

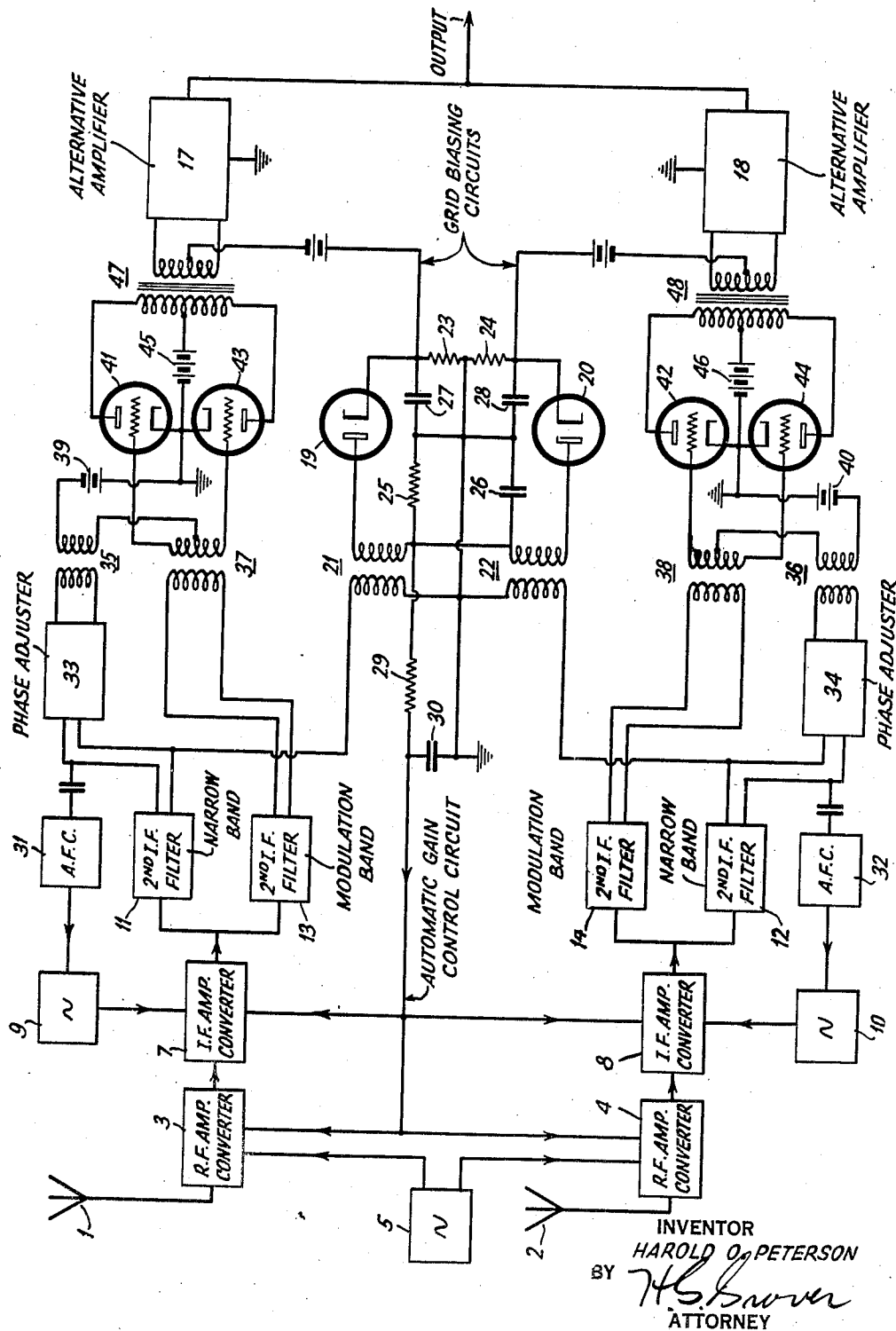
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DIVERSITY RECEIVING SYSTEM

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DIVERSITY RECEIVING SYSTEM

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This invention relates to diversity receiving systems and more particularly to that type of a diversity system in which means are provided for automatically switching the signals through alternative amplifiers at the receiving station so as to maintain connection of a responsive device with the path over which the signal of greatest amplitude is arriving at any particular moment.

In the usual diversity receiving system, the same transmitted signal is simultaneously received on different antennae. The amplitude of the received signals at different antennae is quite frequently varied because of multipaths over which the signals are communicated through space. The signals received over paths of different length are apt to be combined at any one antenna in an out-of-phase relation. At such times, the signal must be utilized as received at an antenna where an in-phase relation exists.

My invention is particularly adapted for use in radio communication systems employing amplitude modulation, phase modulation or single side band transmission. In accordance with any of these methods, it may be of advantage to use an exalted carrier in the local receiver.

It is an object of my invention to provide a diversity receiving system which is suitable for use in association with radio receiving apparatus that may be responsive to either frequency modulated signals, phase modulated signals, amplitude modulated signals or a single side band communication system.

It is another object of my invention to provide a form of diversity receiving system wherein the carrier wave is exalted and where use is made of a signal energy component from a narrow band filter for switching into service one of a plurality of amplifiers, each connected in a different receiving channel.

It is another object of my invention to provide a diversity receiving system in which reception is improved by the use of carrier wave filters and modulation band filters both feeding into balanced detectors, the output from which may be utilized in a system of alternative amplifiers which are selected for feeding the signal energy into a responsive device in dependence upon the energy control derived from the particular receiving channel upon which the strongest signal is impressed.

Other objects of my invention will be made apparent in the description to follow.

My invention will now be described in more detail, reference being made to the accompanying drawing, the sole figure of which shows dia-

grammatically a circuit arrangement of a preferred embodiment.

Referring to the drawing, I show two antennae 1 and 2 which are presumed to be geographically separated so as to receive signals conducted through space over different paths. The signals received on antenna 1 are fed to the radio frequency amplifier and converter 3 while signals from antenna 2 are likewise fed to a radio frequency amplifier and converter 4. These two units 3 and 4 are supplied with local oscillations from generator 5 for purposes of heterodyning.

Output currents from the converter units 3 and 4 are fed to intermediate frequency amplifiers and converters represented by the units 7 and 8 respectively. The unit 7 is served by a local oscillator 9 for purposes of producing a second intermediate frequency while the unit 8 is likewise served by a local oscillator 10 for producing a corresponding second intermediate frequency with respect to the signals received on antenna 2. If desired, the signals fed to units 7 and 8 may be heterodyned with oscillations from a single generator replacing the units 9 and 10.

The output from the converter unit 7 is fed to two separate filters 11 and 13, and similarly the output from the converter unit 8 is fed to two separate filters 12 and 14. The filters 11 and 12 are designed to pass a very narrow band of frequencies such as the carrier frequency plus and minus a few cycles. The filters 13 and 14, however, are characterized as having a pass band sufficiently wide to cover the entire modulation range.

Since the filters 11 and 12, normally pass only the carrier frequency, or, as an alternative some pilot tone frequency, I preferably utilize the output therefrom to operate a switching means and automatic gain control circuit presently to be described. The outputs from filter units 11 and 13 are, however, combined in a balanced detector comprising discharge tubes 41 and 43, and the combined energy is fed therefrom to a so-called "alternative amplifier" 17. Correspondingly, the outputs from the filter units 12 and 14 are combined and rectified in the balanced detector comprising discharge tubes 42 and 44, and fed therefrom to the "alternative amplifier" 18.

The balanced detector tubes 41 and 43 are controlled by energies derived from the secondaries of transformers 35 and 37. One terminal of the secondary of transformer 35 is connected through a biasing source 39 to the grounded cathodes of tubes 41 and 43, while the other terminal

of this transformer secondary is connected to a mid-tap on the secondary of transformer 37. The terminals of the last mentioned secondary are connected respectively to the grids of the tubes 41 and 43. Output from the modulation band filter 13 is fed directly to the primary of transformer 37. Output from the carrier frequency filter 11 is fed through a phase adjuster 33 to the primary of transformer 35. The anodes of tubes 41 and 43 are connected to the two terminals of the primary winding on transformer 47, the secondary of which is in the input circuit for the amplifier 17. The cathodes of tubes 41 and 43 are connected through an anode potential source 45 to a mid-tap on the primary of transformer 47.

The circuit arrangement shown for the balanced detector tubes 42 and 44 in the other of the diversity receiving channels is identically like that already described. In other words, the even numbered phase adjuster 34, the three transformers 35, 36 and 48, the biasing source 40 and the anode potential source 45 correspond with like parts which bear odd numbers in the circuit already described.

The phase adjusters 33 and 34 are required for obtaining proper detection, depending upon whether the system is to be used for reception of phase modulated signals, or amplitude modulated signals. In changing from phase modulation to amplitude modulation, the phase adjusters would be shifted 90°. It is obvious, however, that the balanced detector may also serve for single side-band reception.

The output circuits from the amplifiers 17 and 18 are combined and connected to any suitable utilization device. These amplifiers are so controlled by two diode rectifiers 19 and 20 respectively that usually only one of them is rendered operative at any one time. This is accomplished by the use of a D. C. biasing potential on the control grids of the amplifier tubes such that they can amplify input energy only in the presence of a rectified signal component from one or the other of the rectifiers 19 and 20. Rectifier 19 receives signal energy through the secondary of transformer 21, the primary of which is connected in an output circuit from the narrow band filter unit 11. Likewise, rectifier 20 is fed with signal energy from the secondary of transformer 22, the primary of which is fed with signal energy derived from the narrow band filter 12. The rectified signal energy is impressed across resistors 23 and 24, depending upon the respective amplitudes of the signals received on the two antennae 1 and 2. The stronger the signal the more positive will be the cathodes of the tubes 19 and 20. The positive potential thus obtained operates to unblock the amplifiers 17 and 18.

The rectifiers 19 and 20 have a common load impedance 25. The potentials developed across this impedance 25 are fed through an impedance 26 and thence to the various units 3, 4, 7 and 8 for controlling the gain therein. Capacitor 30, one side of which is grounded and the other side of which is connected to the automatic gain control circuit, cooperates with the impedance 26 for controlling the time constant of the automatic gain control circuit. Capacitors 27 and 28 are disposed between the respective cathodes of rectifiers 19 and 20 and ground in order to bypass alternating current components of the rectified energy. Capacitor 26 is also an alternating current by-pass to ground.

It is preferable to automatically control the frequency of the local oscillators 9 and 10, and

for this purpose automatic frequency control devices 31 and 32 are employed. These devices are controlled by output energy from the narrow band filters 11 and 12.

If the load impedance 25 is made large compared with the impedances 23 and 24, it is found that diode current will flow only in that rectifier having the strongest impressed signal voltage. Consequently, the control voltage required for switching the alternative amplifiers 17 and 18 in and out of service is, in general, such that only one of these amplifiers will be operative at any one time.

To those skilled in the art, the advantages of the system herein disclosed will be apparent. The system is, however, capable of modification to meet specific cases and, as indicated at the outset, is adaptable to a variety of different radio systems and methods of modulation.

I claim:

1. In a diversity receiving system of the type having a plurality of antennae each individually connected to a separate group of responsive devices, each said group being arranged to feed signals through an appropriate alternative amplifier to a common utilization device, the method of improving reception which comprises separating out from a modulation frequency band a narrow frequency band including the signal carrier, normally blocking said alternative amplifiers with respect to weak signals fed thereto from certain of said antennae, and unblocking said alternative amplifiers one at a time, each in response to the carrier energy component derived from a particular one of said antennae and fed to its appropriate group of responsive devices, and during a period when the amplitude of said component in that group predominates over such components in other groups.

2. The method according to claim 1 and including the step of automatically controlling the gain in said responsive devices in accordance with the amplitude of the predominating group derivative of said carrier energy.

3. In a diversity receiving system comprising a plurality of radio reception branches comprising amplifiers connected to a common utilization device, a heterodyne converter in each branch, a modulation band filter and a narrowly selective carrier frequency filter in each branch, said filters being coupled in parallel to the output circuit of their converter, a phase adjuster in the output circuit of each carrier frequency filter, a balanced detector in each branch under joint control of modulated signals derived from said modulation band filter and of carrier wave energy fed through said phase adjuster, and means controlled solely by rectified components of the filtered carrier energies in the respective branches for transferring to said utilization device the products of that one of said balanced detectors which is of the branch receiving at the moment the strongest carrier wave.

4. A system in accordance with claim 3 and including automatic gain control devices common to, and operable upon, the amplifiers of said radio reception branches in accordance with the strongest of the carrier wave components of the several branches.

5. A system in accordance with claim 3 in which said phase adjusters include means settable to produce a conductance phase in said balanced detectors and in said utilization device whereby phase-modulated signals are translated into intelligence.

6. A system in accordance with claim 3 in which said phase adjusters include means settable to produce a conductance phase in said balanced detectors and in said utilization device whereby amplitude-modulated signals are translated into intelligence.

7. A diversity receiving system comprising a plurality of antennae, a separate radio frequency amplifying and heterodyning unit connected to each antenna, a pair of parallel connected filters for passing the output from each of said units, one filter in each pair having a modulation band pass characteristic, the other filter of each pair having a pass characteristic which is sharply selective of a given carrier wave, balanced demodulators each fed with suitably phase-related energies derived from an appropriate pair of said filters, a plurality of normally blocked amplifiers each connected to receive the rectified output energy from an appropriate balanced demodulator, said amplifiers having a common output circuit feeding to a utilization device, and means for comparing the amplitudes of the output components from the respective sharply selective filters, said means being effective to unblock said amplifiers one at a time and each during a period in which the carrier component of the signal applied thereto is relatively the strongest.

8. A system in accordance with claim 7 wherein the last said means comprises a plurality of diode rectifiers each having a cathode in circuit with a grounded cathode resistor, the several anodes of said rectifiers being in circuit with a common load resistor, the impedances of said cathode resistors being individually high with respect to the impedance of said common load resistor.

9. A diversity receiving system comprising a plurality of radio reception branches each fed with energy collected by a different antenna, filter means coupled to each branch for passing a narrow frequency band including the carrier wave, an amplifier for modulated frequency components of the energy in each branch, each said amplifier being normally blocked with respect to relatively weak signals, means for rectifying an output component from each said filter means, means including a system of impedances con-

nected to each of said rectifying means whereby rectified current is derived solely from the branch having the strongest impressed signal voltage, and means responsive to the rectified current so derived for unblocking a particular amplifier, thereby to utilize only the modulated frequency signal components from the branch in which the carrier wave is strongest.

10. In combination, a pair of diode rectifiers each having an anode and a cathode, a first impedance carrying currents to be rectified and being connected between the anodes of said diodes, a second impedance interconnecting their cathodes, a third impedance interconnecting mid-taps on the first and second impedances, respectively, a gain control circuit utilizing the voltage drop across the third impedance, and selective means differentially responsive to a voltage drop in one arm of the second impedance when it exceeds the voltage drop in the other arm thereof.

11. In combination, a pair of diode rectifiers each having an anode and a cathode, a divided inductance carrying currents to be rectified and being connected across the anodes, a divided resistor interconnecting the cathodes, a capacitively-shunted resistor interconnecting the mid-points of said inductance and said divided resistor, means utilizing the potential drop across said capacitively shunted resistor, and other means differentially responsive to the predominance of voltage drop in one arm as compared with the other arm of said divided resistor.

12. A circuit arrangement comprising a balanced detector having two diode discharge tubes, two independent alternating current circuits each arranged to deliver an output component to a respective one of said tubes, whereby said component is rectified, an automatic gain control device common to the two translating circuits and operable by rectified output energy from said diode tubes, and switching means for connecting a selected one of said translating circuits to a common utilization device, said means being automatically controlled by the moment-to-moment predominance of rectified output energy derived from one over the other of said diode tubes.

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