

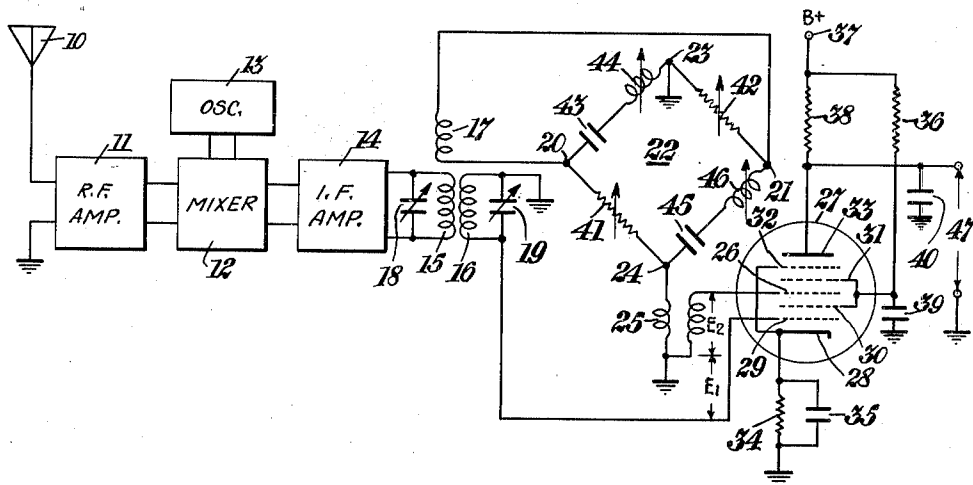
Nov. 29, 1949

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2,489,313

FREQUENCY MODULATION DISCRIMINATOR

Filed March 8, 1947



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2,489,313

FREQUENCY MODULATION
DISCRIMINATOR

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Application March 8, 1947, Serial No. 733,412

9 Claims. (Cl. 250—27)

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This invention relates to frequency or phase-modulation receiving systems and more especially to improvements in the frequency discriminating and detecting portions of such systems.

A principal object of the invention is to provide an improved frequency discriminator and detector arrangement employing a multi-grid tube in conjunction with a frequency-phase responsive bridge.

Another object is to provide a simplified frequency discriminator and detector for frequency-modulated receivers, employing a single multi-grid tube in conjunction with special alternating current bridge network, thereby obviating the drawbacks of the usual two-tube differential detectors.

A feature of the invention relates to the combination of a special alternating current bridge of the frequency-phase variation type, in conjunction with a demodulator tube of the multi-grid type, whereby the disadvantages of so-called square law detectors are avoided.

A further feature relates to the novel organization, arrangement and relative interconnection of parts which cooperate to provide an improved and simplified discriminator and detector arrangement for frequency-modulated carriers or phase-modulated carriers.

In the drawing,

The figure is a schematic wiring diagram of a receiving system embodying the invention.

Referring to the figure, there is shown a receiving system employing a receiver of the well-known superheterodyne type. The signals to be detected are picked up by any suitable means such as the antenna 10, and are amplified in the radio frequency amplifier 11 and are converted into corresponding intermediate frequency signals by the mixer device 12 and its associated local oscillator 13. The intermediate frequency signals are then amplified in any suitable intermediate frequency amplifier 14, whose output includes a tuned coupling transformer with primary winding 15, and a pair of secondary windings 16, 17. Windings 15 and 16 are tuned by respective condensers 18, 19, to the mean frequency of the received frequency-modulated carrier, it being understood of course that this coupling transformer is designed to pass the necessary frequency band representing the limits of frequency deviation of the said mean or center frequency of the carrier. Winding 17 is untuned so as to apply a portion of the frequency-modulated intermediate frequency carrier directly to the conjugate points 20, 21, of a special alternat-

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ing current bridge 22. The remaining two conjugate points 23, 24, of this bridge are connected to the primary winding 25 of a coupling transformer whose secondary winding is connected to the second control grid 26 of a multi-grid tube 27, such for example as a so-called pentagrid tube having an electron-emitting cathode 28; a first control grid 29; interconnected shield grids 30, 31 which shield the second control grid 26; a suppressor grid 32, and a plate or output electrode 33. The winding 16 is connected across the control grid 29 and cathode 28 which is self-biased with respect to ground by the usual cathode bias resistor 34 and its shunt condenser 35. The shield grids 30, 31, are connected in the usual way through a resistor 36 to the +B terminal 37 of the D. C. plate power supply, the plate 33 likewise being connected to this terminal through a suitable plate load resistor 38. In the conventional way, the resistors 36 and 38 are by-passed to ground for the intermediate frequencies by the respective by-pass condensers 39 and 40.

The bridge 22 comprises two equal resistor arms 41, 42, and two similar resonant arms. One of these resonant arms includes capacitor 43 in series with adjustable inductance 44. The other resonant arm includes a similar capacitor 45 in series with an adjustable inductor 46. The bridge is balanced for example by the inductors 44 and 46 so that when the mean center frequency of the received carrier is present at the points 20, 21, the voltage E_2 is zero. The windings 15 and 16 are loosely coupled and are respectively tuned to the same frequency for coupling the voltage E_1 to the grid 29 of tube 27. When the carrier frequency excursion is in one direction from the center frequency, the bridge 22 is unbalanced and produces a corresponding amplitude variation in the voltage E_2 . However, this voltage E_2 will be either at the same phase as voltage E_1 , or will be 180° out of phase with respect to the voltage E_1 , depending upon the direction of excursion of the carrier frequency from its center frequency. Thus the bridge 22 performs the double function of producing zero or 180° phase difference between the voltages E_1 and E_2 , and at the same time causes the voltage E_2 to be amplitude modulated in accordance with the deviation of the carrier from its center frequency. The grids 26 and 29 of tube 27 are biased by resistor 34 so as to operate preferably on the linear portions of their respective plate-current grid-voltage characteristic curves. The net result is that the two voltages applied to

the grids 26 and 29 appear as a corresponding demodulated variable amplitude audio frequency signal at the output terminals 47. For a detailed description of the demodulating action of the tube 27, reference may be had to my prior Patent No. 1,945,814. While the said patent discloses a triode as the demodulator, the electrodes 28, 29 and 26 of this application function similarly to the cathode, grid, and plate of the triode demodulator in said patent, in so far as the demodulating action is concerned.

From the foregoing described arrangement, it will be seen that the demodulation is effected without the use of the conventional double diode or differential detector tubes which operate on the square law principle. If desired, any of the well-known amplitude limiters may be inserted between the intermediate frequency amplifier 14 and the coupling transformer 15-16, so that the detected output at the terminals 47 is a true replica of the original signals to be transmitted and received. It will be understood of course that any suitable audio frequency amplifier and signal translating device may be connected to the terminals 47.

While one particular embodiment has been described herein, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention. Thus, while the discriminator-detector unit is shown in connection with a frequency-modulated intermediate frequency carrier, it will be understood that the bridge 22 may be used in conjunction directly with a frequency-modulated radio frequency carrier.

What is claimed is:

1. A frequency discriminator and demodulator arrangement for frequency-modulated receivers and the like, comprising an alternating current bridge of the Wheatstone type, a multi-grid electron tube having a cathode, an anode, and at least two control grids, means to impress a first portion of the frequency modulated carrier on one of said control grids, means to impress a second portion of the frequency-modulated carrier on two conjugate points of said bridge to derive at the other two points a voltage whose phase angle with respect to the phase angle of the first portion is either zero or one-hundred eighty degrees, said voltage having amplitude modulations representing the frequency deviation of the carrier from its center average frequency, and means to impress on the other of said control grids the said derived voltage at said other two conjugate points.

2. A frequency discriminator and demodulator arrangement for frequency modulation receivers and the like, comprising an alternating current bridge having a pair of balancing arms including adjustable reactance elements, a multi-grid demodulator tube having a cathode, an anode, and at least two control grids, means to impress a received frequency-modulated carrier directly on one of said control grids, means to impress on the other control grid the frequency-modulated carrier after being acted upon by said bridge, and means including said reactance elements to balance said bridge at the average center frequency of said frequency-modulated carrier.

3. A frequency discriminator and demodulator arrangement for frequency modulation receivers and the like, comprising a multi-grid demodulator tube having a cathode, an anode, and at least two control grids, an alternating current bridge of the Wheatstone type having a pair of balancing arms each including an adjustable reactor, means

for coupling the frequency-modulated waves to one pair of conjugate points of the bridge, means for coupling the other pair of conjugate points to one of said control electrodes, means for coupling the frequency-modulated waves to the other control grid independently of said bridge, said bridge being balanced at the mean center frequency of said carrier.

4. A frequency discriminator and demodulator arrangement according to claim 3 in which said bridge is of the resonant type which when balanced produces zero output for input waves at the resonant frequency of the bridge.

5. A frequency discriminator and demodulator arrangement for frequency modulation receivers and the like, comprising a coupling transformer excited by frequency-modulated carrier, means to tune said transformer to the mean center frequency of said carrier, a multi-grid demodulator tube having a cathode, an anode, and at least two control grids, means connecting said transformer to one of said control grids, an alternating current bridge of the resonance type, means coupling one pair of conjugate points of said bridge to said transformer, and means coupling the other pair of conjugate points of said bridge to the other control grid.

6. A frequency discriminator and demodulator arrangement for frequency modulation receivers and the like comprising, a coupling transformer having input and output windings respectively tuned to the center frequency of a received frequency-modulated carrier, a multi-grid demodulator tube having a cathode, an anode, and at least two control grids, means coupling said output winding of said transformer to one of said control grids, an additional winding coupled to the primary of said transformer, an alternating current bridge of the resonant type, means to balance said bridge at the center frequency of said carrier, two conjugate points of said bridge being connected to said additional winding and the other two conjugate points of said bridge being connected to the other of said control grids.

7. A frequency discriminator and demodulator arrangement comprising a plural grid demodulator tube having a cathode, an anode, and at least two control grids, an input device for supplying a frequency-modulated carrier, a pair of paths coupling said device respectively to the two control grids of said tube, the first of said paths having a voltage ninety degrees out of phase with the received carrier, the second of said paths including means to control the phase angle of the carrier to be zero or 180 degrees with respect to the carrier phase angle in the first path, the last-mentioned means comprising an alternating current bridge having two of its balancing arms each consisting of capacitance and adjustable reactance for balancing the bridge at the mean center frequency of the carrier.

8. A frequency discriminator and demodulator arrangement comprising, a source of frequency-modulated carrier, a carrier demodulating device, a pair of paths coupling said source to said device, the second one of said paths having means to control the carrier to be zero or 180 degrees with respect to the carrier phase in the first path while producing an amplitude variation corresponding to the deviation of the carrier from its center frequency, and means to impress the carriers from both said paths simultaneously on said demodulator device.

9. A frequency discriminator and demodulator arrangement comprising, a source of frequency-

modulated carrier, a carrier demodulating device, a pair of paths coupling said source to said device, the second one of said paths having means to control the carrier to be zero or 180 degrees with respect to the carrier phase in the first path, means to impress the carriers from both of said paths simultaneously on said demodulator device, said second path including a Wheatstone bridge of the alternating current type which is normally balanced to produce zero amplitude output at the center frequency of the frequency-modulated carrier.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,945,814	Kolozsy -----	Feb. 6, 1934
2,063,588	Crosby -----	Dec. 8, 1936
2,215,284	Armstrong -----	Sept. 17, 1940
2,332,540	Travis -----	Oct. 26, 1943
2,411,605	Webb -----	Nov. 26, 1946