This invention relates to a radio frequency switching, and particularly to a broad band lobbing switch.

The present invention has particular application to a radio frequency lobbing switch which serves to connect a plurality of radio frequency circuits with a common circuit to provide successive paths for pulsed radio frequency signals. Switching may be accomplished continuously at a specified scanning rate per second whereby, for example, radio frequency signals are transferred in sequence from a plurality of coaxial line circuits to a common coaxial line circuit.

For ideal radio frequency performance, the scanning time for each radio frequency channel should be characterized by having the period for each circuit long as compared to the changeover time, or the time between channels. Ideally, all the energy is transferred through the switch uniformly during the scanning period for each radio frequency channel while all other circuits are completely isolated, and no energy is coupled to the unused circuits. Similarly, the electrical characteristics, e.g., the characteristic impedance, of each channel should remain constant during each scanning period. A further consideration for ideal radio frequency performance is that each channel should cover a wide radio frequency band, i.e., from 1000 megacycles to 11,000 megacycles.

It is an important object of the present invention to provide a radio frequency lobbing switch which closely approaches realization of the foregoing ideal characteristics for such a switch.

Another object of the present invention is to provide a novel switching configuration for coaxial lines.

In accordance with the objects of the present invention, there is provided a radio frequency switch having novel shutters for isolating unused circuits.

A further feature of the present invention resides in the provision of a switch for coaxial lines utilizing a tri-plane conductor configuration for selectively interconnecting the lines.

In accordance with further objects of the invention, there is provided a radio frequency lobbing switch wherein each radio frequency channel has a retractable radio frequency contact, self contained in the radio frequency channel. A channel is active only when the blade is actuated and closes the circuit.

In accordance with another feature of the invention, each circuit is closed in sequence through a cam action and the cam controls the closed circuit time of each radio frequency circuit.

A further feature of the invention resides in the provision of a lobbing switch construction which readily accommodates break-before-make or make-before-break operation.

Another object, features and advances of the present invention will be apparent from the following detailed description, taken in connection with the accompanying drawing, in which:

FIGURE 1 is a longitudinal sectional view of a switch constructed in accordance with the present invention;

FIGURE 2 is a cross sectional view taken generally along the line II--II of FIGURE 1:

FIGURE 3 is a diagrammatic illustration of the operation of the switch for break-before-make operation; and

FIGURE 4 is a view similar to FIGURE 3 but diagrammatically illustrating make-before-break operation of the switch of FIGURE 1.

As shown on the drawings:

The present invention has been illustrated by way of example, as it would be embodied in a four channel lobbing switch wherein four channels are successively interconnected with a common channel. The switch is generally indicated by the reference numeral 10 and is illustrated as having a shaft 11 which is continuously driven by means of a motor 12 during operation of the switch. In the illustrated embodiment, the switch is adapted to interconnect branch coaxial terminals such as indicated at 14, 15 and 16 in FIGURES 1 and 3. It will be understood that there may be four branch terminals located 90° apart with respect to the central axis of the switch indicated at 18 in FIGURE 1. The switch 10 serves to interconnect the branch terminals with a common terminal indicated at 20. Each of the coaxial terminals comprises an externally threaded outer conductor sleeve portion 23 having a reduced portion 23a fitting within an aperture 25 of switch body 26. An inner conductor such as indicated at 27 is supported in each of the branch terminals by means of an insulating sleeve 29 which is retained in the sleeve 23 by means of an insert 30. An inner conductor 32 of slightly different configuration is mounted in the central common terminal 20 by means of an insulating sleeve 34 and an insert 35.

The switch body 26 has a central aperture 40 and a series of further apertures 41 receiving inner conductors 32 and 27 in coaxial relationship to provide continuations of the respective outer conductors defined by the interior surfaces of sleeves 23. The switch body 26 further provides a flat planar conductive surface 48 which provides a part of the radio frequency transmission path between each of the branch terminals and the common terminal. A body cap 50 is secured to body 26 by means of screws such as indicated at 51 to provide an enclosed generally cylindrical switching chamber.

For defining a further component part of each radio frequency transmission path within the switch, a generally disk-shaped conductive member 54 is mounted by means of bosses 56, 57, 58 and 59 projecting from the surface 48 of body part 26. Screws are indicated at 62 in FIGURES 1 and 2 for securing the member 54 to the bosses.

A third part of the transmission path between the branch terminals and the common terminal is provided by respective switch blades 70, 71, 72 and 73 which in switching position are adapted to extend intermediate surface 54e of conductive member 54 and surface 48 of body part 26 in parallel spaced relation to the surfaces. Each switch blade such as 70 together with the adjacent portions of surfaces 54a and 48 define what may be termed a tri-plane radio frequency transmission path.

The spacing between the elements of the transmission path is governed by the required characteristic impedance, which may be 50 ohms in the illustrated embodiment. Each switch blade is provided with a conductive contact 77 at its outer end for electrical contact with the end of the corresponding inner conductor 27 as illustrated for terminal 14 in FIGURE 1. The opposite end of each of the switch blades is adapted to overlap and contact a flange 32a of inner conductor 32 of the common terminal 20 as illustrated in FIGURES 1 and 2. It is to be understood that the branch terminals and the central terminal will be matched to a 50 ohm characteristic impedance and will be connected to coaxial lines having a
characteristic impedance of 50 ohms in the illustrated embodiment. In other words, the characteristic impedance of the flat strip transmission lines provided by switch blades 70, 71, 72 and 73 will be equal to the characteristic impedance of the branch terminals such as 14, 15 and 16 and the common terminal such as 20. As indicated for switch blade 72 in FIGURE 1, continuity between a branch terminal and the common terminal may be interrupted by shifting the switch blade in the axial direction out of engagement with inner conductors 27 and 32.

It will be observed that the contact blades 70–73 are are carried by means of ram members such as indicated at 89 having enlarged bead portions 90 against which the blades are seated and retained by means of pins such as indicated at 81. The ram members 80 have caps 83 secured at their opposite ends by means of pins 84, and the caps are guided for axial reciprocation by means of axially aligned apertures 54b of member 54 and 87a of flanges 87 integral with member 54. Springs means as indicated at 90 act between the member 54 and an end portion of each cap 83 to urge the rams to retract the switch blades to the inactive position shown for blade 72 in FIGURE 1.

Shutter 50 is illustrated as having an integral cam member 93 providing a cam surface 93a for controlling the axial position of the ram members 80. The shaft 11 is mounted for rotation on axis 18 by means of bushings 96 and 97 and as it is rotated by motor 12, successively presses the ram members 80 against the action of the springs 90 to successively interconnect the branch terminals with the common terminal 20. It will be appreciated that in the present embodiment, the raised portion 93b of cam surface 93a which presses the successive ram members 80 to actuating position may extend for approximately 90° of the periphery of the cam member 93, so that generally only one of the switch blades will be in the position shown for switch blade 70 in FIGURE 1. In general, the remaining ram members will be engaged with depressed portions 93c of cam surface 93a so that the associated contact blades as a given instance will be in inactive position as shown for contact blade 72 in FIGURE 1.

For insuring that the inactive branch terminals are isolated from the active terminals, a disk-like shutter member 100 of conductive material is provided for sliding engagement with surface 48 and for closing off the inactive terminals as indicated for terminal 16 in FIGURE 1. The shutter member is coupled to a drive element 102 which is secured by means of screws 103 to cam member 93 for rotation therewith. Specifically as illustrated in FIGURES 1 and 2, disk 100 may have portions 104a angularly offset to engage in corresponding notches such as indicated at 103a in drive element 102. As seen in FIGURES 1 and 2, shutter disk 100 is provided with a gap as indicated at 105 so as to accommodate engagement of one of the contacts 77 with one of the branch inner conductors 27, as illustrated for switch blade 70 in FIGURE 1. Since contact is maintained with a given branch conductor for approximately 90° of rotation of cam 93, it will be appreciated that gap 105 must have approximately a 90° expansion. Thus, the successive contacts 77 will be actuated toward active position by cam member 93 after leading gap edge 106 has moved past the respective contacts, and the contacts 77 will be moved to inactive position as indicated for the contact associated with switch blade 72 in FIGURE 1 prior to the trailing gap edge 107 reaching the successive contact positions.

FIGURE 3 illustrates the general arrangement of the cam surface 93a in relation to the shutter gap by means of a diagram showing the periphery of cam member 93 and of shutter 100 in linear development. Assuming the periphery of the cam member 93 of the shutter member 100 to be moving in the direction of arrows 110 and 111, it will be observed that contact member 77 associated with branch terminal 15 will have moved out of engagement with the corresponding inner conductor 27 prior to the time when the contact 77 associated with branch terminal 14 is moved into engagement with the corresponding inner conductor. Further, it is illustrated that leading edge portion of gap 105 will have moved past inner conductor 27 before the associated contact 77 is moved downwardly (in the diagram) by means of sloping cam surface 93d. Similarly, it is illustrated that cap 83 associated with branch terminal 15 will have moved up sloping cam surface 93e to clear the corresponding contact 77 of the corresponding inner conductor 27 before the trailing edge of gap 105 passes the contact position. This operation is termed break-before-make switch operation, since engagement with the inner conductor of terminal 15 is interrupted before continuity is established with the inner conductor of terminal 14, for example.

FIGURE 4 illustrates make-before-break operation wherein the raised cam surface portion 93b is of somewhat greater extent than in FIGURE 3 so that engagement is established at terminal 14 before terminal 15 is disconnected. This type of operation may be termed make-before-break operation.

It will be appreciated that since the shutter 100 is in sliding conductive contact with the conductive surface 48 and with the end of the inner conductors 27, a complete short circuit of the inactive terminals is provided in the illustrated embodiment to completely isolate the inactive terminals from the active terminals.

Summary of operation

In operation, motor 12 is continuously energized to rotate shaft 11 and with it cam member 93, drive element 102 and shutter plate 100. Cam surface 93a is operative to successively depress ram 80 to press the corresponding switch blades 70–73 into the active position shown in FIGURE 1 for switch blade 70. In active position of the switch blade, contact 77 is in engagement with the corresponding inner conductor 27 of one of the branch terminals such as 14 to provide a tri-plane transmission path between the branch terminal and common terminal 20. Inactive terminals have the associated switch blade such as 72 in FIGURE 1 in a retracted position with the corresponding contact 77 spaced from the corresponding inner conductor 27 and with the shutter plate 100 short circuiting the inner and outer conductors of the branch terminals. Thus, if a gap 105 in shutter plate 100 accommodates the active position of the associated contact member 77 as illustrated at the left in FIGURE 1. It will be understood that each of the contact blades 70–73 is moved to active position once each revolution of shaft 11, and remains in active position for from 80 to 90 degrees of rotation of the shaft, for example. The shaft 11 may, for example, rotate at the speed of 18 revolutions per second. The cross talk isolation is insured by having the shutter 100 make intimate conductive contact with surface 48 of the switch body 26.

Clearance is provided between the shutters 77 in inactive position and the shutter 100 as illustrated at the right in FIGURE 1. As illustrated in FIGURES 3 and 4, by changing the length of the raised cam surface portion 93b of cam surface 93a, either break-before-make or make-before-break operation of the switch may be achieved.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A radio frequency lobing switch comprising a housing having a common radio frequency terminal and a plurality of branch radio frequency terminals, means providing a flat planar radio frequency energy guiding surface along the periphery of a cam member 93 of said terminals, means for selectively interconnected said common terminal with each one of said branch terminals
individually in succession, and means synchronized with said interconnecting means for isolating the ones of said branch terminals not interconnected with said common terminal, said interconnecting means comprising radio frequency energy guiding means for actively guiding radio frequency energy along a path between interconnected terminals and movable from an operative position in the path of movement of said shutter means to an inoperative position out of the path of movement of said shutter means.

2. A radio frequency lobing switch comprising a housing having a common radio frequency terminal and a plurality of branch radio frequency terminals having axes parallel to the axes of said common radio frequency terminal, continuously rotatable actuating means rotatable on an axis parallel to the axes of said branch radio frequency terminals for interconnecting said common terminal with each of said branch terminals in succession, and means rotating on an axis coincident with the axis of said continuously rotatable interconnecting means in synchronism with said continuously rotatable actuating means for isolating the ones of said branch terminals not interconnected with said common terminal with each of said branch terminals in succession, and shutter means comprising a disk rotating on said axis with said rotary actuating means for closing off terminals not interconnected with said central terminal and having a gap accommodating interconnection of successive ones of the branch terminals with said central terminal, said rotary actuating means having radio frequency energy guiding means movable into said gap for interconnecting successive ones of said branch terminals with said central terminal.

3. A radio frequency lobing switch comprising a housing having a central common terminal and a plurality of branch terminals disposed about the central terminal and having axes extending parallel to the axes of said central terminal, rotary actuating means rotatable about the axis of said central terminal for interconnecting said central terminal with each of said branch terminals in succession, and shutter means comprising a disk rotating on said axis with said rotary actuating means for closing off terminals not interconnected with said central terminal and having a gap accommodating interconnection of successive ones of the branch terminals with said central terminal, said rotary actuating means having radio frequency energy guiding means movable into said gap for interconnecting successive ones of said branch terminals with said central terminal.

4. A radio frequency switch comprising a housing having a series of radio frequency terminals of predetermined characteristic impedance and having axes extending parallel to each other, means defining a tri plane conductive path for interconnecting said terminals comprising a switch blade defining an intermediate plane and shiftable in a direction parallel to the axes of said terminals to interrupt continuity between the terminals, said triplane conductive path having a characteristic impedance substantially matching the characteristic impedance of said terminals, and shutter means synchronized with the axially shiftable switch blade for closing off a terminal when continuity therewith is interrupted.

5. A switch comprising a plurality of radio frequency terminals of predetermined characteristic impedance and having axes extending parallel to each other, means defining a tri plane conductive path for interconnecting said terminals including a switch blade defining an intermediate plane and shiftable in a direction generally parallel to said axes of said terminals to interrupt continuity between the terminals, said triplane conductive path having a characteristic impedance substantially matching the characteristic impedance of said terminals, and shutter means means rotatable on an axis parallel to said axes of said terminals for shifting said switch blade for engaging and bridging between selected pairs of said inner conductors, and rotary cam means means for actuating said switch blade means to establish and interrupt continuity between said terminals, and rotary shutter means rotatable in synchronism with said interconnecting means for isolating terminals with which the switch blade means is out of continuity.

6. A radio frequency switch comprising a housing having an interior flat planar conductive surface, means comprising a series of apertures in said surface defining radio frequency channels, means comprising shiftable switch blades extending generally parallel to said flat planar conductive surface for establishing continuity between said channels, and switch means operable in synchronism with said switch blades means for shifting said switch blades for engaging and bridging between selected pairs of said inner conductors, and rotary cam means means for actuating said switch blade means to establish and interrupt continuity between said terminals, and rotary shutter means rotatable in synchronism with said interconnecting means for isolating terminals with which the switch blade means is out of continuity.
switch blades for shifting said blades axially of said terminals between an active and an inactive position, rotary cam means for successively actuating said rams, and a flat disk-like shutter plate of conductive material moveable with said rotary cam means and providing a conductive shield between the inner conductors and the associated switch blades when the switch blades are moved to inactive position.

13. A radio frequency switch comprising a central terminal having an axis and a plurality of branch terminals disposed about said axis, switch blade means shiftable generally parallel to said axis to control continuity between said terminals, and rotary shutter means rotatable about said axis and operative to isolate branch terminals with which said switch blade means is out of continuity.

14. A switch comprising a plurality of radio frequency terminals having axes which are parallel but offset, means for selectively establishing continuity between said terminals comprising radio frequency energy guiding means for actively guiding radio frequency energy along a path between a pair of said terminals whose axes are offset, and shutter means in the form of a thin conductive sheet disposed substantially at right angles to said axes of said terminals and movable to substantially cover the area of an unused terminal to isolate the same.

15. A radio frequency switch comprising a plurality of radio frequency terminals having axes which are parallel but offset with respect to each other, means for selectively establishing continuity between said terminals comprising radio frequency energy guiding means for actively guiding radio frequency energy along a path between a pair of said terminals whose axes are offset, and shutter means separate from said continuity establishing means and rotatable about an axis generally parallel to the axes of said terminals and operative to isolate unused terminals.

References Cited in the file of this patent

UNITED STATES PATENTS

1,926,857 Moister --------------- Sept. 12, 1933
2,426,186 Dow -------------- Aug. 26, 1947
2,498,907 Atwood ------------- Feb. 28, 1950
2,576,943 Jenks -------------- Dec. 4, 1951
2,748,208 Koertge -------------- May 29, 1956
2,784,379 Schunemann --------- Mar. 5, 1957
2,846,653 Lanctot ------------- Aug. 5, 1958
2,879,483 Montani 1959 Mar. 24

OTHER REFERENCES
