

June 27, 1961

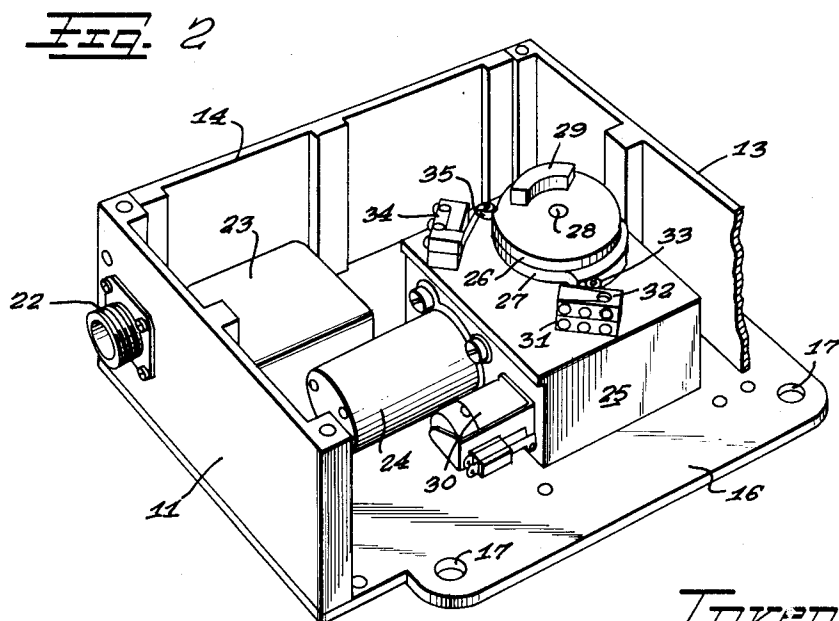
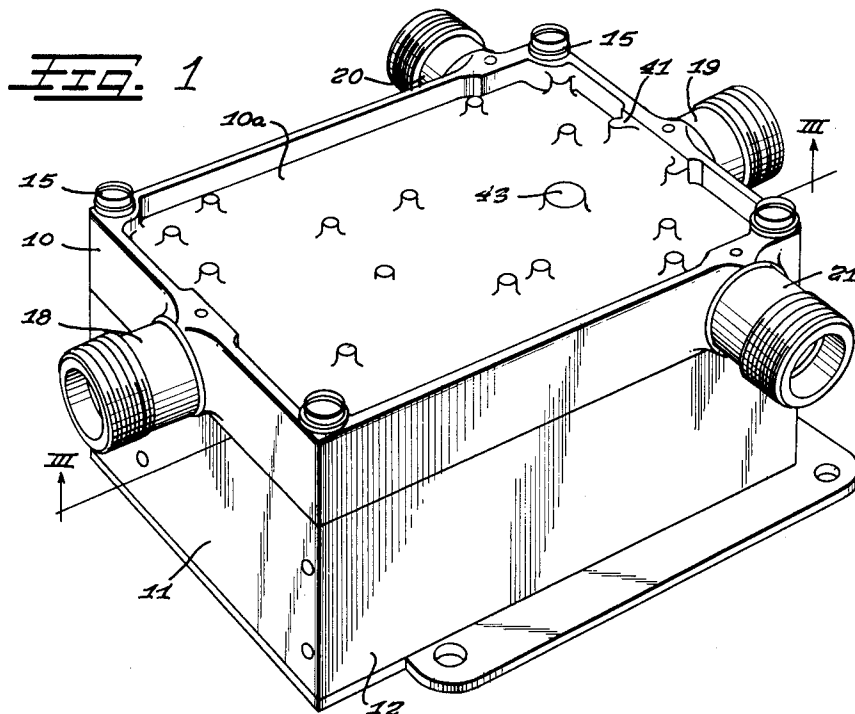
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TRI-PLATE LINE SWITCH AND POWER SPLITTER

Filed Dec. 3, 1958

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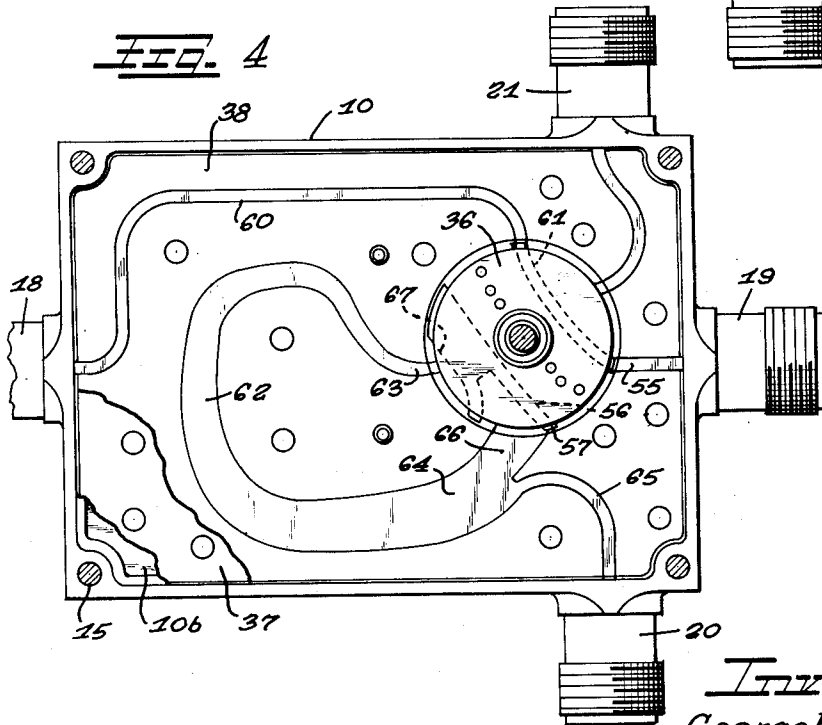
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TRI-PLATE LINE SWITCH AND POWER SPLITTER

3 Sheets-Sheet 2



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TRI-PLATE LINE SWITCH AND POWER SPLITTER

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3 Sheets-Sheet 3

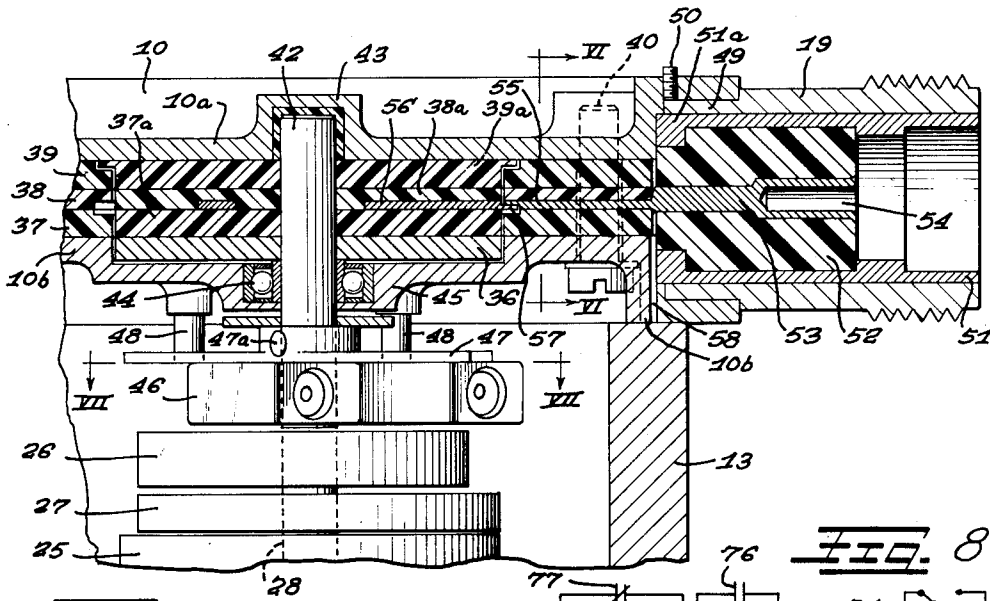


FIG. 5

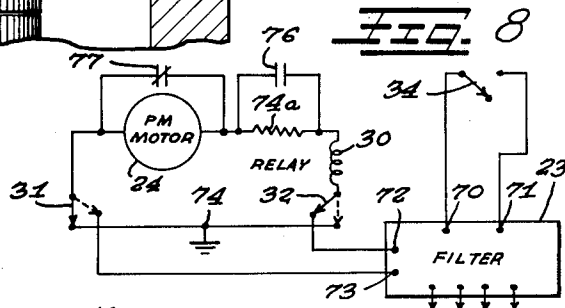


FIG. 8

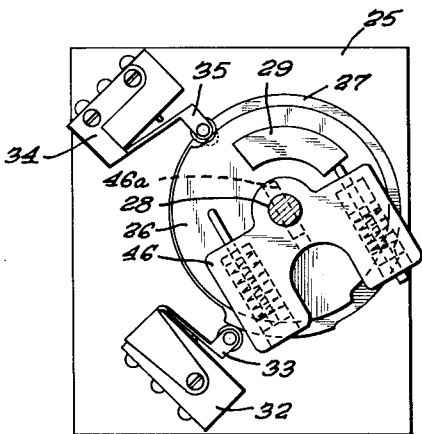


FIG. 7

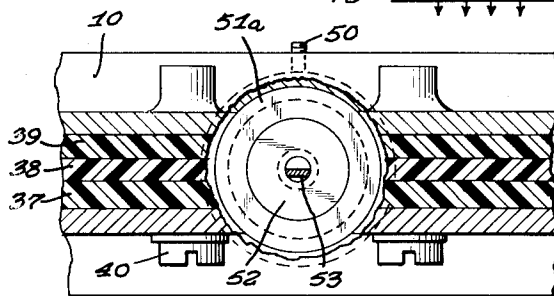


FIG. 6

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2,990,523

TRI-PLATE LINE SWITCH AND POWER SPLITTER

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12 Claims. (Cl. 333-7)

This invention relates to apparatus for performing the combined functions of switching and dividing microwave energy. More particularly, this invention relates to such apparatus utilizing printed circuit board or micro-strip techniques in a tri-plane or tri-plate conductor arrangement such that microwave input energy from one coaxial line may be supplied either entirely to a single output coaxial line or equally divided between three output coaxial lines.

The apparatus of the present invention may for example find application in radar systems wherein it may be desired to supply the output of a transmitter either to a single antenna such as the forward antenna of an airborne three antenna array, or to divide the transmitter output equally between all three antennas. It is a feature of the present invention to accomplish the foregoing result by providing a printed circuit board, a portion of which forms a switch rotor and the whole of which is positioned between two conducting planes to form a tri-plate microwave conducting path. The circuitry on the printed circuit board and rotor is such that in one position of the rotor a fifty ohm line, for example, leads from an input to one output with constant impedance characteristics. In another position of the rotor, the input is connected to all three outputs through a printed circuit which acts as an impedance matching transformer, the impedance at the input being the above-noted exemplary fifty ohms and the impedance at each output being one-third of the input impedance. The rotor may of course be either manually actuated or may be actuated by any suitable known means such as a motor driven actuator to be described below.

It is thus an object of the present invention to provide a tri-plate line switch and power splitter for use in directing microwave energy alternatively either entirely to a single output channel or equally to each of a plurality of output channels.

It is a further object of this invention to provide such apparatus using microstrip printed circuit board techniques to achieve efficiency of operation and economy of manufacture.

It is a further object of this invention to provide apparatus for use both as a switch and as a power divider for microwave energy.

Other objects, features, and advantages of the present invention will be more fully apparent to those skilled in the art from the following detailed description taken in connection with the accompanying drawings in which like reference characters refer to like parts throughout and wherein:

FIGURE 1 is a perspective view of the switch and power splitter assembly.

FIGURE 2 is a perspective view of the structure shown in FIGURE 1 with the top printed circuit board element removed and partially broken away to show the switch actuating mechanism contained in the housing.

FIGURE 3 is a sectional view taken on the line III—III of FIGURE 1 and showing the circuit configuration of the printed circuit board and rotor of the apparatus with the rotor in the position in which the circuit acts as a power divider.

FIGURE 4 is a sectional view similar to FIGURE 3 but showing the rotor in a second position in which all

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of the microwave energy is switched to a single output.

FIGURE 5 is a sectional view taken on the line V—V of FIGURE 3.

FIGURE 6 is a sectional view taken on the line VI—VI of FIGURE 5.

FIGURE 7 is a sectional view taken on the line VII—VII of FIGURE 5.

FIGURE 8 is a schematic circuit diagram of the switch actuating mechanism shown in FIGURE 2.

Turning now to the drawings, there is shown in FIGURE 1 an external perspective view of the tri-plate line switch and power splitter of the present invention. The device generally comprises a substantially rectangular top member 10 which is secured across the tops of four upstanding side walls 11, 12, 13 and 14, by any convenient means such as the screws 15. The side walls are similarly secured to each other and to a bottom or base plate 16 so as to form a box or enclosure having an upper section within the top member 10 in which the printed circuit board and switch rotor are located and a lower section enclosed by the side walls as shown in FIGURE 2 in which the rotor or switch actuating mechanism may conveniently be located. Holes 17 may conveniently be provided in protruding flange portions of the base plate 16 to facilitate mounting of the switch assembly in any convenient location.

As may be seen generally in FIGURE 1, and in greater detail in FIGURES 3, 4, 5 and 6, the device is provided with a single input coaxial fitting 18 and with a plurality of output coaxial fittings such as the forward output fitting 19, the left output fitting 20, and the right output fitting 21. Each of these fittings may be externally threaded to receive standard coaxial cable and are mounted in the top member 10 in a manner which will be described in detail below.

Turning, for the moment, to FIGURE 2, there is shown a partly broken away perspective view of the lower portion of the housing of the device enclosing one type of switch actuating mechanism which may, for example, be used with the line switch and power divider. It will be noted that a power and control cable input fitting 22 is mounted on side wall 11 of the housing. The cable is connected through a radio noise filter 23 to actuate a reversible direct current motor 24 which is preferably of the permanent magnet type. The motor 24 is mounted on the side wall of an interior housing 25, the shaft of the motor being connected to a right angle driving gear mechanism contained in housing 25. This gear mechanism in turn drives a pair of cams 26 and 27 which are mounted one above the other on a common shaft 28. The cam 26 has an upper boss or stop 29 thereon for a purpose which will be described in detail below. Also mounted on the interior housing 25 is a relay 30 and a pair of micro-switches 31, 32, which are operated by a common actuator 33 riding on cam 27. Positioned on the top of interior housing 25 at approximately 90° of rotation about shaft 28 from the micro-switches 31 and 32 is a third micro-switch 34 which is operated by an actuator 35 riding on the edge of cam disc 26. The circuit connections of the elements shown in FIGURE 2 are shown in the schematic circuit diagram of FIGURE 8 and their operation will be discussed below in connection with FIGURE 8.

FIGURES 3 and 4 are elevational plan views of the printed circuit board and rotor contained within the top member 10 shown in FIGURE 1 and are taken on the line III—III of FIGURE 1 looking upwardly at the interior of the top member 10. FIGURES 3 and 4 respectively show the rotor 36 in two different operating positions. FIGURE 5 is a sectional view taken on the line V—V of FIGURE 3 through the rotor 36 and the top member 10 and coaxial fitting 19 with the top mem-

ber 10 positioned on the actuating housing as shown in FIGURE 1. From FIGURES 1, 3, 4 and 5, it will be noted that the top member 10 has a generally rectangular periphery formed by four side walls which are dimensioned to mate with the lower side walls 11, 12, 13 and 14 of the housing. The four side walls of the top member 10 are, however, preferably cast as a single assembly composed of brass or other good electrical conducting material with a generally flat planar top member 10a which may be slightly depressed beneath the tops of the side members as shown in FIGURE 1 and the interior surface of which forms a first conducting plane of the tri-plate conductor arrangement. As may be best seen in FIGURE 5, the second conducting plane of the tri-plate arrangement is formed by a metallic insert 10b which has substantially the same peripheral rectangular dimensions as the surface 10a and which forms mechanically the sixth wall completing the separate enclosure of the top member 10. Of course, the upper or interior surface of the member 10b forms the second conducting plane of the tri-plate arrangement. Sandwiched between the lower metallic plate member 10b and the upper surface member 10a of the top assembly 10 is a first insulating board 37, a printed circuit board 38, and a second insulating board member 39 arranged in stacked relationship as best seen in FIGURE 5. The stacked or sandwiched assembly of the planar top member 10a, insulating board 39, printed circuit board 38, insulating board 37, and lower conducting insert member 10b may be secured together by screws such as the screw 40 which may be received in a boss 41 in the top surface 10a of top member 10. As shown in FIGURES 3 and 4, apertures or holes may be provided as needed for other similar fastening means which may similarly be received in other upstanding bosses shown on member 10a in FIGURE 1.

It will further be noted from FIGURE 5 that the metallic rotor plate 36 is mounted on a shaft 42, the upper end of which is received in a recess in a boss 43 on the upper plate member 10a. Shaft 42 is journaled in ball bearing supports 44 which in turn are mounted in a recessed depending portion 45 of the lower plate insert member 10b. The rotor comprises the metallic disc 36 which is positioned on shaft 42 so that its upper surface is aligned with the upper surface of the plate insert member 10b to form a continuation of the above-noted lower conducting plane of the tri-plate conductor arrangement. Mounted concentrically with the disc 36 on shaft 42 is an insulating disc 37a, a printed circuit board disc 38a, and a second insulating disc 39a which are positioned axially of the shaft 42 so as to have their surfaces aligned with the insulating boards 37 and 39 and the printed circuit board 38 respectively.

Shaft 42 extends downwardly from the boss 43 through the ball bearing drawing arrangement 44 and continues downwardly into the lower switch actuating housing so that it is aligned vertically with the shaft 28 on which the cams 27 and 26 are mounted. The lower extension of the shaft 42 has mounted thereon a switch stopping member 47 and a yoke member 46. These members may conveniently be mounted on the shaft 42 by means of pins passing through holes in the members and in the shaft 42 as shown at 47a in FIGURE 5 and as shown in dotted lines at 46a in FIGURE 7 which is a plan view taken on the line VII—VII of FIGURE 5 and looking downwardly at the top of the gear housing 25. It will be noted that the spring biased plungers in yoke member 46 cooperate with the ends of stop member 29 (which has an arcuate length of slightly less than 90°) to afford a stopping action between the two positions of the rotor. In operation, the motor drives the shaft 28 which drives cams 26 and 27 and thus, the stop member 29 which in turn drives the yoke member 46 after depression of its spring biased plunger. Since the yoke member 46 is rigidly attached to shaft 42, the shaft is rotated and

thereby rotates the rotor assembly 36 which is also rigidly attached thereto. The stop member 47 cooperates with depending stops 48 to assure that the rotor will rotate exactly 90° from one position to the next whereas the spring biased yoke member 46 permits a slight mechanical override in the driving motor in order to permit a transmitter interlock action under the control of microswitch 34 in a manner which will be described in greater detail below. It is sufficient here to note that the mechanism is such that under the control of microswitch 34 the transmitter may be switched off during rotation of the rotor. It will, of course, be understood that this is merely an additional desirable feature of the device and could be omitted if so desired.

The manner in which the four coaxial fittings 18, 19, 20 and 21 are connected into the top member 10 of the instant tri-plate line switch and power splitter may best be seen in FIGURE 5 which includes an axial sectional view of the forward coupling 19 and in FIGURE 6 which is a sectional view taken on the line VI—VI of FIGURE 5. It will be noted that a reduced portion 49 of the generally cylindrical coaxial fitting 19 is seated in a shouldered aperture in the side wall of top member 10 and is firmly secured therein by a set screw 50. An inner conductive member 51 forms a sleeve within coupling 19 and is shaped to receive a standard coaxial line. Mounted within the sleeve 51 is a cylindrical dielectric spacer member 52 having a central bore which receives a center conductor 53 which is slotted at the enlarged end thereof to form an aperture 54 which is adapted to receive the center conductor of the coaxial fitting. Conductor 53 may be soldered or otherwise connected to the portion 55 of the microstrip circuit printed on the printed circuit board 38. The microstrip portion 55 is in turn connected to the printed microstrip section 56 on the rotor portion 38a of the printed circuit board by a contact finger 57 which rotates with the rotor.

As noted above, the microstrip section 55 may be soldered or otherwise connected to the tapered end of the central conductor 53 of coaxial fitting 19. This tapered end may be seen more clearly in that portion of the sectional view of FIGURE 6 which is broken away to show the end of the coaxial fitting which abuts against the shoulder of the aperture in the side wall of top member 10. From FIGURES 5 and 6, it will be noted that an annular member 51a may be positioned to retain the dielectric spacer sleeve 52 in the coaxial fitting when the fitting is assembled to the housing as shown in FIGURE 5. From FIGURE 5, it will also be noted that the bottom plate insert member 10b is recessed peripherally along the area adjacent to the coaxial fitting so as to afford a gap or separation 58 between the coaxial fitting 19 and the bottom plate member 10b. It will, of course, be understood that the other coaxial fittings 18, 20 and 21 are substantially identical to the coaxial fitting 19 shown in FIGURES 5 and 6.

Turning now to FIGURES 3 and 4, there is shown a plan view of the printed circuit board 38 showing the microstrip printed circuitry which forms the center conductor for the tri-plate power splitter and switch, FIGURE 3 showing the rotor 36 in a first position in which the device functions as a power splitter and FIGURE 4 showing the rotor 36 in a second position in which all of the input energy applied to coaxial fitting 18 is conducted to the output coaxial fitting 19. It will be noted that the printed microstrip circuitry consists of a first input portion or section of line 60 which leads from the input coaxial fitting 18 to a point immediately adjacent the rotor 36. It will be noted that the section 60 is of uniform width, W_1 , so that this section of line has a constant impedance of a first value which is selected to match the impedance of the input line for which the device is intended. Typically, the input section 60 may have an impedance of 50 ohms. As shown in dotted lines in FIGURES 3 and 4, the disc shaped printed cir-

cuit board 38a which forms a part of rotor 36 has printed thereon a second section of microstrip line 61. This section of line 61 is of the same width W_1 as the section 60 and may be joined by a contact finger similar to the finger 57 described above.

In the position of the rotor shown in FIGURE 3, the section of line 61 at its output end joins a transformer line section 62 at a point 63 where the width of the transformer line section is the same as the width, W_1 , of sections 60 and 61. Again, a contact finger may be used to make this connection. The section 62 of microstrip line is essentially an impedance matching transformer and accomplishes this function by being gradually increased in width from the point 63 where it has a width W_1 to a point 64 at which it has a width W_2 which is larger than the width W_1 by a factor equal to the ratio of the number of output terminals to the number of input terminals. In the instant case where energy from a single input terminal is to be supplied to three output terminals the width W_2 is three times the width W_1 so that the impedance of the line at this point is one-third of the impedance of the input line. Where the input line has a 50 ohm impedance, in other words, the impedance at the point 64 will be 50/3 ohms. Branching off from the section 62 just beyond the point 64 is another section 65 of microstrip line which has a width equal to the width W_1 of the input line. The section 65 joins the section 64 to one of the output coaxial terminals such as the terminal 20. Beyond the point at which the section 65 branches off is a section 66 of microstrip line which continues the section 62 but has a width which is equal to the width W_2 at point 64 less the width of the section 65. That is to say, in the present case, the section 66 has a width equal to two-thirds of the width at point 64. By virtue of this relationship, one-third of the microwave energy being conducted along section 62 will be diverted through section 65 to the coaxial output terminal 20 whereas two-thirds of the microwave energy will continue along the section 66 to re-enter the rotor 36. On the circuit board portion of the rotor 36 is another section of microstrip line 67 having the same width as the section 66 and being provided with a contact finger to make contact therewith as shown in FIGURE 3. The section 67 of the microstrip line branches into two separate sections each having a width equal to one-half of that of section 67 and hence, each equal to the width W_1 of the input line section 60. These two branching sections 56 and 68 are each provided with suitable contact fingers as noted above. The contact finger 57 on section 56 makes contact with the section 55 on the printed circuit board 38 and thereby conducts a second third of the microwave energy to the forward output coaxial terminal 19. The rotor line section 68 is connected through its contact finger to a section 69 of microstrip transmission line printed on board 38 which has a width equal to the width W_1 of section 60 and which therefore conducts the final one-third of the microwave energy to the coaxial output terminal 21. It is thus seen that in the position of the rotor shown in FIGURE 3, the device functions as a power splitter, the sections 62, 65, 66, 56, and 68, acting as an impedance matching transformer and power divider. In this position of the rotor shown in FIGURE 3, one-third of the microwave energy supplied to input coaxial fitting 18 will be conducted to each of the output coaxial fittings 19, 20 and 21 respectively.

In the position of the rotor shown in FIGURE 4, it will be noted that the rotor 36 has been rotated 90° in a clockwise direction as viewed in FIGURE 4 from the position it occupies in FIGURE 3. This rotation is, of course, accomplished by the switch actuating mechanism as described above in response to an appropriate input signal to the motor control circuitry or, alternatively, the rotor could be manually operated between stops such as those shown in FIGURE 5.

In FIGURE 4, it will be noted that the microstrip section 61 on the rotor joins the input line 60 on the printed circuit board with the section 55 leading to the output coaxial fitting 19. This result follows from the fact that the length of arc of the rotor 36 between the point at which the input line 60 joins the rotor and the point 63 at which transformer section 62 joins the rotor is equal to the rotor arc length between the input point of line 60 and the point at which the section 55 of output line joins rotor 36 so that these two equal sections of arc subtend equal angles at the center of the rotor. That is to say, the angular separation with respect to the center of the rotor of the input line and the transformer output section is equal to the angular separation between the input line and the output section 55. Hence, when the rotor is rotated through an angle equal to this angular separation, which in the present exemplary embodiment is shown as being substantially 90°, the section 61 of microstrip line on the rotor will be moved from a position in which it joins the input section 60 to transformer section 62 to a position in which it joins the input section 60 to the output section 55 which, like the rotor section 61, has the same width as the input section 60. Hence, in this second position shown in FIGURE 4, all of the microwave input energy will be conducted over a constant impedance line to the output terminal 19. In the position shown in FIGURE 4, the transformer section 62 is open circuited, inasmuch as there is no connection through the rotor from the input line 60 to transformer section 62.

The control circuitry by which the switch actuating mechanism shown in FIGURES 2, 5 and 7 may be controlled to rotate the rotor between the two different positions shown in FIGURES 3 and 4 is illustrated in the circuit diagram of FIGURE 8. Connection is, of course, made from the input terminal 22 to the radio noise filter 23 which may be of any standard commercially available type. First and second output terminals 70 and 71 on the radio noise filter are connected to the opposite sides of the microswitch 34 which is controlled by the cam 27 in such a manner that the switch 34 is open during the switching interval. That is to say, the cam 27 is shaped so that the switch 34 will be closed when rotation is such as to position the rotor 36 in either of the positions shown in FIGURES 3 and 4 but will be open during any intermediate position. This circuit is independent of the rest of the circuitry shown and functions merely as an interlock to shut off the transmitter supplying input power to the coaxial fitting 18 during the actual switching operation from the position shown in FIGURE 3 to that shown in FIGURE 4 or vice versa.

As noted above, the motor 24 is preferably of the direct current permanent magnet type which is such that the direction of rotation of the motor is dependent upon the polarity of the supply voltage applied thereto. Motor 24 is connected in circuit between terminals 72 and 73 on the filter 23 to either of which a positive voltage may be selectively applied. The motor circuit is completed alternatively through either microswitch 31 or microswitch 32 and thence in one direction or the other through the motor to a common ground terminal 74 which in practice may also be provided for on the filter 23. Specifically, it will be noted that one possible circuit through the motor 24 includes the terminal 72 on the filter, the microswitch 32 which in the position shown in FIGURE 8 connects a relay coil 30 to the terminal 72. Relay coil 30 is connected through a current limiting resistor 74 which is in turn connected to one side of the motor 24. The other side of motor 24 is connected through microswitch 31 to the ground terminal 74 thereby completing the motor circuit for one direction of rotation. It will be noted that current limiting resistor 74 is connected in parallel with a pair of normally open relay contacts and that a pair of normally closed relay contacts are connected in parallel with the motor 24. When the relay

30 is energized, the normally open contacts 76 are closed thereby shorting out the current limiting resistor 74a and the normally closed contacts 77 are open thereby placing the motor 24 in the circuit. The function of the current limiting resistor 74a and the relay contacts 76 and 77 is of course to prevent excessive current from flowing through the motor until such time as the relay is actuated. Application of a positive voltage to the terminal 72 will thus actuate the motor 24 through the above-discussed circuit and the motor will drive the cams 26 and 27 until the cam surfaces reverse the relative positions of microswitches 31 and 32. When this happens, the terminal 72 on the filter is open circuited and the motor 24 will stop. The circuit is then left in a condition such that the application of a positive voltage to the terminal 73 will actuate the motor 24 to operate in the opposite direction so that the rotor may be turned back to the other position from which it had previously been rotated. The circuit through which this is accomplished is indicated by the dotted line showing of the switch arms of the microwave switches 31 and 32. This circuit will be seen to include the terminal 73, the microswitch 31, the opposite side of motor 24, the original side of motor 24, the relay 30, the microswitch 32 in its dotted line position, and the common ground terminal 74. It is thus apparent that a positive voltage applied to terminals 72 or 73, selectively, will also actuate the rotor to the position shown in FIGURE 4 wherein the device functions as a single pull-single throw switch to conduct microwave energy from the input terminal 18 to the output terminal 19.

Many modifications and variations of the device are of course possible. It may, for example, be preferred to support the upper end of shaft 42 on a ball bearing rather than a sleeve mount. Also, the printed circuitry may be placed on either or on both sides of the printed circuit board.

While a particular exemplary preferred embodiment of the present invention has been described in detail above, it will be understood that modifications and variations therein may be effected without departing from the true spirit and scope of the novel concepts of the present invention as defined by the following claims.

I claim as my invention:

1. A line switch and power splitter for microwave energy comprising, an input terminal, a plurality of output terminals, a rotor member, first and second separate and coplanar microwave conductors on said rotor member, first stator microwave conductor means positioned in a first rotary position of said rotor to connect said input terminal to only one of said output terminals through a circuit including said first rotor conductor, and a second and separate stator microwave conductor means coplanar with said first stator conducting means and positioned in a second rotary position of said rotor to connect, with said first stator conductor, said input terminal to all of said plurality of output terminals in parallel circuit relation to each other through a circuit including both said first and second microwave coplanar conductors of said rotor member.

2. A line switch and power splitter for microwave energy comprising, an input terminal, a plurality of output terminals, a rotor member, a first stator microwave conductor having an impedance substantially uniform along its length leading from said input terminal to said rotor, a second stator microwave conductor having the same impedance uniform along its length as said first conductor and leading from said rotor to one of said output terminals, a third microwave conductor mounted for rotation with said rotor and having the same impedance uniform along its length as said first conductor, said third microwave conductor being positioned on said rotor to connect said first and said second conductors to each other in one rotary position of said rotor, a branched stator microwave conductor having an impedance varying sub-

stantially uniformly along its lengths leading from said rotor, said third microwave conductor on said rotor being positioned to connect said first microwave conductor to said branched conductor in a second rotary position of said rotor, and a plurality of output microwave conductors each having the same impedance uniform along their lengths as said first conductor and each connecting one branch of said branched conductor to one of said output terminals in said second rotary position of said rotor, said branched conductor being open circuited in said first rotary position of said rotor and being connected to act as an impedance matching transformer in said second rotary position of said rotor.

3. A tri-plate line switch for microwave energy comprising, a coaxial input terminal, a plurality of coaxial output terminals, means providing a box-like switch casing comprising first and second spaced apart parallel, stator, conducting plates electrically and structurally connecting the outer conducting portions of said coaxial terminals and also forming the top and bottom of said box-like switch casing, a pair of stator insulating sheets between said stator plates, an inner stator printed circuit board engaged between said insulating sheets to form a stator unit therewith, the stator unit, comprising said printed circuit board and said stator insulating sheets, having a circular aperture therethrough, a rotor unit comprising an inner printed circuit board disc and an insulation disc engaging it on each side thereof to provide a unit therewith, said rotor unit being mounted in said aperture with its circuit disc in substantially co-planar relationship with said stator printed circuit board, said stator printed circuit board having a plurality of sections of microstrip conductor printed thereon connecting each of said terminals to a point adjacent said rotor, said printed circuit board rotor disc having at least one section of microstrip conductor printed thereon and extending between two points adjacent the periphery of said disc, and contact finger means to connect the two ends of said microstrip section on said rotor disc to each of predetermined pairs of said microstrip sections on said printed circuit board in at least two different rotary positions of said rotor.

4. A tri-plate line switch and power splitter for microwave energy comprising, a coaxial input terminal, a plurality of coaxial output terminals, first and second spaced parallel conducting plates connecting said terminals, a printed circuit board having insulation on each side thereof engaged between said conducting plates to form a stator unit therewith, only said printed circuit board and its said insulation having a circular aperture therethrough, a rotor disc unit including a printed circuit board disc and insulation on each side thereof mounted in said aperture in substantially co-planar relationship with said printed circuit board, first and second separate and coplanar microstrip conductors on said rotor disc, microstrip circuit means positioned on said coplanar circuit board to connect said input terminal to only one of said output terminals through a circuit including said first rotor conductor in a first rotary position of said rotor, and further microstrip conductor means on said circuit board positioned to connect said input terminal to all of said output terminals in parallel circuit relation with each other through a circuit including both said first and second coplanar microstrip rotor conductors in a second rotary position of said rotor.

5. A tri-plate line switch and power splitter for microwave energy comprising, a coaxial input terminal, a plurality of coaxial output terminals, first and second spaced, parallel, and stator conducting plates connecting said terminals, a pair of stator insulating sheets therebetween, a stator printed circuit board engaged between said insulating sheets, said stator insulating sheets and said printed circuit board having a circular aperture there-through, a rotor member including a pair of insulating

discs and a printed circuit board disc therebetween mounted in said aperture with said circuit disc in substantially co-planar relationship with said stator printed circuit board, a first stator microstrip conductor having an impedance substantially uniform along its length leading from said input terminal to said aperture, a second stator microswitch conductor having the same impedance substantially uniform along its length and leading from said aperture to one of said output terminals, a third microstrip conductor printed on said rotor disc and having the same impedance substantially uniform along its length, said third rotor microstrip conductor being positioned on said rotor to connect said first and second stator conductors to each other in one rotary position of said rotor, a branched stator microstrip conductor having an impedance varying substantially uniformly along its several lengths on said circuit board leading from said aperture, said third rotor microstrip conductor on said rotor being positioned to connect said first stator microstrip conductor to said branched stator conductor in a second rotary position of said rotor, and a plurality of separate output microstrip conductors coplanar with each other and with said third rotor conductor and each having the same impedance as said first conductor and each connecting one branch of said branched conductor to one of said output terminals in said second rotary position of said rotor, said branched conductor being open circuited in said first rotary position of said rotor and being connected in a circuit to act as an impedance matching transformer in said second rotary position of said rotor.

6. A line switch and power splitter for microwave energy comprising, an input terminal, a plurality of output terminals, a rotor having first and second coplanar microwave conductors thereon, a first, stator, microwave conductor means having an impedance substantially uniform along its length and positioned to connect said input terminal to only one of said output terminals through a circuit including said first rotary rotor conductor in a first position of said rotor, and a second, stator, and branched, microwave conductor means, having an impedance changing substantially uniformly along its several lengths, and positioned to connect said input terminal to all of said output terminals in parallel circuit relation to each other through a circuit including both said first and second microwave conductors of said rotor in a second rotary position of said rotor.

7. A tri-plate line switch and power splitter for microwave energy comprising, an input terminal, a plurality of output terminals, first and second spaced parallel conducting plane members connecting said terminals, a printed circuit board disposed in parallel spaced insulated relationship between said conducting planes, said printed circuit board defining an aperture therein, a rotor member including a printed circuit board disc mounted in said aperture in substantially co-planar relationship with said printed circuit board, said printed circuit board having a plurality of sections of microstrip conductor printed thereon connecting each of said terminals to a point adjacent said rotor, said printed circuit board rotor disc having at least two sections of microstrip conductor printed thereon each extending between two points adjacent the periphery of said disc, a tapered branched microstrip conductor on said printed circuit board extending between two points adjacent said rotor, means to connect the two ends of one of said microstrip sections on said rotor to each of two of said microstrip sections on said printed circuit board in at least one position of said rotor to connect said input terminal to only one of said output terminals, and means to connect the two ends of both of said microstrip sections on said rotor in circuit with said first and said branched microstrip sections on said printed circuit board in a second position of said rotor to connect all of said output terminals in parallel to said input terminal, said branched

conductor being open circuited in said first position of said rotor and being connected in circuit to act as an impedance matching transformer in said second position of said rotor.

8. A line switch and power splitter for microwave energy comprising, an input terminal, a plurality of output terminals, a rotor member, first and second separate and coplanar microwave conductors on said rotor member, a first stator microwave conductor means having an impedance varying substantially uniformly along its length and positioned to connect said input terminal to only one of said output terminals through a circuit including said first rotary rotor conductor in a first position of said rotor, and a second stator and branched microwave conductor means having an impedance varying substantially uniformly along its several lengths and positioned to connect said input terminal to all of said output terminals in parallel circuit relation with each other through a circuit including both said first and second microwave conductors of said rotor in a second rotary position of said rotor, said second stator and branched microwave conductor means having portions arranged so that it is open circuited in said first rotary position of said rotor and so that it acts as an impedance matching transformer in said second rotary position of said rotor.

9. A line switch to select between different lines combined with a power splitter to divide microwave energy from a single input equally between at least three outputs, comprising an input terminal, at least three output terminals, a rotary selecting, switching disc having, on a face thereof, a plurality of coplanar and separate conductive strips extending to the periphery thereof, and, of which, at least one is branched to connect one station on said periphery to two stations on said periphery, a stator member surrounding said disc and having thereon a plurality of stator, circuit forming, conductor strips coplanar with each other and with said disc conductor strips and each connecting each of said terminals to peripherally spaced stations adjacent the periphery of said disc to selectively connect said input terminal to only one of said output terminals in one selected, rotary position of said disc and to selectively connect said input terminal to at least three outputs in parallel relation to each other in a second, selected, rotary position of said disc, said stator conductor strips including at least one which is branched to connect one of said terminals to said two peripheral stations of said branched rotor conductor strip.

10. A tri-plate combined and coplanar power splitter and line switch comprising an input, and a plurality of output, coaxial terminals all substantially coplanar with each other and generally radially inwardly directed, a pair of substantially parallel and spaced apart, conductive plates electrically connected to the outer conductive portions of all of said coaxial terminals, said plates engaging a pair of insulating sheets having a conductor carrying board engaged therebetween, said sheets and said board having a circular opening therethrough and forming a stator switch unit with conductive plates, a rotary switch disc unit in said circular opening and comprising outer insulating sheets, an inner conductor carrying disc engaged therebetween and using the stator conductive plates as its outer tri-plate conductors, a plurality of separate and coplanar conductor strips on only one face of said conductor carrying disc and a plurality of separate, stator, conductive strips coplanar therewith, and connected to all said terminals, to be engaged in a plurality of selected rotary positions by said disc conductor strips to connect said input to only one of said outputs in a first rotary position of said disc unit and to connect said input to a plurality of said outputs in parallel with each other through a circuit including a plurality of said

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separate rotor conductor strips in series with each other, in a second rotary position of said disc unit.

11. A tri-plate line switch and power splitter for microwave energy comprising, a coaxial input terminal, a plurality of coaxial output terminals, a stator printed circuit board having insulation on each side thereof, said printed circuit board and its insulation having a circular opening therethrough, a rotor unit comprising a printed circuit board disc having insulation on each side thereof and mounted for rotation in said circular opening of said stator printed circuit board and its insulation and in substantially co-planar relationship therewith, a plurality of separate and co-planar sections of microstrip conductor printed on said stator circuit board and a plurality of separate and co-planar sections of microstrip conductor printed on said rotor disc, means forming first and second spaced parallel conducting plates connecting said terminals and in tri-plate relationship with said stator conductors and said rotor conductors, said microstrip conductor sections of said stator and of said rotary disc being so positioned that in one rotary position of said rotor said input terminal is connected to only one of said output terminals and in another rotary position of said rotor said input terminal is connected to a plurality of said output terminals through a circuit including said plurality of separate conductor sections of said rotor providing an impedance matching transformer with constant impedances in said first and in said second rotary positions of said rotor.

12. A combined and co-planar, tri-plate type, power splitter and line switch comprising an input, and a plurality of output, terminals, all substantially co-planar with each other and generally radially inwardly directed, a pair of insulating sheets having a printed conductor carrying board engaged therebetween, said sheets and

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said board having a circular opening therethrough and forming a stator switch unit, a rotary disc unit in said circular opening and comprising outer, insulating sheets and an inner, conductor carrying, disc engaged therebetween, means forming a pair of conductor surfaces on either side of said insulating sheets connected to provide a tri-plate arrangement for the conductors of said stator and for the conductors of said rotor, a plurality of separate and co-planar conductor strips on one face of said conductor carrying disc and a plurality of separate stator conductor strips co-planar therewith and connected to all said terminals to be conductively engaged in a plurality of selected, rotary positions by said disc conductor strips to connect said input to only one of said outputs through only one of said plurality of conductor strips on said disc in a first rotary position of said disc unit and to connect said input to a plurality of said outputs in parallel with each other through a circuit including said plurality of separate and co-planar conductor strips on said disc in a second rotary position of said disc unit.

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