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Oct. 27, 1936. G. L. BEERS 2,059,081

DIVERSITY RECEIVER

Filed Oct. 31, 1933 2 Sheets-Sheet 1

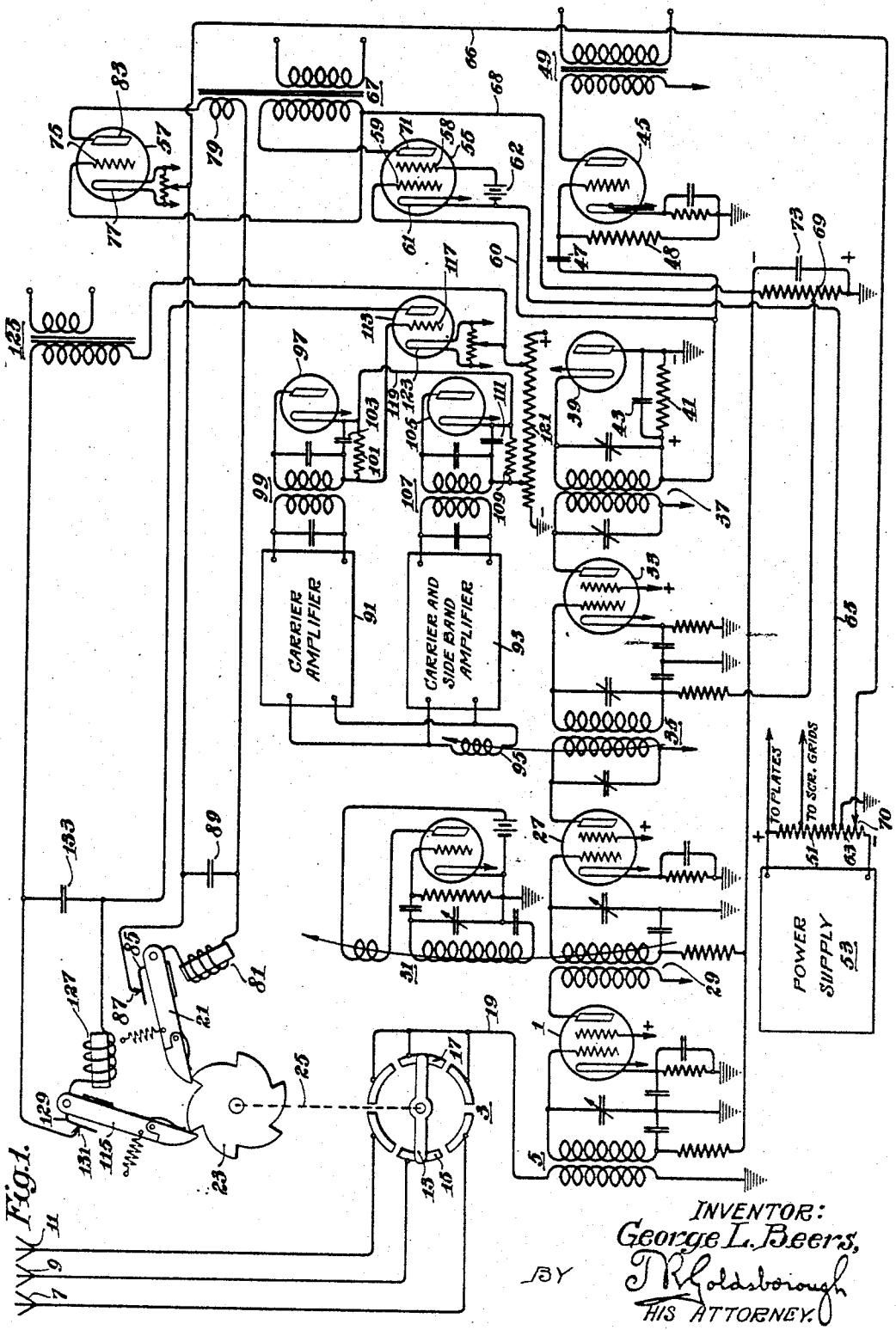


Fig. 1.

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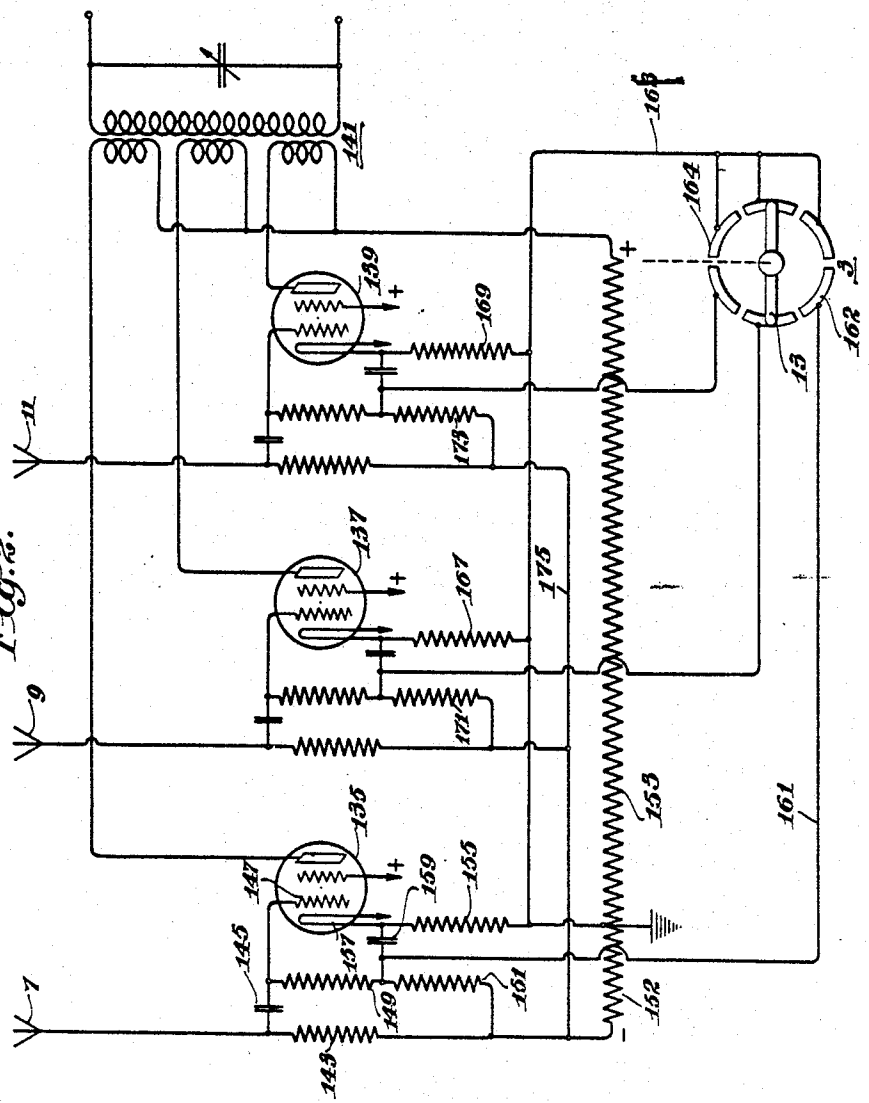


Fig. 2.

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Patented Oct. 27, 1936

2,059,081

UNITED STATES PATENT OFFICE

2,059,081

DIVERSITY RECEIVER

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Application October 31, 1933, Serial No. 695,980

26 Claims. (Cl. 250—20)

My invention relates to radio receiving systems, and particularly to radio receiving systems of the diversity receiver type employing a plurality of antennas.

It is well known that during periods of fading, the variations in amplitude of the signals derived from antennas spaced apart geographically do not occur simultaneously. Advantage has been taken of this fact by employing several receiving antennas spaced apart several wave lengths or more, each antenna being connected to a radio receiver tuned to the frequency of the desired signal. By coupling the output circuits of the receivers to a common translating device, such as an audio frequency amplifier, a signal may be obtained which does not fade as much as when employing conventional receiving apparatus. A diversity receiving system of this type is described in the Proc. I. R. E. for April, 1931, vol. 19, page 531.

I have discovered that when signaling by means of radio waves having a very short wave length (less than ten meters, for example) the use of a plurality of geographically spaced antennas is desirable to overcome the effect of a phenomenon distinct from the above mentioned fading. The phenomenon referred to is that of the setting up of interference patterns by signal waves reflected from points near the receiver. Thus, for the signal from a certain transmitter, there may be points of minimum and maximum signal strength. If a single antenna were employed, it might be located at one of the points of minimum signal strength.

Since the points of minimum and maximum signal strength will not coincide for different transmitters, an antenna so located as to receive efficiently from one transmitter may pick up a very weak signal from another transmitter. A receiver of the diversity type has, therefore, been found desirable for the reception of ultra-high frequency signals.

Heretofore, diversity receiving systems generally have had the disadvantage that a separate receiver unit was required for each antenna, thereby increasing the cost of such systems and making it more difficult to tune in a signal.

An object of my invention is to provide an improved diversity receiver system in which only one radio receiver is required.

It is a further object of my invention to provide an improved apparatus for reducing the effect of "selective" fading, that is, the signal distortion resulting from the independent fading of side bands and carrier wave of a modulated signal.

It is a still further object of my invention to provide an improved ultra-high frequency receiver system for reducing the effect of interference patterns near the receiver.

In one embodiment of my invention, a diversity radio receiving system is provided with a plurality of antennas and with switching means for successively connecting the antennas to the input circuit of a single receiver. In the event that a region of low signal strength is produced at an antenna connected to the receiver another is automatically selected and connected with the receiver. The antennas may be spaced apart a distance, such as several wave lengths, sufficient to make it unlikely that severe fading will occur at all the antennas at the same time, or they may be spaced apart solely for the purpose of reducing the effects of interference patterns.

The antenna switching means includes a switching mechanism operated by means of a relay so connected to the receiver that as long as a signal is of normal strength, the relay does not operate. As soon as a signal fades, however, or if the receiver is tuned into a different transmitting station having a region of minimum signal strength at the antenna in use, the relay is operated to actuate the above-mentioned switching mechanism and a different antenna is connected to the receiver input circuit. If the signal is fading or weak for any reason at this antenna also, the relay will again operate and a still different antenna will be connected to the receiver input circuit.

Other features and advantages of my invention will appear from the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a circuit diagram of one embodiment of my invention; and

Fig. 2 is a circuit diagram of a modified form of input circuit for the apparatus shown in Fig. 1.

Referring to Fig. 1, my invention is shown applied to a superheterodyne receiver comprising a radio frequency amplifier 1, which is provided with an input circuit coupled to an antenna switch 3 through a suitable tuned radio frequency transformer 5.

In the example illustrated, any one of the three antennas 7, 9, and 11, may be connected to the input circuit of the amplifier 1 by rotating a switch arm 13. In the diagram, the antenna 9 is shown connected to the reeciver, the connection being from a switch segment 15 through the switch arm 13, to an opposite switch segment 17,

and through a conductor 19 to the transformer 5.

The switch arm 13 may be rotated by step-by-step motor means comprising a pawl 21 and a ratchet 23 coupled to the switch arm 13 through a suitable connection indicated by the dotted line 25, the pawl 21 being operated through a relay circuit described hereinafter.

The radio frequency amplifier 1 is suitably coupled to the input circuit of a first detector 27 through a tuned radio frequency transformer 29.

An oscillator 31 is coupled to the input circuit of the detector 27 for converting the incoming radio frequency signal to an intermediate frequency signal in the usual manner.

The detector 27 is, in turn, coupled to an intermediate frequency amplifier 33 through a transformer 35 which is tuned to the intermediate frequency.

The output of the amplifier 33 is fed through a tuned intermediate frequency transformer 37 to a diode rectifier 39 which functions as the second detector of the receiver. The rectifier circuit includes a resistor 41 connected in series with the secondary of the transformer 37, this resistor being shunted by an intermediate frequency bypass condenser 43. The anode end of the resistor 41 is connected to ground.

The audio signal output of the second detector 39 appearing across the resistor 41 is impressed upon the input circuit of an audio frequency amplifier 45 by means of a suitable coupling condenser 47 and grid resistor 48. The audio frequency amplifier 45 is provided with an output circuit which may be coupled to any suitable amplifying or translating device (not shown), by means of an audio frequency transformer 49.

The screen grids and plates of the radio frequency amplifier 1, the first detector 27, and the intermediate frequency amplifier 33 are supplied with operating potentials from any suitable source such as tap points on the usual voltage divider resistor 51 connected to a power supply means 53.

In accordance with my invention, an electric discharge device or tube 55, which may be an ordinary three element or four element tube, is provided for controlling a second electric discharge device such as a gas tube relay 57 which functions to control the ratchet 21 and the antenna switch 3.

The control grid 59 of the tube 55 is connected through a conductor 60 to that end of the resistor 41 in the detector circuit which is positive when current is flowing through it. The cathode 61 of the tube 55 is connected to the voltage divider 51 at a point which is positive with respect to ground.

If a screen grid tube is utilized, as illustrated, the screen grid 58 may be supplied with an operating potential from any suitable source such as a battery 62 or the voltage divider 51.

The input circuit of the tube 55 may be traced from the control electrode 59 through the resistor 41 in the second detector circuit through ground to the voltage divider 51, and through a lower section 63 of the voltage divider, through a conductor 65 to the cathode 61 of the tube 55.

It will be apparent that, if there is no incoming signal, there will be no voltage drop along resistor 41, and the control grid 59 will be at a negative potential determined by the voltage drop in the resistor section 63. An incoming signal will decrease the negative bias on the grid 59 since the voltage drop produced in the resistor 41 will be in opposition to the voltage drop in the resistor section 63.

Alternating current is supplied to the plate circuit of the tube 55 through a transformer 67. This alternating current is rectified by the tube 55, when the negative potential on the grid 59 is reduced sufficiently, and is supplied to a volume control resistor 69 which is connected in the plate circuit of tube 55. The plate circuit of tube 55 may be traced from the plate 71 through the secondary of the transformer 67, through the volume control resistor 69 to ground, through ground to the voltage divider 51, through a lower section 63 of the voltage divider, and through the conductor 65 to the cathode 61.

The volume control resistor 69 is shunted by the usual filter condenser 73 for preventing audio frequency signals from being applied to the control grids of the tubes 1, 27 and 33, these grids being connected to the volume control resistor so that they are automatically biased in accordance with the strength of an incoming signal.

The above-described volume control circuit, which has as one of its features the application of alternating voltage to the plate of a volume control tube, is described and claimed in my copending application Serial No. 703,034, filed December 19, 1933, and assigned to the same assignee as this application.

As stated above, when there is no incoming signal, the control grid 59 of the vacuum tube 55 is negative with respect to the cathode 61 due to the biasing potential on the voltage divider section 63, since there is no opposing voltage drop along the detector resistor 41. This negative voltage on the grid 59 is made sufficient to substantially block the tube 55 so that there is no rectified current flow through the volume control resistor 69.

Likewise, if an incoming signal fades below a predetermined level, of if a transmitter station is tuned in, which has low signal strength at the antenna in use, the voltage drop in the detector resistor 41 will be so reduced that the control grid 59 will reach a negative value such that current flow through the volume control resistor 69 will stop.

Referring now to the gas tube relay 57, its control-electrode 75 is preferably maintained at a constant positive potential with respect to its cathode 77 by means of the voltage divider 51. This biasing potential is for the purpose of controlling the sensitivity of the relay 57 and is applied to the grid 75 through a circuit which may be traced from the cathode 77, through a conductor 66 to a variable tap 70 on voltage divider 51, through the voltage divider to ground, through ground to the volume control resistor 69, and through the volume control resistor and the conductor 68 to the control grid 75.

So long as there is an incoming signal of sufficient strength, the current flow in the resistor 69 maintains the grid 75 sufficiently negative to prevent the relay tube 57 from operating. As soon as a sufficient reduction in signal strength occurs at the antenna in use, the current flow in resistor 69 is so reduced in value that the negative potential on grid 75 is reduced to a point where the relay operates. When the relay operates the switch 3 is advanced one step to connect a successive antenna with the receiver, as will hereinafter be described.

It will be apparent that, by adjusting the variable tap 70, the signal level at which the system

operates to switch in a different antenna may be determined. Such an adjustment is desirable since the ratio of signal strength to noise level will vary from day to day. If this ratio is high, the signal strength at the antenna in use may drop to a comparatively low level before there is any object in having a different antenna switched in. On the other hand, if the noise level is high, it may be desirable to have a different antenna switched in in response to a small drop in signal strength.

Operating voltage for the tube relay 57 is supplied through another secondary winding 79 of the transformer 67.

An electromagnet or solenoid 81 connected in series with the plate circuit of the tube relay 57 actuates the pawl 21 for stepping around the ratchet 23. The relay plate circuit may be traced from the plate 83 of the relay tube 57 through the secondary winding 79 of the supply transformer 67, through the electromagnet 81, through a spring contact arm 85 on the pawl 21, and through a contact point 87 to the cathode 77 of the relay tube.

A condenser 89 is connected across the contact points and the electromagnet 81 in series to prevent any alternating current from flowing through the latter.

In operation, as soon as the potential of the control grid 75 is reduced sufficiently due to interference patterns, fading, or the like, at the first antenna, a gaseous discharge takes place in the relay tube and current flows through the solenoid 81 to pull the pawl 21 downwardly and rotate the ratchet 23 one step, thereby connecting a second antenna to the receiver. At the end of the downward movement of the pawl, the relay plate circuit is broken at the contact point 87 and the discharge in the relay tube 57 is stopped. When the pawl returns to its original position, the action will be repeated to connect the third antenna to the receiver input circuit if the signal strength at the second antenna is not sufficient to return the grid 75 of the relay tube to its normal highly negative condition. In other words, the switch 3 is stepped around continuously to switch the antennas successively to the receiver input circuit until an antenna is finally switched in which is receiving signal energy at the desired level.

From the foregoing description it will be seen, also, that, when tuning in a transmitting station, the antenna switch 3 is stepped around during the period that no signal is tuned in. The switch mechanism is designed to operate rapidly so that if the antenna which is connected to the receiver at the instant the receiver is tuned in to a certain signal is at a point of low signal strength, a different antenna will be switched in before the receiver is tuned off the said signal.

The circuit described above is designed to overcome the detrimental effects due to interference patterns or due to fading caused by a variation in the amplitude of the incoming carrier wave and side bands. "Selective" fading, hereinbefore referred to, often occurs due to a reduction in the amplitude of the carrier with respect to the amplitude of the side bands, that is, the carrier may drop to zero or almost zero amplitude, while the side bands remain at their normal amplitude. Or, the amplitude of the side bands may increase while the amplitude of the carrier remains unchanged. In order to switch the receiver to a different antenna when this type of fading occurs, an additional relay circuit may be provided, as shown in Fig. 1.

This additional circuit comprises a carrier wave amplifier 91 and a carrier wave and side band amplifier 93 which have their input circuits connected in parallel and coupled to the output circuits of the first detector 27 through a transformer winding 95.

The carrier wave amplifier 91 is provided with an output circuit which is coupled to a diode rectifier 97 through a tuned intermediate frequency transformer 99. The circuit of the rectifier 97 includes a resistor 101 connected in series with the secondary of the transformer 99 and shunted by an intermediate frequency bypass condenser 103.

In a similar manner, the carrier wave and side band amplifier 93 is provided with an output circuit which is coupled to a second diode rectifier 105 through an intermediate frequency transformer 107. The circuit of this rectifier also includes a resistor 109 shunted by an intermediate frequency bypass condenser 111.

The output energy of the diode rectifiers 97 and 105 control a gas tube relay 113 which operates a second pawl 115 for stepping around the ratchet 23.

The tube relay 113 is provided with a control electrode 117 which is connected to that end of the resistor 101 which becomes negative when a signal is received. The cathodes of the rectifiers 97 and 105 are connected together through a conductor 119, and that end of the resistor 109 which becomes negative is connected to the negative end of a voltage divider 121. The voltage divider 121 may be supplied with direct current from any suitable source such as the power supply unit 53 in the same manner as the divider 51, leads thereto being omitted to simplify the circuit diagram.

The input circuit of the relay tube 113 is completed by a connection from its cathode 123 to a point of positive potential on the voltage divider 121. This input circuit may now be traced from the control electrode 117, through the resistor 101 and the conductor 119, through the second resistor 109 to the voltage divider 121, and through the voltage divider to the cathode 123.

It will be noted that the resistors 101 and 109 are connected in opposition so that if there is the same voltage drop in each resistor, as will hereinafter be pointed out, the control electrode 117 will be maintained at a negative potential with respect to its cathode 123. This negative potential is made high enough normally to prevent the relay 113 from operating.

The plate circuit of the relay 113 is supplied with alternating current through a transformer 125. When the relay 113 is caused to operate, this current is rectified by the relay tube 113 and is supplied to a solenoid 127 which operates the pawl 115. As in the previously described relay circuit, the pawl 115 is provided with a spring switch arm 129 which is in contact with a contact point 131 until the pawl 115 is pulled down to its bottom position, at which time the plate circuit is broken at the contact point 131 to stop the discharge through the relay tube 113.

A filter condenser 133 is connected across the solenoid 127 and the contact points for preventing alternating current pulsations from passing through the solenoid winding.

If the carrier wave and its side bands are at the proper relative amplitude, the voltage drop

in the resistors 101 and 109 will be equal and the control grid 117 will be sufficiently negative to prevent plate current flowing in the relay tube 113.

If, however, selective fading occurs, the voltage drop in resistor 101 will become less than the voltage drop in the resistor 109 and the grid 117 becomes less negative. If the negative potential on the grid 117 is reduced below a certain value, an electric discharge takes place in the tube 113, and the resulting flow of current through the solenoid 127 pulls the pawl 115 down to step the switch arm 13 around to the next antenna position. This action will continue until an antenna, located at a point where there is no selective fading, is connected to the receiver input circuit.

While my above-described circuit may be arranged to operate in response to selective fading of any degree or appreciable range, it is preferably designed to respond to selective fading of sufficient magnitude to make the modulation of the incoming signal exceed 100%. This is for the reason that unless selective fading is of this magnitude, it does not ordinarily cause serious distortion of the signal.

Obviously, the selective fading control circuit and the amplitude fading control circuit may be used together, as illustrated, or either one may be used separately. If they are used together, either type of fading will cause a different antenna to be switched automatically to the receiver input circuit.

Since the carrier wave amplifier 91 should be tuned very sharply, it may be desirable to utilize a quartz crystal filter. Instead of using a separate carrier and side band amplifier 93, as illustrated, the intermediate frequency amplifier 33 in the signal channel may be used. In that case, the amplifier 93 is omitted, and the input circuit of the diode rectifier 105 is coupled to the output circuit of the intermediate frequency amplifier 33 in any suitable manner, such as the similar circuit for the rectifier 33.

The gas tube relays referred to above may be of any suitable type such as an electric discharge device known commercially as a thyratron, or a grid glow tube relay.

A circuit involving the feature of two rectifier tubes fed from separate circuits and connected in opposition for controlling an electric discharge device is disclosed and claimed in my co-pending application, Serial No. 712,526, filed February 23, 1934 and assigned to the same assignee as this application.

It may be preferred to employ coupling tubes between the antennas and the input circuit of the receiver, as shown in Fig. 2. By employing coupling tubes it is possible to prevent the occurrence, under certain operating conditions, of "clicks" in the receiver at the instant that a different antenna is switched into the circuit.

Referring to Fig. 2, where parts corresponding to those in Fig. 1 are indicated by like reference numerals, the antennas 7, 9, and 11 are provided with coupling tubes 135, 137, and 139, respectively, each having an output circuit coupled to the input circuit of the receiver through a transformer 141 which replaces transformer 5 in Fig. 1.

The antenna 7 is coupled to the input circuit of the coupling tube 135 through a coupling resistor 143 and a coupling condenser 145. The control grid 147 of tube 135 is normally maintained at a high negative potential which biases the tube to cut-off by means of the portion 152 of a voltage divider 153, the grid 147 being connected to the negative terminal of voltage divider 153 through grid leak resistors 149 and 151 connected in series. The tube 135 is also provided with a self-biasing resistor 155 connected between cathode 157 and ground.

A filter condenser 159 is connected between the cathode 157 and the junction point of the two grid leak resistors 149 and 151 to aid in preventing "clicks" when switching from one antenna to another. This point on the grid leak resistors is connected to a segment 162 of the antenna switch 3 through a conductor 161, an opposite segment 164 of the switch being connected to the lower end of the cathode biasing resistor 155 through a conductor 163.

If the switch arm 13 is not in contact with the switch segment 162, the coupling tube 135 is blocked so that the antenna 7 is, in effect, disconnected from the input circuit of the receiver. If the switch arm 13 is rotated to connect the switch segment 162 with the opposite switch segment 164, the lower end of the grid leak resistor 149 is connected directly to the lower end of the cathode biasing resistor 155, whereby the negative potential on the control grid 147 is reduced to a point where the tube 135 becomes effective to transfer energy from the antenna 7 to the receiver.

The time constants of the circuit of condenser 159 and of the circuit of condenser 145 are made such that the tube 135 gradually becomes operative when switch arm 13 makes contact with segment 162, and gradually becomes inoperative when switch arm 13 is moved out of contact with segment 162. The condenser circuits of the coupling tubes 137 and 139 are similarly adjusted. In operation, therefore, one coupling tube is gradually becoming operative as another coupling tube is becoming inoperative.

The time constants necessary to prevent "clicks" in the receiver will not be the same under all conditions. For example, if the receiver has a very low frequency response, the time constants should be greater than when utilizing a receiver which does not respond to low frequency impulses.

It may be noted that if the coupling condenser 145 is given a very small value, the time constant of its circuit may be ignored and the tube circuit adjusted to avoid "clicks" solely by the adjustment of the circuit of condenser 159.

The tube coupling circuits for the antennas 9 and 11 are identical with the one described above, the lower ends of the cathode biasing resistors 155, 167, and 169 being connected together by the conductor 163. Also, the lower ends of the grid leak resistors 151, 171, and 173 are all connected to the negative terminal of the voltage divider 153 through a conductor 175 so that each coupling tube is blocked until its grid potential is reduced by the operation of the antenna switch 3.

Instead of utilizing a plurality of antennas spaced apart geographically, a plurality of different types of antennas located at approximately the same point may be employed since a signal may have different fading characteristics when received by different types of antennas. For example, a loop antenna and a vertical non-directive antenna may be arranged to be connected successively to the receiver in the event fading occurs. Since various forms of antennas, including the above, are well known, and since any type

250 RADIANT ENERGY

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may be used, the same are not shown and are represented by the antennas 7, 9 and 11.

It will be understood that the cathodes of the electric discharge tubes shown in Figs. 1 and 2 may be either directly or indirectly heated by current supplied from any suitable source (not shown).

Various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. A radio system comprising a plurality of non-directive, geographically spaced antennas, a radio receiver having a common input circuit for said antennas and an output circuit, means for selectively connecting said antennas singly to said input circuit, and means responsive to the characteristic of a signal received by said receiver for controlling said first means.

2. A radio system comprising a plurality of antennas, an amplifier tunable to an incoming signal, said amplifier having a common input circuit for said antennas and an output circuit, and means for selectively connecting said antennas singly to said input circuit in response to fading of the signal energy in said output circuit.

3. In combination, a plurality of antennas, a superheterodyne receiver having an input circuit, said receiver including means for converting an incoming signal to an intermediate frequency signal, and means including a circuit tuned to said intermediate frequency for selectively connecting said antennas singly to said input circuit in response to fading of an incoming signal.

4. In combination, a plurality of antennas, a tunable selecting circuit having an input circuit, means for successively connecting said antennas singly to said input circuit, and means for actuating said first means in response to the fading of an incoming signal.

5. In combination, a plurality of antennas, a radio frequency amplifier having an input circuit for said antennas and an output circuit, a gas tube relay having a control electrode, means including a resistor connected to said output circuit and with said control electrode for maintaining said control electrode negative so long as the incoming signal at said input circuit is above a certain strength, and means including said gas tube relay for selectively connecting in rotation a single and different one of said antennas to said input circuit in response to fading of said signal.

6. In combination, a plurality of antennas, an amplifier having an input circuit and an output circuit, switching means for successively connecting said antennas to said input circuit, means including a gas tube relay for actuating said switching means, said tube relay including a control electrode, means for maintaining said control electrode negative so long as the incoming signal does not fade, means for lowering the negative potential on said control electrode in response to fading of said incoming signal whereby an electric discharge takes place in said tube relay, and means for stopping said discharge in response to the actuation of said switching means.

7. In combination, a plurality of antennas, a superheterodyne receiver having an input circuit, said receiver including means for converting an incoming signal to an intermediate frequency signal, switching means for successively connecting said antennas to said input circuit, means including a gas tube relay for actuating said switching means, said tube relay including a control electrode, means including a circuit tuned to said intermediate frequency normally for maintaining said control electrode negative, means for lowering the negative potential on said control electrode in response to fading of an incoming signal whereby an electric discharge takes place in said tube relay, and means for stopping said discharge in response to the actuation of said switching means.

8. In combination, a plurality of antennas for receiving an incoming signal, an amplifier having an input circuit and an output circuit, switching means for successively connecting said antennas to said input circuit, an electric discharge tube having a control grid, means including a rectifier coupled to said output circuit for biasing said electric discharge tube substantially to cut-off when said incoming signal is below a predetermined strength, a gas tube relay having a control electrode, means including said electric discharge tube for applying a negative bias to said control electrode, means for reducing said negative bias in response to the biasing of said electric discharge tube substantially to cut-off whereby said relay is operated, and means for actuating said switching means in response to the operation of said relay.

9. A radio system for supplying signals to the input circuit of an amplifier tunable to an incoming signal, said system comprising a plurality of antennas, a plurality of coupling tubes having input circuits and output circuits, each of said antennas being coupled to said amplifier input circuit through one of said coupling tubes, means including said coupling tubes for selectively connecting said antennas to said input circuit in accordance with the signal energy in said output circuit, and means including filters in said coupling tube input circuits for preventing a change in antenna connection from causing a sudden change in energy in said amplifier output circuit.

10. Electrical apparatus comprising means for receiving a modulated radio wave, an electric discharge tube for controlling said apparatus, said tube having a control electrode, bias means for rendering said tube substantially inoperative, two rectifiers having output circuits connected in opposition and means including said rectifiers for rendering said tube operative in response to a predetermined change in percentage modulation of a received carrier wave.

11. Electrical apparatus comprising means for receiving a modulated radio wave, a translating device, an electric discharge tube having a control electrode, said tube having an output circuit coupled to said translating device, two rectifiers having output circuits connected in opposition, means for connecting said control electrode to said output circuits, and means including said rectifiers for controlling the potential on said control electrode in response to a predetermined change in percentage modulation of said radio wave.

12. In combination, a plurality of antennas, radio receiving apparatus having an input circuit, means for successively connecting said antennas to said input circuit, and potential controllable means for actuating said first means in response to selective fading of an incoming modulated carrier wave, said last named means including a controlling source of potential variable in response to changes in the relative

strength of the carrier wave and the side bands thereof, and an actuating device connected therewith and responsive to said potential variations.

13. In a diversity radio receiving system, antenna selecting means having a movable selecting element, means providing a signal amplifying channel connected with said selecting means to receive and amplify a signal from a selected antenna, means associated with said signal channel for receiving a signal and separating the carrier wave with side-bands and the carrier-wave thereof to provide opposing control potentials responsive to changes in the relative amplitude of said side-bands and carrier wave, and means responsive to a predetermined difference in said opposing potentials for actuating said selecting element.

14. In a diversity radio receiving system, antenna selecting means having a movable selecting element, step-by-step motor means for moving said selecting element, means providing a signal amplifying channel connected with said selecting means to receive and amplify a signal from a selected antenna, tuning means in said channel for causing said system to be responsive to signals within a predetermined frequency band, means associated with said signal channel for receiving a signal and for separating the carrier-wave with side-bands and the carrier-wave thereof to provide opposing control potentials responsive to changes in the relative amplitude of said side-bands and carrier-wave, and means responsive to a predetermined difference in said opposing potentials for actuating said motor means successively during the existence of said potential difference, said last named means including an actuating electro-magnet for said motor means, a grid-controlled electric discharge device in circuit with said electro-magnet for controlling the flow of operating current thereto, means for applying said potential difference to said device to cause current flow therethrough to energize said electro-magnet, and means for stopping said current flow in response to the operation of said step-by-step motor.

15. In a diversity radio receiving system, the combination of a single radio receiver, means providing a plurality of signal supply sources, means having a movable selecting element for successively connecting said receiver with said signal supply sources, means for moving said selecting means in response to a predetermined low average signal amplitude, means for separating the carrier-wave with side-bands and carrier wave of a signal to provide opposing control potentials responsive to changes in the relative amplitude of said side-bands and carrier wave, and means responsive to a predetermined difference in said potentials for actuating said selecting means.

16. A radio system comprising a plurality of antennas, a radio receiver having an input circuit and an output circuit, means for selectively connecting only one of said antennas at a time to said input circuit and for disconnecting said previously connected antenna from said receiver, and means responsive to a signal characteristic for controlling said first means.

17. A radio system comprising a plurality of antennas, a radio receiver having an input circuit and an output circuit, a switch for selectively connecting said antennas to said input circuit, and means for controlling said switch in response to the signal impressed upon said input circuit decreasing below a predetermined amplitude.

18. A radio system comprising a plurality of antennas, a radio receiver having an input circuit and an output circuit, a switch for selectively connecting said antennas to said input circuit, and means for switching to a different antenna in response to the signal to which said receiver is tuned and which is impressed upon said input circuit being below a predetermined amplitude.

19. A radio system comprising a plurality of antennas, a radio receiver having an input circuit and an output circuit from which output energy is supplied, a switch for selectively connecting said antennas to said input circuit, and means for operating said switch in response to said output energy falling below a predetermined value.

20. A radio receiving system comprising a plurality of antennas, a radio receiver having an input circuit, said receiver being tunable to receive a certain modulated carrier wave, means for selectively connecting said antennas to said input circuit, and means responsive to variations in the relative strength of the carrier wave to the side band strength for continuously operating said first means until there is connected to said input circuit an antenna which has impressed thereon a signal to which said receiver is tuned which has a certain predetermined normal relation between the strength of the carrier wave and the side-bands thereof.

21. A radio receiving system comprising a plurality of antennas, a radio receiver having an input circuit, said receiver being tunable to receive a certain modulated carrier wave, means for selectively connecting said antennas to said input circuit, potential controllable means for continuously operating said first means, and means connected with said last named means and responsive to a received modulated carrier wave for applying a controlling potential to said last named means, and means for causing said potential to change in response to change in carrier wave strength with respect to the strength of the side-bands thereof.

22. A radio system comprising a plurality of antennas, a radio receiver having an input circuit and including means for demodulating a modulated carrier wave to reproduce the modulating signal, means for selectively connecting said antennas to said input circuit, and means responsive to fading of said modulated carrier wave for controlling said antenna selecting means.

23. The combination with a radio receiver having automatic volume control means, of a plurality of signal energy collectors, a signal input circuit for said receiver, switch means for selectively connecting said energy collectors successively to said circuit, and means connected with and responsive to said automatic volume control means for actuating said switch means.

24. In a radio signal receiving system for modulated carrier wave signals, the combination of means providing a plurality of signal sources, means providing a signal amplifying channel including an input circuit, means for selectively connecting said input circuit with each of said signal sources successively, means for actuating said last named means responsive to variations in a controlling potential, a second means for actuating said selective collector means in response to variations in a controlling potential,

means for supplying a control potential to said first named actuating means responsive to variations in the strength of a received carrier wave, and means for applying a controlling potential to the second actuating means in response to variations in the strength of the received carrier wave with respect to the strength of its sidebands.

25. A radio system comprising a plurality of geographically spaced antennas, a radio receiver having a common input circuit for said antennas and an output circuit, means for selectively connecting said antennas singly to said input circuit, and means responsive to the amplitude of a carrier-wave impressed on said receiver for controlling said first means.

26. The combination of a radio receiving system, a plurality of geographically spaced antennas therefor, said system having a common input circuit for said antennas and an output circuit, means for selecting each of said antennas singly for impressing signals on said receiving system through said input circuit, and means responsive to the amplitude of a received carrier-wave for controlling the last-named means.

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