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ANTENNA FEED SELECTOR SYSTEM

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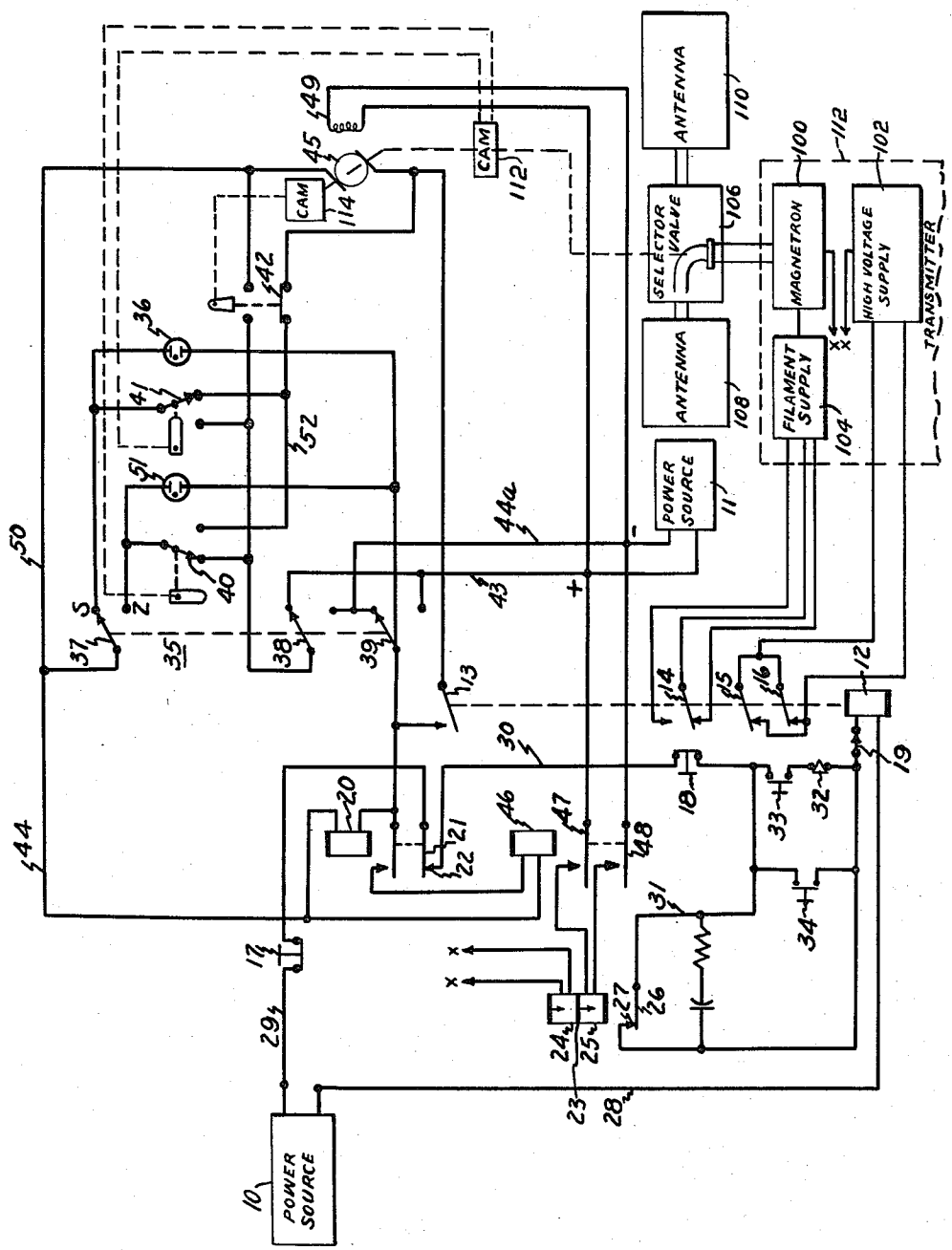

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ANTENNA FEED SELECTOR SYSTEM

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This invention relates to control circuits and more particularly to an electric circuit adapted to control a mechanism located between a main input feed means and a plurality of branch feed means the said mechanism being adapted to selectively join the input feed means to one of the branch feed means.

In radar systems used aboard ship it has been found that a suitable antenna arrangement includes a plurality of separate antennas any one of which may radiate the high frequency energy pulses generated by the radar transmitter. Each of the separate antennas is designed to radiate the energy in a predetermined area and range pattern, the radiation patterns of the plurality of antennas combined providing ample detection coverage. The preferred embodiment of the invention dislcosed is an electrical control system for switching the energy output of the radar transmitter between either of two antennas, one of which is designed for surface search and the other for zenith search.

An object of this invention is to provide a system arranged to control the continuity between an input energy conduit and any one of a plurality of branch conduits or any one of a plurality of energy utilizing means.

A further object is to provide a system adapted to selectively complete the continuity between an input energy conduit and any one of a plurality of energy utilizing means and to discontinue the energy feed during the period that the continuity is broken.

A further object is to provide a system adapted to control the coupling of a radar transmitter waveguide to either of two antennas and additionally arranged to discontinue the generation of high frequency energy pulses during the period of decoupling.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

The single figure is a circuit diagram of a preferred embodiment of the control system of this invention.

The control system is energized from two separate power sources 10 and 11. The source 10 supplies the energy needed to operate the radiation control relay 12 which relay includes contactors 13, 14, 15 and 16. The circuit joining the source 10 to relay 12 includes among other elements three normally closed manually operable switches 17, 18 and 19. The switches 17 and 18 are conveniently located to terminate radiation when desired. Switch 19 may be a safety cutoff switch such as may be found adjacent the door of a chassis cabinet. Any convenient number of these switches may be incorporated into the circuit. The contactor 21 and stationary contact 22 are also in the circuit of relay 12. During normal operation with either the zenith antenna or the surface antenna coupled to the transmitter waveguide the intermediate relay 20 is deenergized. The latter will become evident as the description proceeds. When the relay 20 is deenergized the contactor 21 and the stationary contact 22 are engaged and are in the energizing circuit of relay 12.

The further relay 23 has two separate energizing coils 24 and 25. The coil 24 is connected in series with the magnetron 100 and therefore during normal operation of the associated radar equipment the coil 24 is energized retaining the contactor 26 in engagement with the fixed contact 27.

Under the operating conditions described the coil of relay 12 is connected across power source 10 by lead 28 which connects one side of power supply 10 to one side of the coil of relay 12 and by a second lead 29 having normally closed switch 17 which lead is electrically connected to lead 30 through contacts 21 and 22, the lead 30 having normally closed switch 18, and through the lead 31 having the closed relay contacts 26 and 27 to the other side of the coil of relay 12 through normally closed switch 19.

If the circuit is undisturbed the relay 12 remains energized and its contactors 13, 14, 15 and 16 occupy the positions shown on the drawing. The purpose of contactor 13 will be subsequently described. The contactors 15 and 16 control the application of high voltage from high voltage supply 102 to the magnetron 100. When contactors 15 and 16 are engaged with their corresponding stationary contacts the high anode-cathode voltage for the magnetron 100 is turned on and when they are disengaged the high voltage for the magnetron 100 is turned off. The contactor 14 controls the filament supply 104 for the magnetron 100. In the position of the contactor 14 shown on the drawing, reduced heater voltage is provided by the filament supply 104; the magnetron cathode is kept hot by bombardment during operation. When the high voltage supply 102 is turned off that is, when contactors 13, 14, 15, and 16 are in their raised positions, enough heater voltage is provided by the filament supply 104 to maintain the magnetron 100 in standby condition. When the high voltage supply 102 for the magnetron is turned on, radiation is turned on and when the high voltage supply 102 is turned off, radiation is turned off.

Radiation may be terminated at any time by actuation of either of the manual switches 17 and 18 since either switch when actuated decouples the relay 12 from the power source 10 permitting the relay 12 to become deenergized. Immediately after the relay 12 is deenergized the magnetron current drops to zero because high voltage supply 102 is shut off when contactors 15 and 16 become disengaged from their stationary contacts. The relay 23 is designed for delayed opening of its contactor 26 in any manner well known in the art. Since the coil 24 is connected in series with the magnetron 100, the coil 24 is deenergized when the magnetron current flow ceases; a predetermined time interval after current flow through coil 24 ceases the contactor 26 is permitted to become disengaged from contact 27.

The member 32 is an interlock switch which is adapted to be coordinated with an associated part of the radar equipment. The interlock switch 32 is in series with the normally open switch 33. The normally open switch 34 is connected in shunt with the combination of the interlock switch 32 and the normally open switch 33. When the radiation is turned off closing the switch 33 will initiate radiation assuming the necessary conditions are existent for the interlock switch 32 to be in closed circuit position. In the event that it is necessary to initiate radiation regardless of the position of the interlock switch 32 the switch 34 may be actuated. Even though either of the switches 33 and 34 are only momentarily actuated, the radiation stays on because the magnetron current passing through coil 24 causes the latter to close the contacts 26 and 27. Contacts 26 and 27 connect the relay

12 across the power source 10 in the manner previously described.

Microwave energy generated in the magnetron 100 is channeled to selector valve 106. The selector valve 106 is adapted to occupy one position where it transfers the microwave energy to antenna 108 and is adapted to occupy another position where it transfers the microwave energy to antenna 110.

A triple-pole double-throw manually operable switch 35 controls the switchover from one antenna to the other. With the switch 35 in position as shown the selector valve 106 occupies the positions where it channels microwave energy from the magnetron 100 to the surface antenna 108 and the indicator lamp 51 is lighted. The lamp 51 is connected in series with the switch 40 across the power source 11.

The switch 35 comprises three contactors 37, 38, and 39. The contactors 38 and 39 and their corresponding stationary contacts constitute a polarity reversing switch in series with power source 11. When the switch 35 is thrown from the S to the Z position the relay 20 is energized. The coil of relay 20 is connected to one side of source 11 through contactor 39 in circuit with lead 43 and to the other side of source 11 through the lead 44, the contactor 37 in Z position in circuit with the switch 40 as shown and the contactor 38 in its other position than shown. As the relay 20 is energized the relay 12 is deenergized due to the separation of contacts 21 and 22. When relay 12 is deenergized its contactors 13 through 16 assume their other positions as previously described in which position radiation ceases. It is to be noted that the contactor 13 in circuit with motor armature 45 does not close until contactors 15 and 16 are in open position wherein radiation ceases. This feature prevents damage resulting from R.F. arcing due to switching the antenna selector valve while the transmitter is supplying the high frequency energy.

As soon as the relay 20 is energized and its contactors have moved to their raised positions the relay 46 whose contactors 47 and 48 are subject to the delayed release feature is connected in parallel with relay 20 whereby it also is energized from source 11. In rapid sequence the coil 25 of the holding relay 23 is likewise connected across supply 11 through contactors 47 and 48. By this means the holding relay 23 retains the contacts 26 and 27 in engagement. Because relay 23 has a delayed opening, contactor 26 will remain in engagement with contact 27 between the time coil 24 is deenergized and coil 25 is energized. Relay 12 remains deenergized due to the separation of contactor 21 from contact 22.

The plurality of contactors of relay 12 assume their new positions substantially instantly after the switch 35 is thrown to its other position. The motor armature 45 begins to rotate since it is put in circuit with supply 11 by contactor 13. The motor field coil 49 is continuously connected across supply 11. Closure of the motor circuit by contactor 13 actually puts the armature 45 in parallel with relay 20.

The selector valve 106 is linked to the motor armature 45 by means of any suitable coupling arrangement that can function to accurately position the valve in either of its two positions. There can be used a Geneva wheel and cam preferably of the type disclosed in U.S. Patent #2,798,208 of July 2, 1957. The Geneva wheel would be coupled to the selector valve 106 and the Geneva cam would be coupled to the motor armature 45. The switches 40 and 41 are operated by one cam 112 which is rotatable with the selector valve 106 while the switch 42 is operated by a cam 114 which is coupled to the motor armature 45. The switch operating cams are so designed that none of the switches are depressed during rotation of the selector valve. When the valve is in the position for coupling the transmitter 112 to the surface antenna 108, switches 41 and 42 are depressed, whereas when the transmitter is coupled to the zenith antenna 110, switches 40 and 42 are depressed.

On the drawing the contactors of switches 40 and 41 are over to the left and the contactor of switch 42 is in raised position during the period of motor rotation. As soon as the valve approaches its other end position one of the switches 40 or 41 is depressed depending on whether the valve is rotated into surface or zenith position and shortly after this and just before the motor shaft reaches the end of its travel, switch 42 is depressed. In its released position switch 42 serves to by-pass either switch 40 or 41 and to maintain the circuit to relay 20 through leads 50 and 44 in the interval from that moment when switches 40 for zenith or 41 for surface are released to the moment when switch 42 is depressed. (This interval is necessary so that the motor shaft may continue to turn after the switches 40 or 41 have been depressed in order to properly lock the Geneva cam and wheel.) Switch 42 serves to close a shorting path across the motor armature of 45 to produce dynamic braking.

During the period of motor rotation switch contactor 42 is in raised position and as previously explained the contactor 13 is in closed circuit position whereby the motor armature 45 is directly across the power source 11. This is true for both positions of switch 35.

In operation when the radar is radiating and the selector valve is on surface search, the circuit is as follows:

(1) Switches 41 and 42 are depressed by their cams.

(2) Switch 40 is released.

(3) Radiation relay 12 is energized and its contactor 13 is in open position.

(4) Relay 20 is non-energized and its contacts 21 and 22 are closed. The other set of contacts are open, deenergizing relay 46 and the holding winding 25 of relay 23.

(5) Surface indicator lamp 51 is glowing, its voltage being supplied as follows: one side of source 11 through contactor 39, the other side of supply 11 through contactor 38 and switch 40.

(6) Zenith indicator lamp 36 is not glowing, being connected to only one lead of the source 11.

(7) The motor armature 45 is shorted through the contactors 42, 41 and 37.

When the switch 35 is thrown from S to Z, the sequence of the circuit actions is as follows:

(1) Surface indicator lamp 51 continues to glow.

(2) Relay 20 is connected to supply 11 through lead 43 in circuit with contactor 39 on one side and lead 44*a* in circuit with contactor 38 and thence through the contactors 40 and 37 to the other side of relay 20. Its contacts 21 and 22, which control relay 12, open. The second set of contacts on relay 20 are closed energizing relay 46 which in turn energizes the holding winding of relay 23, which is holding on delayed release, and maintains the shunt 26, 27 across the switches 32, 33 and 34. The contacts 26 and 27 are shunted by a resistor condenser combination to extend their period of usefulness in the manner well known in the art.

(3) After the brief interval required for relay 12 to open, this relay is completely deenergized, shutting down the radiation by turning off the high voltage and closing contactor 13 and its mating contact.

(4) The motor armature 45 is connected to power source 11 and rotates selector valve 106. One side of the motor armature 45 is coupled to supply 11 through the lead 43 in circuit with contactors 39 and 13. The other side of the motor is coupled to supply 11 through lead 50 in circuit with contactors 37 and 40 and thence through contactor 38 to lead 44*a*.

(5) As the motor 45 begins to rotate the switches 41 and 42 are released in order, the switch 40 already having been released.

Zenith indicator lamp 36 begins to glow and surface indicator lamp 51 continues to glow.

(6) When the switch 42 is released its contactor opens an additional path from one side of the motor to the supply 11. The motor continues to rotate.

(7) When the associated Geneva wheel (not shown) completes the partial rotation for which it is designed, one switch cam depresses switch 40 and as the Geneva cam (also not shown) completes its rotation switch 42 is depressed by the other switch cam. Switch 41 remains released. Surface indicator lamp 51 will go out as switch 42 is depressed and breaks its released position circuit.

(8) The motor stops abruptly since dynamic braking is applied by shorting the armature through contactors 42, 40 and 37.

(9) Zenith indicator lamp 36 remains glowing since it has one side connected to one lead 43 of the supply through contactor 39, and its other side connected to the other lead 44a through contactor 38 and switch 41.

(10) Simultaneously with step (7), both sides of relay 20 are connected to one side of the power source 11, and since there is no potential difference across its winding, the relay is deenergized. In parallel with relay 20 is relay 46, but due to the delayed-release feature of relay 46, the holding coil of relay 23 remains energized for a further short period of time and maintains the shunt across the switches 32, 33, and 34. The deenergizing of relay 20 permits contacts 21 and 22 to close, reenergizing relay 12, and radiation commences again. Magnetron current builds up in the undercurrent winding 24 of relay 23 in sufficient time to keep contactor 26 engaged with contact 27. When the time lag of relay 46 has elapsed, its contacts open and the holding coil of relay 23 is deenergized. The radar is now operating on zenith search.

When the radar is radiating and the selector valve is on zenith search, the circuit is as follows:

(1) Switches 40 and 42 are depressed.

(2) Switch 41 is released.

(3) Radiation relay 12 is energized and its contactor 13 is in open position.

(4) Relay 20 is non-energized and its contacts 21 and 22 are closed.

(5) The zenith indicator lamp 36 is glowing, its voltage being supplied as follows: the lead 43 from supply 11 through contactor 38 and thence through switch 41 in the released position.

(6) The surface indicator lamp 51 is not glowing having only one side connected to source 11 and being shorted by the coil of relay 20 by way of lead 44 and contactor 37 in the Z position.

(7) The motor armature 45 is shorted through the contactors 42, 40 and 37.

In switching from zenith search back to surface search the sequence of circuit actions is similar in principle to that given above, except that the supply 11 is now reversely connected to motor armature 45, causing it to rotate in the opposite direction. When the action is completed the surface indicator lamp 36 glows and radiation is restored automatically. When the system is not radiating and switch 35 is thrown from S to Z or from Z to S the circuit behaves differently than described above under radiating conditions. The principal difference is in the operation of relay 23 in that it does not close when switch 35 is thrown from S to Z or from Z to S and energy is supplied to its coil 25 as explained previously. The energy supplied to coil 25 is sufficient to maintain the relay in its energized position if it has been previously energized and is holding with delayed release energy but is insufficient to operate the relay from a deenergized position. Since relay 23 does not initially operate, the circuit to relay 12 through contacts 26 and 27 remains open during the rest of the cycle and relay 12 does not operate and radiation does not start when relay 20 is deenergized and closes contacts 21 and 22. This feature of relay 23 prevents radiation from accidentally occuring when switch 35 is operated under non-radiation conditions.

The control system disclosed may be used with equipment or systems other than radar such as fluid systems, transmission systems, etc., or more generally wherever it is desired to transfer energy from a main input to any of a plurality of energy utilizing or transmitting means.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. An electrical control system for use in positioning a selector valve in contiguous relationship with any one of a plurality of output conduits, said control system being operable beginning and ending with a radiating condition or operable beginning with a non-radiating condition so that after the selector valve has moved to selected position radiation may be started by distinct operation of a radiation switch, said control system comprising an electric motor adapted to be coupled to the valve for moving the latter to any one of its positions, a plurality of switches adapted to be actuated from the valve and the output shaft of said motor upon rotation thereof, a first relay having contactors constructed and arranged for controlling the feed adapted to pass through said valve and also the energization of said motor, a second relay having two coils either one of which when energized holds its contactor which is in the energization circuit of the first relay in closed position, one of the coils of the second relay being adapted under feed conditions to be continuously energized, the other of the coils of the second relay adapted to be energized when the first coil is deenergized during the valve transfer period, a third relay having two contactors adapted to alternately assume closed position, one of which contactors is in the energization circuit of the first relay and the other of which controls the energization of the second coil of the second relay, a manually operable main switch for initiating operation of the system by energizing the third relay, whereby the feed to the valve is terminated and the motor rotates for moving the valve to another position, the said switches which are arranged to be actuated from said valve and output shaft of said motor terminate the rotation of the motor at the proper time following which feed to the valve is restored and also condition the system for the next change which is again initiated by the manually operable main switch.

2. A control system for the antenna selector valve of a radar set including a magnetron for controlling the feed of the transmitter energy output to either of a pair of antennas, said control system being operable beginning and ending with a radiating condition or operable beginning with a nonradiating condition so that after the selector valve has moved to selected position radiation may be started by distinct operation of a radiation switch, said control system comprising a reversible D.C. motor adapted to be coupled to said selector valve for rotating it between two angularly spaced positions, a D.C. supply source, a pair of switches adapted to be operated upon rotation of the selector valve, a third switch arranged to be actuated by the motor output shaft, four relays arranged in said control circuit, the first of said relays having contactors that are in the magnetron high voltage circuit, the magnetron filament circuit, and the motor circuit, respectively, the second of said relays having a contactor that is in the energization circuit of the first relay, said second relay having two coils one of which is adapted to carry the magnetron current, the third relay having contactors arranged to connect the other of the coils of the second relay to the D.C. power supply, the fourth relay having a pair of contactors, one of which is in the energizing circuit of the first relay when the said fourth relay is deenergized and the other of which

is in the energizing circuit of said third relay when the fourth relay is energized, a plurality of manually operable switches in the energization circuit of the first relay whereby radiation output from the radar set may be terminated if on or initiated if off, a manually operable triple-pole double throw switch for initiating the control action of the system, whereby when the switch is thrown from one of its two positions to its other position the fourth relay is energized through two of the poles of the manual switch, one of said switches operated from the rotary selector valve from said D.C. supply, said fourth relay causing its contactor to open the circuit to the first relay and close the circuit to the third relay which in turn causes the second one of the two coils of the second relay to be energized under radiating conditions to retain the corresponding contactor in closed position, the first relay having been deenergized permitting its contactors to disconnect the high voltage from the magnetron, change the filament supply of the magnetron and subsequently close the motor circuit whereby the antenna selector valve is rotated to its other position and stopped by means of said switches operated from the selector valve and the motor output shaft, which last-mentioned switches are conditioned for the subsequent control action and the remainder of the control circuit is returned to its original condition, and lamps for indicating the position of said selector valve.

3. A radar antenna feed selector system, comprising a plurality of radar antennas, each positioned for search in a different area than the others, a microwave generator, a selector member positioned relatively to said generator to receive microwaves therefrom, and mounted for movement to deliver said received microwaves to said antennas alternately, a motor connected to said member for imparting said movement thereto, control means for said motor for causing said motor to operate and move said member to connect it to one of said antennas and stop, and then to the other antenna and stop, manually controlled means for initiating an operation of said control means and motor, and means for interrupting the activity of said generator while said motor is moving said member to connect said member to another one of said antennas.

4. The system as set forth in claim 3, wherein there are two of said antennas, one of which is positioned for zenith search, the other of which is positioned for surface search, said member is a rotatable valve rotated by said motor, and said manually controlled means includes a control switch operable selectively between two positions in one of which positions said switch causes the motor to rotate said valve to a position in which said valve connects said generator to one of said antennas and stops, and in the other of which said switch causes the motor to rotate said valve to another position in which said valve connects said generator to the other of said antennas and stops.

5. The system as set forth in claim 3, wherein said control means includes circuit means for controlling the activity of said motor, selector switch means controlling said circuit means, a relay in said circuit means, and auxiliary circuit means controlled by said relay for controlling the activity of said generator and rendering said generator inactive automatically during the period in which said motor is moving said member to change the connection of said generator from one antenna to another.

6. The system as set forth in claim 3, wherein said control means includes means for automatically interrupting the activity of said generator whenever the output of said generator, while said generator is operating, fails.

7. The system as set forth in claim 3, wherein said motor has a continuously excited field and said control means stops said motor by short circuiting the motor armature to stop the motor with dynamic braking.

8. The system as set forth in claim 3, wherein said control means includes a radiation control relay which controls the activity of said generator and an activating circuit therefor, said manually controlled means includes an intermediate relay having contacts controlling said activating circuit and said control relay, a further relay having a undercurrent winding and a holding winding, said further relay also controlling said activating circuit of said radiation control relay, in series with said intermediate relay, means controlled by said intermediate relay and effective when said radiation control relay is operative to cause activity of said generator by activating said holding winding, means responsive to the activity of said generator for normally activating said undercurrent winding of said further relay and thereby operative on said activating circuit of said radiation control relay to cause an interruption of said activating circuit whenever said generator output is below a selected output, and means controlled by said intermediate relay for activating said holding winding while said intermediate relay deactivates said radiation control relay.

9. A radar antenna feed selector system, which comprises a pair of radar antennas, one positioned for search in one area and the other for search in a different area, a microwave generator, a selector member disposed to receive microwaves from said generator and movable to deliver the received microwaves to said antennas alternately, a motor connected to said member for operating it to vary said delivery from one antenna to another, and means for controlling the activity of said motor and having a control element for initiating an operation of said motor and also having means for stopping each operation of said motor when said member reaches a position in which it delivers microwaves from said generator to one of said antennas.

10. The system as set forth in claim 9, and means for interrupting the activity of said generator during movement of said member by said motor.

11. The system as set forth in claim 9, wherein said motor has a continuously excited field and said motor controlling means controls the motor by control of its armature circuit by shorting said armature to stop the motor quickly with dynamic braking and thereby avoid overshooting of the selector member.

12. The system as set forth in claim 9, and means by which the activity of said generator is interrupted whenever its output drops below a selected output.

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