inner conductors 21 and 23 of coaxial lines are terminated within the cavity of hollow portion 11 in capacitive coupling plates 24 and 25 respectively. These plates which are formed as

longitudinal segments of a cylinder should be spaced from outer conductors 20 and 22 and the inner wall of portion 11 by a distance at least as great as the distance between inner and outer conductors of the coaxial lines used. The length of capacitive coupling plates 24 and 25 is one-quarter of a wavelength of the frequency at which this device is intended to operate.

Reduced portion 14 has a centrally located bearing 26 which supports operating shaft 27 in line with inner conductor 17, and which may be rotated by knob or handle 28. A collar 29 is provided on shaft 27 to prevent longitudinal displacement of the shaft. The opening to accommodate this collar is closed by any suitable means such as end plate 30 held in place by screws 31, 31 or by any other suitable means.

A one-quarter wavelength radio frequency choke 32 is attached to shaft 27 at the entrance to the cavity of portion 11. Choke 32 consists of a cylindrical tubular member 33 one-quarter of a wavelength long and surrounds shaft 27 and is shorted to it at its inner end, circuit point A. Member 33 fits within portion 14 but nowhere is in contact with it. To prevent fringing there is an enlarged opening 34 in portion 14 at the open end, circuit point B of choke 32. Thus tubular member 33 forms a one-half wavelength folded coaxial stub.

Shaft 27 extends for a distance of one-quarter wavelength from circuit point A to circuit point C. At circuit point C there is attached to shaft 27 a cylindrical metallic cage 35 one-quarter wavelength long which is completely closed at the end, circuit point C. Cage 35 is bisected along its length forming two semi-cylindrical portions 36 and 37. Portion 36, the capacitive element, is closed at its other end by conductive plate 38. Portion 37, the shielding element, remains open at its other end. Therefore, cage 35 comprises a mechanically distorted form of shorted quarter wavelength stub with shaft 27 being connected to it at circuit point C. Conductor 39 is attached to plate 38 of capacitive element 36, coaxial with center conductor 17 and shaft 27 and extends to inner conductor 17. The connection to inner conductor 17 is not a solid physical connection but is a one-quarter wavelength capacity joint consisting of a reduced portion 40 of inner conductor 17 fitting within an aperture in the end of conductor 39 but not contacting it, thus forming a one-quarter wavelength section of unshorted coaxial line. Since it is essential that under no circumstances portion 40 contact conductor 39 and since the switch may be subject to vibration, it is advisable to protect portion 40 with a dielectric coating adjacent the space 41 between the apertured end of conductor 39 and portion 40.

The foregoing portion of this specification has described the construction and arrangement of parts of a switch representing an embodiment of this invention. With that description in mind the following matter will fully explain the manner of operation.

In normal operation of a coaxial line the outer conductor is grounded. This is assumed to be the operating condition throughout the following description. Since housing 10 is connected to outer conductor 16 of coaxial line 15 all parts of it are at all times at ground potential. Radio frequency energy travelling along line 15 will reach circuit point D where inner conductor 17 is terminated in the capacity joint between portion 40 and conductor 39 which extends one-

quarter wavelength to circuit point E. Since this capacity joint is one-quarter wavelength and, therefore, resonant to the operating frequency the radio frequency energy encounters a very low impedance at circuit point D between inner conductor 17 and conductor 39 and passes through this point with as little attenuation as if these two conductors were mechanically connected. The radio frequency energy proceeds from circuit point E to plate 38 on capacitive cage element 36, designated as circuit point F. When the switch is in the position shown in the drawing, connection is to be made to coaxial line 18 and coaxial line 19 is to be unused. It is therefore necessary to provide a path for the radio frequency energy between capacitive element 36 and inner conductor 21 of line 18. This is afforded by the construction employed in this invention. The outer semi-cylindrical surface of capacitive element 36, which is one-quarter of a wavelength long acts as one of the conductors of a parallel pair, the other conductor of which is capacitive coupling plate 24 which is of the same length. Since this line is open at point G there will appear to the radio frequency energy a virtual short circuit at point F and the radio frequency energy will pass to coupling plate 24 and on to inner conductor 21. It is thus seen that when this switch is in the position shown there is effected a transfer of radio frequency energy from input coaxial line 15 to output coaxial line 18 with no high series impedance anywhere along the path.

The function of shielding element 37 is to prevent an appreciable crossover of energy to output coaxial line 19 when the switch is in the position shown for the output to be through coaxial line 18. Capacitive element 36 and shielding element 37 act as parallel conductors of a shorted one-quarter wavelength resonant stub and there is therefore a very high impedance between them across the open end, circuit point H. As a result, any radio frequency energy which might have a tendency to flow to capacitive coupling plate 25 from capacitive element 36 will meet a very high series impedance. This impedance is not only high itself, but is much higher than that of the other path present for radio frequency energy, that is, between capacitive element 36 and capacitive coupling plate 24. The result is that any actual crossover of energy will be negligible. Cage 35 is well insulated from ground by the combination of choke 32 connected to shaft 27 at a distance of a one-quarter wavelength from the shorted end of cage 35. Shaft 27 is grounded to housing 10 because the impedance at circuit point A between choke 32 and portion 14 is very low because, as has been explained above, choke 32 acts with that portion as a resonant shorted half wavelength stub. This terminates the line formed by housing 10 and shaft 27 at circuit point A in a low impedance. This insures a very high, theoretically infinite, impedance at circuit point C.

When knob 28 is turned through 180 degrees, radio frequency energy will be transmitted from line 15 to line 19 and line 18 will be unused and shielded. A further discussion of the radio frequency energy paths for this position of the switch is not necessary in view of the above detailed discussion. While it has been assumed in the present description and explanation that line 15 is an input line and lines 18 and 19 are output lines, it is obvious that the switch will transmit energy as well in the opposite direction.

It will be obvious to those skilled in the art that the number of coaxial outputs may within practical limitations be increased when desired. The only modification required would be to make shielding element 37 larger than semicylindrical and to decrease capacitive element 36 accordingly. It is obvious that each output would require a capacitive coupling plate. In that case all of the unused ones would be shielded by the enlarged shielding element.

The switch may also be used to divide energy between two outputs by turning knob 28 90 degrees from the position shown. In such a position capacitive element 36 would overlap both capacitive coupling plates 24 and 25 and a radio frequency path of low impedance would be provided between line 15 and both lines 18 and 19.

It will also be obvious to those skilled in the art that alternate means of construction could be used while not actually departing from the principles of this invention.

While there has been here described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention.

What is claimed is:

1. A coaxial transmission line switch comprising a switch housing, an input coaxial line the outer conductor of which terminates in said switch housing, a one-quarter wave capacity joint resonant to the operating frequency and coupled to the inner conductor of said input line, a one-quarter wave rotatably mounted capacitive element coupled to said capacity joint, a rotatably mounted shielding element mechanically attached to and electrically anti-resonant, for the frequency of operation, with said capacitive element, two output coaxial lines the outer conductors of which terminate in said switch housing, capacitive coupling plates coupled one to an inner conductor of each of said output lines and mounted adjacent said capacitive and shielding elements, means coupled to said capacitive and shielding elements for rotating said capacitive element into position to form a low impedance path for radio frequency energy between it and the capacitive coupling plate of one of said output coaxial lines, said means simultaneously rotating said shielding element into position to insulate by a high impedance the capacitive coupling plate of the other of said output coaxial lines from all energy at the operating frequency that is present, said means for rotating said capacitive element and said shielding element also being capable of positioning said capacitive element and said shielding element with respect to said capacitive coupling plates to form a low impedance path for radio frequency energy from said capacitive element to the capacitive coupling plates of both said output coaxial lines.

2. A coaxial transmission line switch comprising a switch housing, an input coaxial line the outer conductor of which terminates in said switch housing, a one-quarter wave capacity joint resonant to the operating frequency and coupled to the inner conductor of said input line, a one-quarter wave rotatably mounted capacitive element coupled to said capacity joint, a rotatably mounted shielding element mechanically attached to and electrically anti-resonant, for the frequency of operation, with said capacitive element, two output coaxial lines the outer conductors of which terminate in said switch housing, capacitive coupling plates coupled one to an inner conductor of each of said output lines and mounted adjacent said capacitive and shielding elements, means coupled to said capacitive and shielding elements for rotating said capacitive element into position to form a low impedance path for radio frequency energy between it and the capacitive coupling plate of one of said output coaxial lines, said means simultaneously rotating said shielding element into position to insulate by a high impedance the capacitive coupling plate of the other of said output coaxial lines from all energy of the operating frequency that is present, and radio frequency choke means positioned one-quarter wavelength away from said capacitive element and said shielding element and electrically insulating said capacitive and shielding elements from said switch housing.

3. A coaxial transmission line switch comprising a switch housing, an input coaxial line the outer conductor of which terminates in said switch housing, a one-quarter wave capacity joint resonant to the operating frequency and coupled to the inner conductor of said input line, a one-quarter wave semi-cylindrical rotatably mounted capacitive element coupled to said capacity joint, a rotatably mounted semi-cylindrical shielding element mechanically attached to and electrically anti-resonant, for the frequency of operation, with said capacitive element, two output coaxial lines the outer conductors of which terminate in said switch housing, capacitive coupling plates coupled one to an inner conductor of each of said output lines and mounted adjacent said capacitive and shielding elements, means coupled to said capacitive and shielding elements for rotating said capacitive element into position to form a low impedance path for radio frequency energy between it and the capacitive coupling plate of one of said output coaxial lines, said means simultaneously rotating said shielding element into position to insulate by a high impedance the capacitive coupling plate of the other of said output coaxial lines from all of the operating frequency energy that is present.

4. A coaxial transmission line switch comprising a switch housing, at least three coaxial lines the outer conductor of all of said lines terminating in said switch housing, a one-quarter wave capacity joint resonant to the operating frequency and coupled to the inner conductor of one of said lines, a one-quarter wave rotatably mounted capacitive element coupled to said capacity joint, a rotatably mounted shielding element mechanically attached to and electrically anti-resonant for the frequency of operation with said capacitive element, capacitive coupling plates coupled one to an inner conductor of each of the remaining ones of said lines and mounted adjacent said capacitive and shielding elements, means coupled to said capacitive and shielding elements for rotating said capacitive element into position to form a low impedance path for radio frequency energy between it and at least one of said capacitive coupling plates, said means simultaneously rotating said shielding element into position to insulate the remainder of said capacitive coupling plates by a high impedance from all energy at the operating frequency that is present.

5. A coaxial transmission line switch comprising at least three coaxial lines including inner and outer conductors, a first plate rotatably mounted and electrically coupled at one end to

the inner conductor of one of said lines, a second plate mounted on said first plate and forming therewith an anti-resonant circuit at the operating frequency at said one end of said first plate whereby the impedance between said second plate and the inner conductor of said one line is large, at least a pair of plates mounted adjacent said first and second plates in positions to be successively capacitively coupled to said first and second plates as they are rotated, each of said pair of plates being coupled one to the inner conductor of each of the remaining one of said lines, and rotating means coupled to said first and second plate for coupling said one line successively to one of said remaining lines and at the same time shielding the other of said remaining lines from said one line.

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