

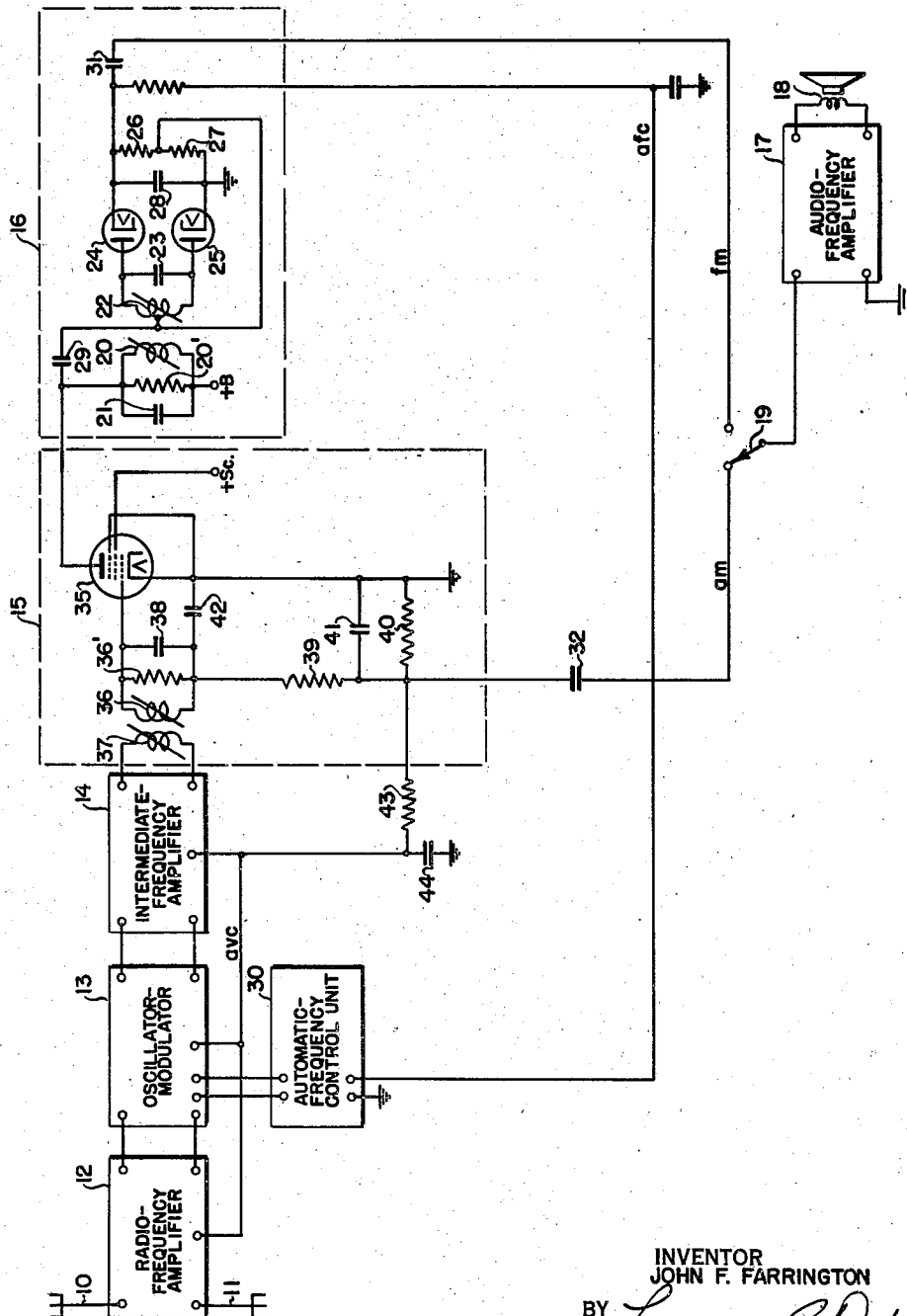
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J. F. FARRINGTON

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COMBINATION AMPLITUDE-MODULATION-FREQUENCY-MODULATION RECEIVER

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INVENTOR
JOHN F. FARRINGTON
BY *Laurence B. Dadds*
ATTORNEY

UNITED STATES PATENT OFFICE

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COMBINATION AMPLITUDE-MODULATION-FREQUENCY-MODULATION RECEIVER

John F. Farrington, Laconia, N. H., assignor to
Hazelbline Corporation, a corporation of Delaware

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This invention relates generally to modulated-carrier signal receivers for receiving and reproducing both amplitude-modulated and frequency-modulated carrier signals and, particularly, to such a receiver in which a single carrier-frequency signal-translating stage is utilized as a limiter when receiving a frequency-modulated signal and as an amplitude-modulation detector when receiving an amplitude-modulated signal.

Certain units of a modulated-carrier wave-signal receiver for receiving an amplitude-modulated signal are identical with, or very similar to, corresponding units of a receiver for receiving and reproducing a frequency-modulated carrier signal. It has previously been proposed to use certain of such units as common elements in a combined amplitude-modulation and frequency-modulation receiver. However, the circuits which have heretofore been used are somewhat more complicated or less satisfactory in operation than is desired. Certain receivers for receiving a frequency-modulated carrier wave require a separate stage in the signal-translating channel of the receiver, the function of which is to limit the translated signal to eliminate therefrom any amplitude-modulation components and amplitude variations. However, if parts of a frequency-modulation receiver circuit are to be used also in the circuit of an amplitude-modulation receiver in which a limiting action is not tolerable, the limiter stage of the frequency-modulation receiver is generally used simply as a carrier-frequency amplifier in the circuit of the amplitude-modulation receiver. However, sufficient carrier-frequency amplification for all purposes must also be provided for the frequency-modulation receiver circuit so that the additional amplification provided by using the limiter stage as an amplifier in the circuit of the amplitude-modulation receiver really serves no useful purpose. Furthermore, a different type of detector circuit is required in a frequency-modulation receiver than in an amplitude-modulation receiver. Therefore, it is very desirable to be able to use the limiter stage of a frequency-modulation receiver as an amplitude detector in an amplitude-modulation receiver.

It is an object of the invention, therefore, to provide an improved receiver circuit for receiving either an amplitude-modulated carrier wave or a frequency-modulated carrier wave in which one or more of the above-mentioned disadvantages of prior art circuits are eliminated.

It is still another object of the invention to provide a combination amplitude-modulation-

frequency-modulation receiver in which a single carrier-frequency signal-translating stage serves as a limiter when the apparatus is being utilized to receive a frequency-modulated carrier signal and as an amplitude detector when the apparatus is being utilized to receive an amplitude-modulated signal.

In accordance with the invention, a modulated-carrier wave-signal receiver comprises a carrier-frequency signal-translating stage and means included in the stage for causing the stage to act as an amplitude limiter over a given carrier-frequency range, so that amplitude modulation is removed from translated signals within the given carrier-frequency range. Means are also included in the stage for causing the stage to act as an amplitude-modulation detector over the above-mentioned carrier-frequency range. Means are further provided for selectively utilizing a first signal output from the stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within the given frequency range or a second signal output from the stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within the given frequency range.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

The single figure of the drawing represents a modulated-carrier wave-signal receiver of the superheterodyne type for receiving either an amplitude-modulated carrier signal or a frequency-modulated carrier signal.

Referring now more particularly to the drawing, the system illustrated comprises a receiver of the superheterodyne type including an antenna circuit 10, 11 connected to a radio-frequency amplifier 12 to which are connected in cascade, in the order named, an oscillator-modulator 13, an intermediate-frequency amplifier 14, and a carrier-frequency signal-translating stage 15 which acts as a limiter when frequency-modulated carrier signals are being received and which acts as an amplitude-modulation detector when amplitude-modulated carrier signals are being received. A frequency-modulation detector 16 is coupled to one output circuit of carrier-frequency signal-translating stage 15, while an audio-frequency amplifier 17 is selectively connected, by means of a switch 19 and coupling condensers 31 and 32, respectively, to either the frequency-

modulation detector 16 or to an output circuit of carrier-frequency signal-translating stage 15 for receiving detected amplitude-modulation components of a desired received signal. A signal-reproducing device 18 is coupled to the output circuit of audio-frequency amplifier 17.

It will be understood that frequency-modulation detector 16 may be of a conventional type and, as shown, is of the type comprising a transformer having a primary winding 20, tuned to the mean frequency of the intermediate-frequency channel of the receiver by a condenser 21, and a secondary winding 22, also tuned to the mean frequency of the intermediate-frequency channel of the receiver by a condenser 23. Damping is provided in the tuned primary winding of transformer 20, 22 by means of a resistor 20'. Diodes 24, 25 are provided having load circuits therefor including resistors 26 and 27, by-passed for carrier-frequency currents by a condenser 28. In order to supply a voltage proportional to the vector sum of the voltages of the primary and secondary windings of transformers 20, 22 to one of the diodes and to provide a voltage proportional to the vector difference of the voltages of the primary and secondary windings to the other of the diodes, a coupling condenser 29 is coupled between one side of winding 20 and a mid-tap on winding 22, while the mid-tap of winding 22 is coupled to the common junction of resistors 26 and 27. Automatic frequency control potentials are derived from frequency detector 16 and applied by means of the conductor designated AFC to an automatic frequency control unit 30 which is coupled to oscillator-modulator 13 to control the frequency of the oscillator section thereof in a manner well understood in the art.

The stages or units 10 to 14, 16 to 18 and 30 may all be of conventional well-known construction so that detailed illustration and description thereof are deemed unnecessary herein. Referring briefly, however, to the operation of the system described above, a desired received carrier signal, which may be either frequency-modulated or amplitude-modulated, is intercepted by antenna circuit 10, 11 and is selected and amplified in radio-frequency amplifier 12 and coupled to the oscillator-modulator 13 wherein it is converted into an intermediate-frequency signal which, in turn, is selectively amplified in the intermediate-frequency amplifier 14 and coupled to the carrier-frequency signal-translating stage 15. If the desired received signal is a frequency-modulated carrier signal, the switch 19 is thrown so that audio-frequency amplifier 17 is connected to an output circuit of frequency-modulation detector 16. The desired intermediate-frequency signals are, therefore, limited in carrier-frequency signal-translating stage 15 and detected in frequency-modulation detector 16, the detected components thereof being supplied through audio-frequency amplifier 17 to signal reproducer 18 for reproduction.

If the desired received signal is an amplitude-modulated carrier signal, the switch 19 is thrown so that audio-frequency amplifier 17 is coupled to carrier-frequency signal-translating stage 15 in order to supply to audio-frequency amplifier 17 the desired amplitude-modulation components for reproduction.

In either case a voltage varying in accordance with the degree of mistuning of the receiver is derived from unit 16 and applied to the automatic

frequency control unit 30 over the conductor labeled A. F. C. to control the tuning of the receiver in a manner which is, per se, well understood by those skilled in the art.

Coming now to the portion of the system embodying an essential feature of the present invention, there is included in the carrier-frequency signal-translating stage 15 a vacuum tube 35, the circuit of which includes means for causing the stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within a given carrier-frequency range. Means are also included for causing the stage to act as an amplitude-modulation detector over the given carrier-frequency range. To this end, input circuit of vacuum tube 35 includes a parallel-resonant circuit comprising an inductance 36 inductively coupled to an inductance 37 which is, in turn, coupled to the output terminals of intermediate-frequency amplifier 14. The secondary winding 36 of the transformer 37, 38 is tuned to the intermediate-carrier frequency of the receiver by means of a condenser 38, the tuned circuit being damped by a resistor 36'.

In order to cause the input circuit of tube 35 to act as an amplitude-modulation detector, there is provided in series with tuned circuit 36, 38 a suitable load circuit including a resistor 39 and a resistor 40 by-passed for carrier-frequency currents by condensers 41 and 42. The output circuit of tube 35 comprises tuned circuit 20, 21 of frequency-modulation detector 16. The unidirectional voltage developed across resistor 40 is applied through a suitable audio-frequency filter, including a series resistor 43 and a shunt condenser 44, and the conductor labeled AVC, to one or more tubes of radio-frequency amplifier 12, the oscillator-modulator 13, and intermediate-frequency amplifier 14 to maintain the amplitude of the signal input to stage 15 within a relatively narrow range for a wide range of received signal amplitudes. Resistor 39 and condenser 42 are proportioned to have a suitable time-constant and the screen grid of tube 35 is maintained at a relatively low potential so that a quickly-responsive limiting action is effected in signals translated to the anode circuit of tube 35.

In considering the operation of the portion of the circuit just described, it will be seen that resistor 40 forms a suitable load circuit so that amplitude-modulation components of the received carrier signal are detected in the input circuit of tube 35. Specifically the input circuit of tube 35 acts as a diode detector, the intermediate-frequency signals of the receiver being applied thereto through tuned circuit 36, 38 and amplitude-modulation components of the signal being derived across resistor 40. Elements 39 and 41 effectively comprise a carrier-frequency filter which aids in eliminating carrier-frequency signals from the output to condenser 32 or to the AVC circuit. Therefore, switch 19 is included in a means for selectively utilizing a first signal output from stage 15, derived through frequency-modulation detector 16, to reproduce a received frequency-modulated carrier wave corresponding to a signal within a given frequency range, or for utilizing a second signal output from the stage, derived from load circuit 40, 41, to reproduce a received amplitude-modulated carrier signal corresponding to a signal within the given frequency range. When operating as a frequency-modulation receiver the elements 39, 42 effectively com-

prise a fast time-constant circuit so that the grid of tube 35, in addition to the usual limiting action thereon provided by the time-constant circuit including elements 40, 41, is made substantially less responsive to higher-frequency components such as noise components.

While it is not intended to limit the circuit of the invention to any particular circuit values, there follows a list of circuit values which have been found to be particularly effective in the circuit of Fig. 1.

Tube 35	Type 6SJ7
Condenser 41	400 micro-microfarads
Condenser 42	50 micro-microfarads
Condenser 44	0.02 microfarad
Resistor 39	50 kilohms
Resistor 40	250 kilohms
Resistor 43	1 megohm
Resistor 36'	20 kilohms
Resistor 20'	20 kilohms
Tuned circuits 36-38, 20, 21, and 22, 23	Tuned to a frequency of 2900 kilocycles

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, and means for selectively utilizing a first signal output from said stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a second signal output from said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

2. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, and means for selectively utilizing a signal output from said output circuit to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a signal output from said input circuit to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

3. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means included in said stage

for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means for detecting amplitude-modulation components in said input circuit and for deriving a signal output therefrom, and means for selectively utilizing a signal output from said output circuit to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range or said detected amplitude-modulation components to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

4. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means comprising a tuned circuit and a time-constant circuit in said input circuit for detecting amplitude-modulation components and for deriving a signal output therefrom, and means for selectively utilizing a signal output from said output circuit to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or said detected amplitude-modulation components to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

5. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means including a tuned circuit and a time-constant circuit for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said carrier-frequency range, means included in said stage for causing said stage to act as an amplitude detector over said given carrier-frequency range, and means for selectively utilizing a first signal output from said stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or amplitude-modulation components derived from said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

6. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means including a tuned circuit and a time-constant circuit in said input circuit for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage and including said tuned circuit and said time-constant circuit for causing said stage to act as an amplitude detector over said given carrier-frequency range, and means for selectively utilizing a first signal output from said stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or the amplitude-modulation components developed in said time-constant circuit to reproduce a received amplitude-modu-

lated carrier wave corresponding to a signal within said given frequency range.

7. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having input and output circuits, means including a tuned circuit and a time-constant circuit in said input circuit for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage and including said tuned circuit and said time-constant circuit for causing said stage to act as an amplitude detector over said given carrier-frequency range, means for selectively utilizing a first signal output from said stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given range, or the amplitude-modulation components derived in said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency-range, and means including a second time-constant circuit in said input circuit for removing carrier-frequency components from the signal supplied to said reproducing means when the receiver is operating as an amplitude-modulation receiver and for causing said stage to be substantially less responsive to higher-frequency modulation components when the receiver is acting as a frequency-modulation receiver.

8. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage including a vacuum tube having an input circuit and an output circuit, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, means included in said input circuit for deriving an automatic amplification control voltage for said receiver, and means for selectively utilizing a first signal output from said stage to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a second signal output from said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

9. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage, a frequency-modulation detector coupled to said stage, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, means for deriving a voltage from said frequency-modulation detector to provide an automatic-frequency control for said receiver, and means for selectively utilizing a first signal output derived from said stage through said frequency-modulation detector to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a second signal output from said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

10. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage, a frequency-modulation detector coupled to said stage, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, means for deriving a voltage from said frequency-modulation detector to provide an automatic-frequency control for said receiver, and means for selectively utilizing a first signal output derived from said stage through said frequency-modulation detector to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a second signal output from said stage to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range.

11. A modulated-carrier wave-signal receiver comprising, a carrier-frequency signal-translating stage, means included in said stage for causing said stage to act as an amplitude limiter over a given carrier-frequency range so that amplitude modulation is removed from translated signals within said given carrier-frequency range, means included in said stage for causing said stage to act as an amplitude-modulation detector over said given carrier-frequency range, a signal reproducer, and means for selectively deriving a first signal output from said stage and applying it to said signal reproducer to reproduce a received frequency-modulated carrier wave corresponding to a signal within said given frequency range, or a second signal output from said stage and applying it to said signal reproducer to reproduce a received amplitude-modulated carrier wave corresponding to a signal within said given frequency range, said last-named means comprising means for disconnecting the circuit for translating each of said signal outputs to said signal-reproducer during the time when the other of said signal outputs is being supplied to said signal-reproducer.

JOHN F. FARRINGTON.