

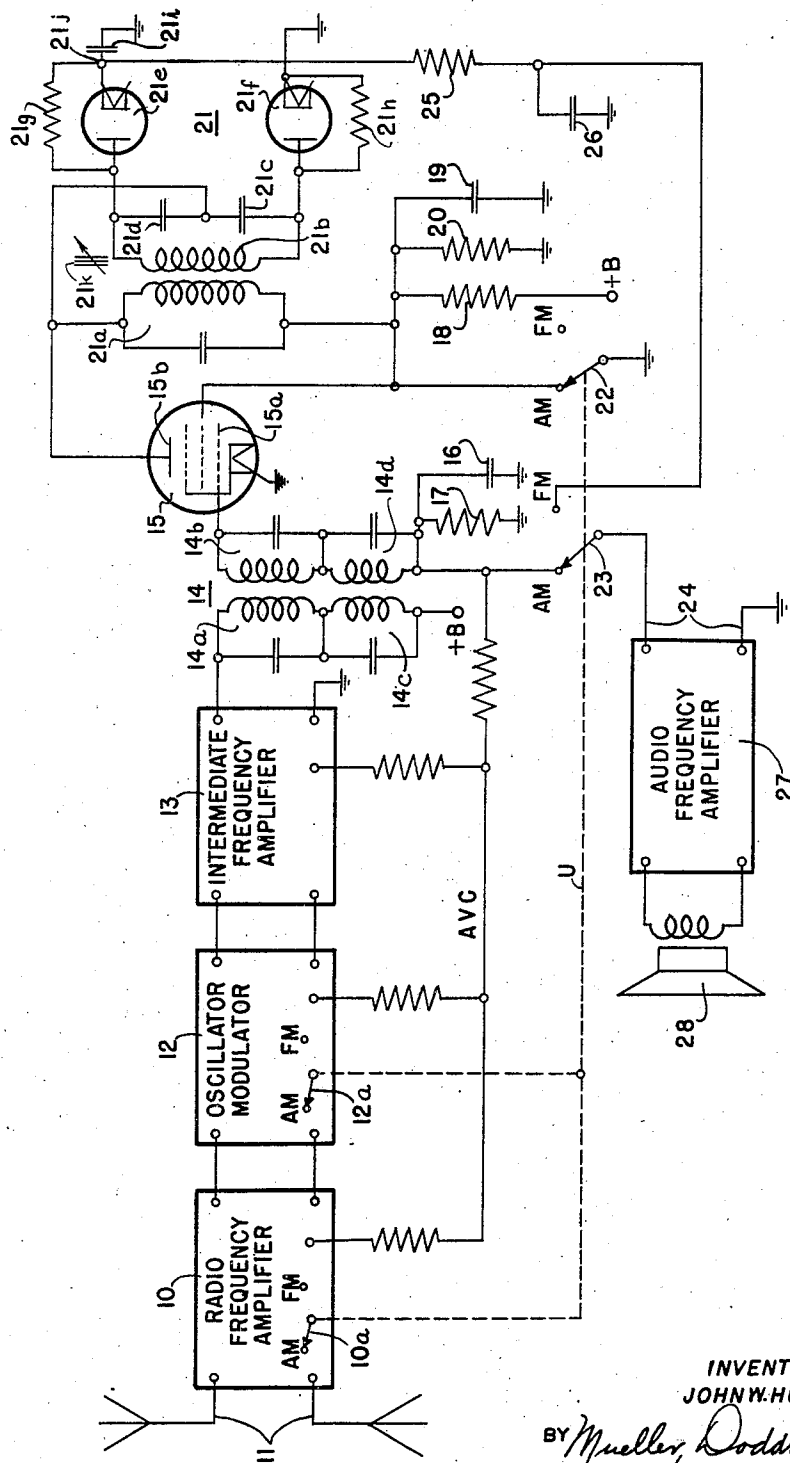
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COMBINED AMPLITUDE-MODULATION AND FREQUENCY-MODULATION RECEIVER STAGE

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COMBINED AMPLITUDE-MODULATION AND
FREQUENCY - MODULATION RECEIVER
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This invention relates to combined amplitude-modulation and frequency-modulation receiver stages and to a receiver embodying the same and particularly to a receiver of the type designed with a view to maximum simplicity for marketing in the lower price ranges.

In the prior art receivers designed for the reception of the standard broadcast band of approximately 500-1500 kilocycles and the frequency-modulation band of 41-50 megacycles, it has been the practice to provide an amplitude-modulation signal-transmitting channel including a diode amplitude-modulation detector, a frequency-modulation signal-translating channel, at least in part distinct from the amplitude-modulation channel and including one or more limiters followed by a frequency discriminator or detector, and an audio-frequency system selectively energized from the amplitude-modulation channel or the frequency-modulation channel. This use of distinct amplitude-modulation and frequency-modulation channels increases the complexity and cost of the receiver and has limited the lower price ranges within which this type of receiver could be marketed.

It is an object of the invention, therefore, to provide a new and improved combined amplitude-modulation and frequency-modulation receiver stage for selectively effecting detection of a received amplitude-modulation signal or acting as a limiter for a received frequency-modulation signal.

It is another object of the invention to provide an improved receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals and including a combined amplitude-modulation and frequency-modulation receiver stage of the type described, in order substantially to reduce the complexity and cost of the receiver.

In accordance with the invention, in a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprises a vacuum tube having a plurality of electrodes, including a signal input electrode and a signal output electrode, and an input circuit for applying received signals to the input electrode. The stage also includes a frequency discriminator coupled to the output electrode of the vacuum tube, a signal-frequency output circuit, circuit connections for the tube electrodes to cause the tube to operate as a diode amplitude-modulation detector and other circuit connections for the tube electrodes to cause the tube to

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operate as a frequency-modulation limiter. The stage also includes switch means operable in a first position to establish the first-named circuit connections and to connect the output circuit to the amplitude modulation detector and operable in a second position to establish the second-named circuit connections and to connect the output circuit to the discriminator.

Also in accordance with the invention, a wave signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals comprises, in the order named, a radio-frequency selecting and converting means for deriving from a selected received radio-frequency signal an intermediate frequency signal, a dual-purpose signal-translating stage of the type described, and a signal-reproducing means coupled to the signal-frequency output circuit of the stage.

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 while its scope will be pointed out in the appended claims.

Referring now to the drawing, the single figure is a circuit diagram, partly schematic, of a complete superheterodyne receiver embodying the combined amplitude-modulation and frequency-modulation receiver stage of the invention.

Referring now to the single figure of the drawing, there is represented, partially schematically, the circuit of a complete superheterodyne wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals. This receiver comprises a radio-frequency amplifying and selecting unit 10 having its input circuit connected to an antenna circuit 11 and its output circuit connected to an oscillator modulator 12, these two units being effective to derive from a selected received radio-frequency signal an intermediate-frequency signal from either the amplitude-modulation range or the frequency-modulation range. The units 10 and 12 may be of conventional design with suitable range switches 10a, 12a, respectively, for selectively translating amplitude-modulated signals or frequency-modulated signals. The receiver also includes an intermediate-frequency selector and amplifier 13 coupled to the oscillator modulator 12 for translating the intermediate-frequency signal of either type. The unit 13 may be of any suitable type and, as shown, includes in its output circuit a composite tuned selector 14 comprising tuned primary and secondary cir-

cuits 14a, 14b tuned to transmit the frequency-modulated intermediate-frequency signal in series with the primary and secondary tuned circuits 14c, 14d, respectively, tuned to the amplitude-modulation intermediate frequency. The series impedance of each of the component tuned circuits is negligible at the intermediate carrier frequency to which it is not intended to respond so that the tuned circuits effectively comprise an automatic switching arrangement for selectively receiving either the amplitude-modulated or the frequency-modulated intermediate-frequency signals.

The receiver also includes a dual-purpose signal-translating stage comprising a vacuum tube 15 having a plurality of electrodes, including a signal input electrode or grid 15a and a signal output electrode or anode 15b. Specifically, the tube is illustrated as of the pentode type including also conventional screen and suppressor electrodes. The secondary circuit of the selector 14 comprises an input circuit for applying received intermediate-frequency signals to the input electrode 15a of tube 15 and includes a time-constant circuit such as a series condenser 16 shunted by a leak or load resistor 17 therefor. The anode 15b of tube 15 and its screen are energized from a suitable source indicated as +B through a dropping resistor 18 by-passed to ground by means of a condenser 19 shunted by a resistor 20.

The receiver also includes a frequency discriminator 21 coupled to the output electrode 15b of tube 15. The discriminator may be of any conventional form but, as illustrated, comprises a primary tuned circuit 21a coupled to a secondary tuned circuit comprising an inductor 21b shunted by two series-connected condensers 21c and 21d. The inductor 21b is inductively coupled to the primary circuit 21a and, as indicated schematically, is adjustably tuned by means of a powdered iron or like ferro-magnetic core 21k. The high signal-frequency-potential terminal of the circuit 21a is connected to the junction between condensers 21c and 21d. Terminals of the secondary tunable circuit 21b, 21c, 21d are connected to diode rectifiers 21e and 21f shunted by load resistors 21g and 21h, respectively, the cathode of the diode 21f being grounded and the cathode of the diode 21e being by-passed to ground for intermediate-frequency signals through a condenser 21i. The signal-frequency output is derived from the terminal 21j of the discriminator 21. With the circuit connections for the tube 15 as described, it operates as a conventional frequency-modulation amplifier and limiter.

The stage also includes circuit connections for the electrodes of tube 15 such that it operates with the time-constant circuit 16, 17 as an amplitude-modulation detector. To this end there is provided switch means operable in its first position to modify the normal tube electrode connections and to establish the amplitude-modulation detector circuit connections. Specifically, this means comprises a two-position switch 22 effective in its first position, as illustrated, to connect the screen and output electrode or anode of tube 15 to ground, so that the input electrode 15a and cathode of the tube 15 function as a diode amplitude-modulation detector with the time-constant circuit 16, 17 as its load circuit. There is also provided a two-position switch 23 operable in its first position, as illustrated, to connect the time-constant circuit 16, 17 to a signal output

circuit 24 of the receiver. The switches 22 and 23 are ganged for unicontrol with each other and with the switches 10a, 12a of the units 10 and 12 by means of a mechanism indicated schematically at U. The switch 22 is operable in its second or FM position to remove the ground connection from the screen and output electrodes of tube 15 and to restore the tube electrode connections to normal; that is, to establish the FM limiter circuit connections. Simultaneously, the switch 23 in its second position is effective to connect the output circuit 24 to the terminal 21j of the discriminator 21 through a filter comprising a series resistor 25 and shunt condensers 21i and 26. The values of the resistor 17 and condenser 16 of the time-constant circuit are chosen to impart a short time-constant of the order of 2 microseconds to this circuit, which is necessary both for good limiter action and for satisfactory amplitude-modulation detection. The negative bias developed across the circuit 16, 17 is applied as an automatic amplification control bias to the control electrodes of one or more of the tubes included within the units 10, 12 and 13 by way of the AVC circuit, as indicated.

The receiver also includes an audio-frequency amplifier 27 coupled to the signal-output circuit 24 and having an output circuit connected to a signal reproducing means, such as a loud speaker 28.

The operation of the complete receiver illustrated in the drawing will be readily understood from the foregoing description. In brief, however, the units 10 and 12 are effective to derive from a signal picked up by the antenna circuit 11 an intermediate-frequency signal having one value of intermediate carrier frequency for frequency-modulated signals and a substantially different, usually lower value, of intermediate carrier frequency for amplitude-modulated signals, as determined by the constants of the oscillator circuit which are adjusted by operation of the switch 12a.

When the switches 10a, 12a, 22 and 23 are operated to their right-hand positions for the reception of frequency-modulated signals, the intermediate-frequency signals derived therefrom are selected by the portions 14a, 14b of selector 14 and applied to the signal-input electrode of tube 15. Due to the self-biasing action of the grid circuit of this tube, including the time-constant circuit 16, 17, and to the selection of its screen and anode potentials, the tube 15 operates in a conventional manner as a limiter to develop in its output circuit intermediate-frequency signals of substantially constant amplitude but frequency-modulated in accordance with the transmitted signal. This intermediate-frequency signal is impressed upon the discriminator 21 which operates in a conventional manner to develop at its terminal 21j a signal-frequency output. While the operation of the discriminator 21 is conventional, its circuit is not entirely conventional in that the primary voltage is fed into the secondary circuit 21b, 21c and 21d at the junction between the condensers 21c and 21d, which effectively comprise a voltage divider, rather than at a mid-tap of the inductor 21b as is conventional. This arrangement permits the use of an inductor 21b without an electrical midpoint and therefore adapted for tuning by the use of an adjustable powdered iron or other ferromagnetic core. Such an arrangement has well known improved frequency stability characteristics.

The signal-frequency output from the ter-

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minal 21j is passed through the carrier frequency filter 21i, 25, 26 and impressed through the switch 23 upon the audio-frequency amplifier 27 from which it is delivered to the loud speaker 28 for reproduction.

On the other hand, if the switches 10a, 12a, 22 and 23 are operated to their left-hand positions, as illustrated in the drawing, an intermediate-frequency signal of lower carrier frequency is developed by unit 13 and selected in portions 14c, 14d of selector 14 and impressed upon the signal-input electrode 15a of tube 15. With this connection, the screen and anode electrodes of tube 15 are effectively grounded so that the grid and cathode of this tube operate with the time-constant circuit 16, 17 as a conventional diode peak detector, developing a signal-frequency output across the time-constant circuit 16, 17. This output is impressed through the switch 23 upon the audio-frequency amplifier 27 from which it is delivered to the loud speaker 28 for reproduction.

As is well understood in the art, the AVC connection from the time-constant circuit 16, 17 is effective to impress upon the control electrodes of the tubes of the units 10, 12 and 13 a negative bias potential proportional to the average intensity of the received carrier signal and thus to control the amplification in these units in such a way as to maintain the amplitude of the signal input to detector 15 within a narrow range for a wide range of received signal intensities.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

I claim:

1. In a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprising, a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, circuit connections for said tube electrodes to cause said tube to operate as a diode amplitude-modulation detector, circuit connections for said tube electrodes to cause said tube to operate as a frequency-modulation limiter, and switch means operable in a first position to establish said first-named circuit connections and to connect said output circuit to said amplitude-modulation detector circuit and operable in a second position to establish said second-named circuit connections and to connect said output circuit to said discriminator.

2. In a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprising, a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a time-constant circuit, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, circuit connections for said tube electrodes to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector, circuit connections for said tube

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electrodes to cause said tube to operate as a frequency-modulation limiter, and switch means operable in a first position to establish said first-named circuit connections and to connect said output circuit to said time-constant circuit and operable in a second position to establish said second-named circuit connections and to connect said output circuit to said discriminator.

3. In a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprising, a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a series condenser and a leak resistor therefor, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, circuit connections for said tube electrodes to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector, circuit connections for said tube electrodes to cause said tube to operate as a frequency-modulation limiter, and switch means operable in a first position to establish said first-named circuit connections and to connect said output circuit to said condenser and operable in a second position to establish said second-named circuit connections and to connect said output circuit to said discriminator.

4. In a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprising, a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a time-constant circuit, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, said tube electrodes normally being connected to operate as a frequency-modulation limiter, and switch means operable in a first position to modify said tube electrode connections to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector and for connecting said output circuit to said time-constant circuit and operable in a second position to restore said tube electrode connections to normal and to connect said output circuit to said discriminator.

5. In a wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals, a dual-purpose signal-translating stage comprising, a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a time-constant circuit, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, said tube electrodes normally being connected to operate as a frequency-modulation limiter, and switch means operable in a first position to connect said signal output electrode to ground to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector and for connecting said output circuit to said time-constant circuit and operable in a second position to restore said tube electrode connections to normal and to connect said output circuit to said discriminator.

6. A wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals comprising, a radio-

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frequency selecting and converting means for deriving from a selected received radio-frequency signal an intermediate-frequency signal, a dual-purpose signal-translating stage including a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a time-constant circuit, a frequency discriminator coupled to said output electrode, a signal-frequency output circuit, circuit connections for said tube electrodes to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector, circuit connections for said tube electrodes to cause said tube to operate as a frequency-modulation limiter, and switch means operable in a first position to establish said first-named circuit connections and to connect said output circuit to said time-constant circuit and operable in a second position to establish said second-named circuit connections and to connect said output circuit to said discriminator, and a signal-reproducing means coupled to said output circuit.

7. A wave-signal receiver adapted selectively to receive amplitude-modulated signals or frequency-modulated signals comprising, a radio-frequency selecting and converting means for de-

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5 riving from a selected received radio-frequency signal an intermediate-frequency signal, a dual-purpose signal-translating stage including a vacuum tube having a plurality of electrodes including a signal input electrode and a signal output electrode, an input circuit for applying received signals to said input electrode including a time-constant circuit, a frequency discriminator coupled to said output electrode, a signal-frequency 10 output circuit, circuit connections for said tube electrodes to cause said tube to operate with said time-constant circuit as a diode amplitude-modulation detector, circuit connections for said tube electrodes to cause said tube to operate as a frequency-modulation limiter, and switch means operable in a first position to establish said first-named circuit connections and to connect said output circuit to said time-constant circuit and operable in a second position to establish said 20 second-named circuit connections and to connect said output circuit to said discriminator, switch means included in said selecting and converting means for selecting signals from the amplitude-modulation range or the frequency-modulation range, unicontrol operating means for both of said switch means, and a signal-reproducing means coupled to said output circuit.

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