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J. D. REID

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FREQUENCY MODULATION SIGNAL DETECTOR

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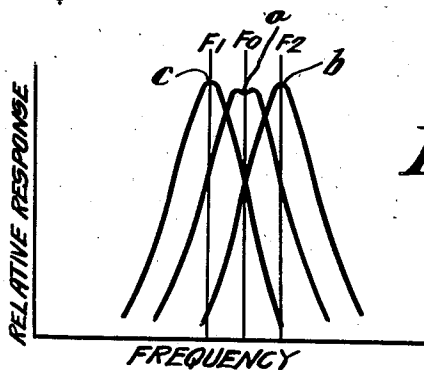
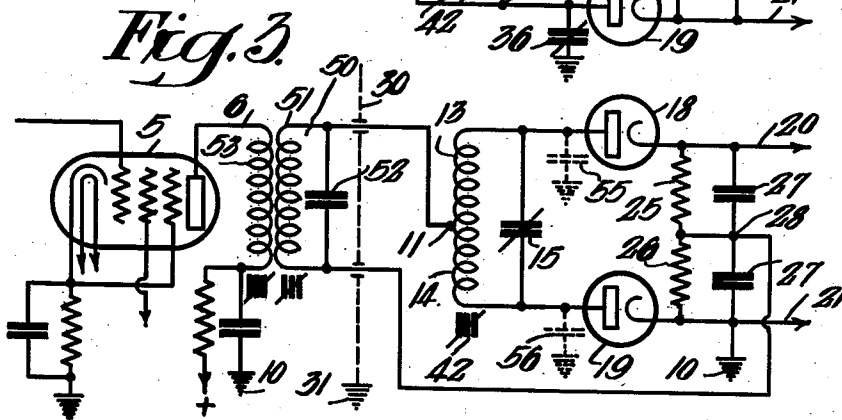
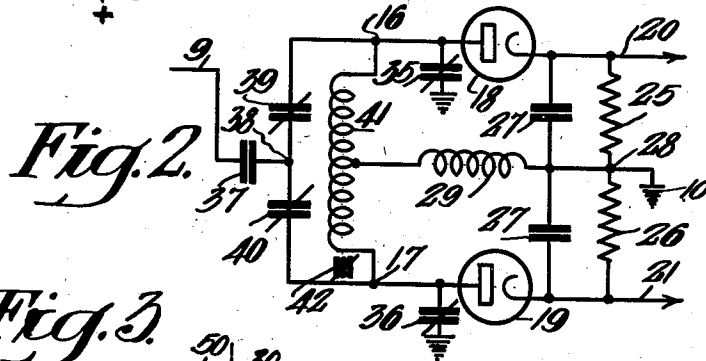
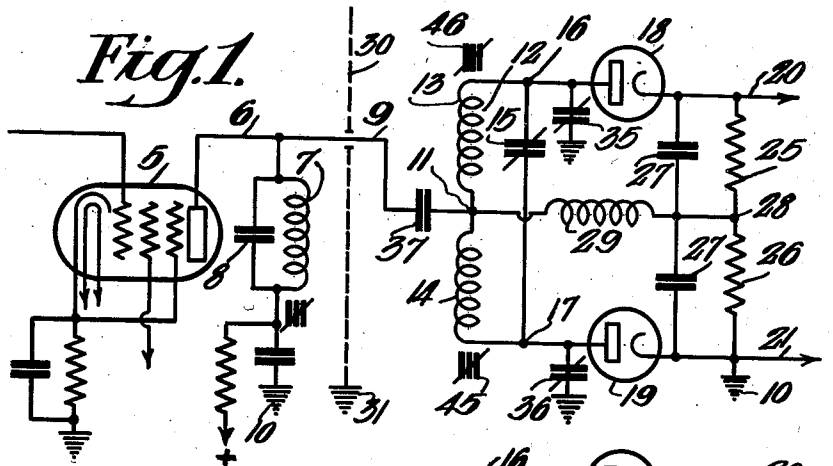


Fig. 4.

Inventor

John D. Reid

Attorney

UNITED STATES PATENT OFFICE

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FREQUENCY MODULATION SIGNAL
DETECTORJohn D. Reid, Philadelphia, Pa., assignor to Radio
Corporation of America, a corporation of Dela-
ware

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This invention relates to frequency modulation signal detectors of the type comprising a frequency discriminator network and rectifier means connected therewith in balanced relation. In known detectors of this type, the frequency discriminator network and rectifier means is arranged in bridge form and the incoming signal is introduced into the network through two paths, one of which provides a connection across one diagonal of the bridge and the other of which provides coupling with two of the bridge arms.

It is an object of this invention to provide an improved and simplified frequency discriminator network and rectifier means arranged for the introduction of signals thereto through a single path, whereby the necessity for multiple coupling elements is obviated.

It is a further object of this invention to provide an improved frequency modulation or variable frequency detector having a simplified frequency discriminator network wherein the tuning alignment is facilitated and which may be resolved into bridge form with input coupling across one diagonal only, thereby eliminating magnetic or additional coupling to the arms of the bridge.

The invention will, however, be better understood when considered in connection with the accompanying drawing, and its scope is pointed out in the appended claims.

In the drawing,

Figure 1 is a schematic circuit diagram of a frequency modulation or variable frequency detector embodying the invention,

Figure 2 is a similar schematic circuit diagram showing a modification of the circuit of Fig. 1, also embodying the invention,

Figure 3 is a schematic circuit diagram of a frequency modulation or variable frequency detector showing a further modification of the circuit of Fig. 1, and

Figure 4 is a graph showing curves illustrating a certain frequency response characteristic of the circuits of Figs. 1, 2 and 3.

Referring to Fig. 1, an amplifier stage 5 terminating any suitable variable frequency or frequency modulation signal channel is provided with a tuned output circuit 6 comprising an inductance 7 and shunt capacitor 8 responsive to the mean or center frequency and coupled through a single path comprising a lead 9 and ground or other suitable return path 10—10, with a tap 11 on a tuned circuit 12 comprising an in-

ductance element 13, a second inductance element 14, and a capacity 15.

The inductance elements are connected in series on opposite sides of the tap 11, with the capacitor 15 connected in shunt with the series-connected inductance elements of the circuit 12 which is adjusted to respond to the center frequency of the amplifier pass band. This may be considered to be an intermediate frequency band in a superheterodyne receiving system of which the stage 5 is the last intermediate frequency amplifier.

The circuit 12 is connected at its terminals 16 and 17, to which the terminal ends of the winding 13—14 are connected in balanced relation with two diode rectifiers 18 and 19, which in turn are connected to a balanced output circuit 20—21 across a pair of series-connected output impedances or resistors 25 and 26 each provided with a suitable high frequency bypass capacitor 27. The midpoint of the output circuit 28 is conductively connected back to the input circuit, as to the center terminal 11, through a high frequency choke coil 29 providing a return path for the diode rectifier current.

This discriminator network resembles known circuits in the general arrangement of the rectifiers in balanced relation between the input circuit 12 and the output circuit 20—21. However, it will be noted that the coupling from the supply circuit, which is the output circuit 6 of the amplifier stage 5, is through a single path 9, and that the arms of the bridge formed by the detector circuit comprising the inductance elements 13 and 14 are not electromagnetically coupled with the tuned circuit 7 in the output circuit 6. Such coupling is readily prevented by suitable shielding means indicated schematically at 30, being a metallic member suitably connected to ground, as indicated at 31.

Furthermore, the network is so arranged that, from the output terminal 16 to ground, the circuit 12 is tuned either above or below the mean or center frequency F_0 . Likewise, the circuit from terminal 17 to ground is tuned in the opposite direction either above or below the center or mean frequency F_0 . This provides an unbalance in the tuning for the signal frequencies F_1 and F_2 , indicated in Fig. 4, above and below the center frequency F_0 , and a balance in the network for the latter frequency whereby the network and rectifier means is effective as a detector for variable frequency or frequency-modulated signals about the said mean frequency F_0 . This provides a maximum output voltage for the

output circuit 20—21 at the frequencies F_1 and F_2 .

The bridge is unbalanced at these frequencies and other frequencies than the center frequency F_0 , by adjusting the inductance element 13 with respect to the inductance element 14 which may be referred to as L_1 and L_2 , respectively. With this arrangement, the inductance of L_1 may be slightly lower than the inductance of L_2 , or vice versa, to cause the said elements to respond respectively to the frequencies F_1 and F_2 , thereby providing effective discrimination without the addition of a second coupling path to the supply circuit.

The two halves of the discriminator network may also be unbalanced or tuned above and below the mean frequency by adjusting a capacity across each of the rectifier devices 18 and 19, utilizing the interelectrode capacity and, if necessary, additional external capacity indicated by the variable capacitors 35 and 36 connected effectively across the rectifiers between the terminals 16 and 17 and ground.

It will be noted that the coupling path to the circuit 9 includes a blocking capacitor 37 which could be omitted except for the fact that plate potential is on the lead 9 from the plate circuit of the tube 5.

The input circuit 9 may be coupled also to the circuit 12, as indicated in Fig. 2, with a center tap 38 between two series-connected capacitors 39 and 40 across the inductance elements L_1 and L_2 , the combined series capacity being equal to that of the capacitor 15 with the inductance L_1 and L_2 the same as the combined inductance of the elements 13 and 14 in Fig. 1. It will be noted in Fig. 2 that the inductance elements 13 and 14 or L_1 and L_2 are combined in a single winding 41 tunable by means of a magnetic core indicated at 42. The unbalance in the circuit may be effected by adjusting the capacitors 35 and 36, as in the circuit of Fig. 1, or by adjusting the capacitors 39 and 40 which are of approximately equal value. The circuit is otherwise the same as in Fig. 1, and operates in a similar manner. The output circuit 20—21 is arranged in balanced relation to the ground connection 10 which is connected to the terminal 28. The choke coil 29 provides a D. C. return path for the diode current and may be connected as shown to any suitable point on the coil 41. In the circuit of Fig. 1, the tuning of the inductances 13 and 14 may be made individually by movable core elements 45 and 46 or the tuning may be accomplished by adjustment of the capacitor 15. The elements 13 and 14 may be electromagnetically separated one from the other or may be electromagnetically coupled, the modification in Fig. 2 showing them coupled, and the circuit of Fig. 1 showing them separated sufficiently to prevent electromagnetic coupling. However, for simplicity of construction, the coils 13 and 14 may be a continuous winding tapped at 11.

Referring now to Fig. 3, the same circuit elements and circuits as in Figs. 1 and 2 are designated by the same reference numerals. In this circuit, the main difference lies in the fact that the choke coil 29 and blocking capacitor 37 are replaced by a tuned circuit 50 comprising a transformer secondary winding 51 and a shunt capacitor 52 connected between the input terminal 11 and the center tap 28 of the output circuit, the signals being thereby introduced across the diagonal of the network from a pri-

mary winding 53 connected in the output circuit 6 of the stage 5 and coupled to the winding 51, as indicated. This gives additional selectivity with a minimum increase in elements involved over the arrangement of Fig. 1.

It will be noted that, in this circuit, the inductances 13 and 14 are unbalanced, that is, not equal in inductance value to provide the resonant characteristic for signals off the center or mean frequency. In this case, therefore, the interelectrode capacity of the rectifiers 18 and 19 are indicated at 55 and 56 without additional shunt capacity elements for unbalancing the tuning of the circuit.

From the foregoing description, it will be seen that a frequency discriminator network may be provided with a single input signal path connected across a diagonal of the bridge circuit and that the circuit may be unbalanced by providing unequal inductance elements serially in the tuned circuit of the network or by unbalancing the capacities across the rectifier elements. Therefore, the resonant frequency from one diode or terminal of the network to ground may be made to fall on one side of the mean or center frequency, while the resonant frequency from the other diode or circuit terminal to ground may be made to fall on the opposite side of the center or mean frequency, thereby to provide effective frequency discrimination and, in connection with suitable rectifier devices, an effective frequency modulation detector, having a relatively high sensitivity and simplified tuning adjustment features.

I claim as my invention:

1. A frequency discriminator network comprising an input circuit having a tuning inductance in two sections serially connected and capacity means in shunt with said inductance providing resonance at a predetermined mean frequency, an output circuit, means for unbalancing said input circuit to provide resonance therein between opposite terminals thereof and ground above and below a center frequency, and means providing a single signal conveying path for introducing signals into said network.

2. In a frequency modulation detector, a frequency discriminator network comprising a pair of unequal inductance elements serially connected, shunt tuning capacity means connected across said series-connected inductance elements to provide a single input circuit for said detector resonant at a predetermined mean frequency, means for adjusting the inequalities of said inductance elements to resonate the terminals of said circuit with respect to ground above and below said mean frequency, and means for introducing signals into said network comprising a single circuit connection to said network between said inductance elements.

3. A frequency modulation signal detector comprising, in combination, a frequency discriminator network having a tuned circuit including two serially connected inductive bridge arms and a shunt tuning capacity element therefor, a rectifier connected to each of the terminals of said circuit, a balanced output circuit for said rectifiers comprising two substantially equal output impedance elements serially connected between said rectifiers, and a tuned input circuit connected between the junction of said inductance elements and the junction of said output impedances across a diagonal of the bridge forming the signal input means for said network.

4. A frequency modulation signal detector comprising, in combination, a frequency discriminator network having a tuned circuit including two serially connected inductive bridge arms and a shunt tuning capacity element therefor, a rectifier connected to each of the terminals of said circuit, a balanced output circuit for said rectifiers comprising two substantially equal output impedance elements serially connected between said rectifiers, and a tuned input circuit connected between the junction of said inductance elements and the junction of said output impedances across a diagonal of the bridge forming the signal input means for said network, said last named circuit including the secondary of a coupling transformer, an amplifier having an output circuit, and a primary winding for said transformer connected in said last-named circuit.

5. A frequency modulation signal detector comprising, in combination, means providing a tuning inductance having a tap intermediate between its terminal ends, a tuning capacitor connected in shunt with said tuning inductance, a pair of diode rectifiers each having an anode connected with a terminal of said circuit and having a cathode, a balanced output circuit for said diode rectifiers comprising a pair of output impedance elements connected serially between said cathodes, a single path signal conveying means connected between said tap and the junction of said impedance elements for introducing a frequency modulated signal into said network, a ground connection for said balanced output circuit, and means for unbalancing the tuning inductance on opposite sides of the tap to provide resonance above a predetermined center frequency for received signals between one of said circuit terminals and ground and resonance below said center frequency between the other of said circuit terminals and ground.

6. A frequency modulation signal detector, comprising, in combination, means providing a

tuning inductance having a tap intermediate between its terminal ends, a tuning capacitor connected in shunt with said tuning inductance, a pair of diode rectifiers having an anode connected with a terminal of said circuit and having a cathode, a balanced output circuit for said diode rectifiers comprising a pair of output impedance elements connected serially between said cathodes, a single path signal conveying means connected between said tap and the junction of said impedance elements for introducing a frequency modulated signal into said network, a ground connection for said balanced output circuit, and means for adjusting the capacity across each of said diode rectifiers to unbalance said network and to provide resonance above a predetermined center frequency for received signals between one of said circuit terminals and ground and resonance below said center frequency between the other of said circuit terminals and ground.

7. A frequency modulation signal detector comprising, in combination, means providing a tuning inductance having a tap intermediate between its terminal ends, a tuning capacitor connected in shunt with said tuning inductance, a pair of diode rectifiers each having an anode connected with a terminal of said circuit and having a cathode, a balanced output circuit for said diode rectifiers comprising a pair of output impedance elements connected serially between said cathodes, single path signal conveying means connected between said tap and the junction of said impedance elements for introducing a frequency modulated signal into said network, a ground connection for said balanced output circuit, and means for unbalancing said network to provide resonance above a predetermined center frequency for received signals between one of said circuit terminals and ground and resonance below said center frequency between the other of said circuit terminals and ground.

JOHN D. REID.