

IX = 43ZE

X 5419 R

2

2

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J. D. REID

2,264,151

FREQUENCY MODULATION SIGNAL RECEIVER

Filed Oct. 26, 1940

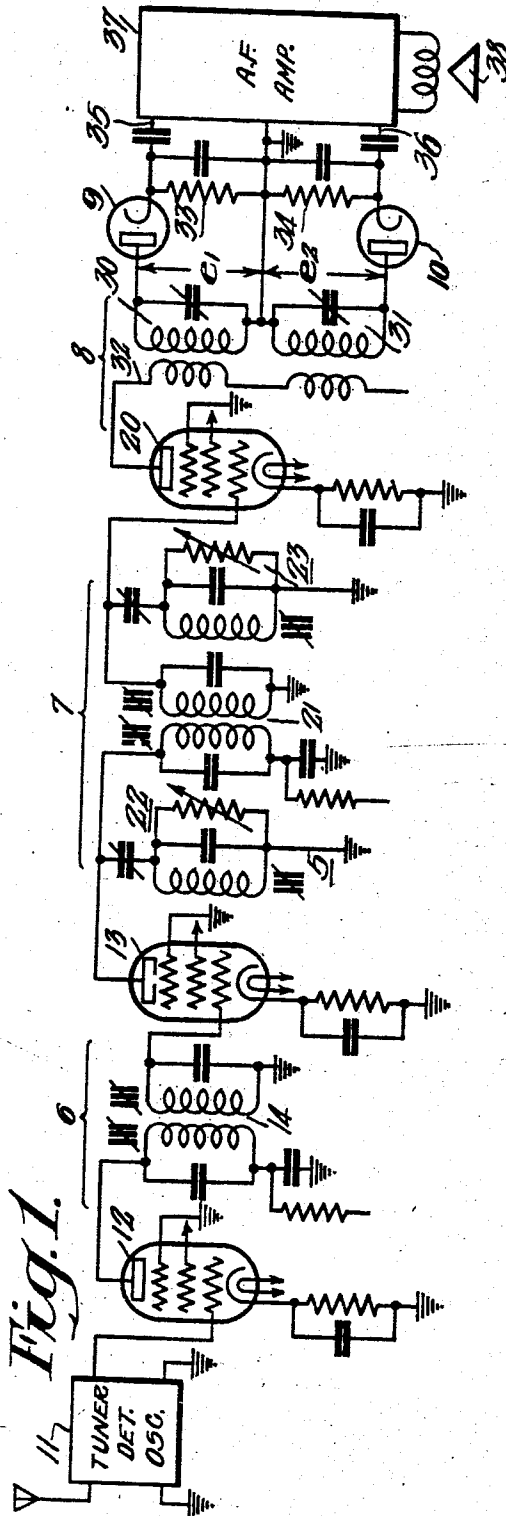


Fig. 1.

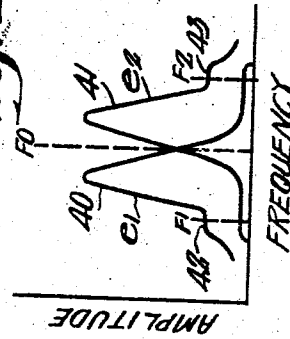


Fig. 3.

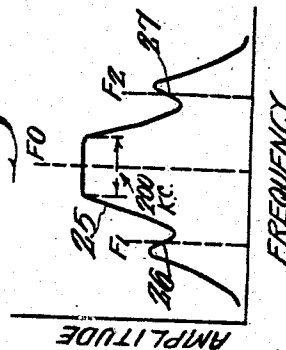
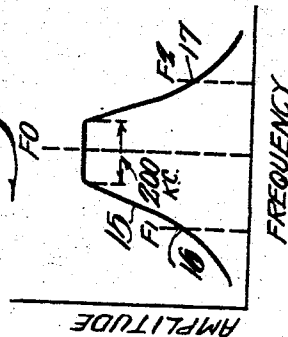


Fig. 4.



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FREQUENCY MODULATION SIGNAL
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8 Claims. (Cl. 250—20)

This invention relates to frequency modulation signal receivers, and has for its primary object to provide an improved frequency modulation signal conveying system comprising a series of tuned signal selecting circuits terminating in a frequency discriminator network and detector, the overall sensitivity characteristic of which has substantially zero slope in the frequency range of an interfering signal.

In frequency modulation signal receiving systems, the overall selectivity characteristic of a series of signal selecting circuits, preceding a discriminator network and second detector, provides a certain band width of response, for example, a band 200 kc. wide, and a selectively characteristic having substantially a flat top and sloping sides on either side of the pass band. The signal output or audio frequency signal derived from a detector comprising a balanced rectifier and frequency discriminator network in connection with such circuits, in response to received frequency modulated signals, is determined by the slope of the selectivity characteristic, and the steeper the sides of such characteristic, the greater the signal output with a given frequency swing.

Therefore, in the example above referred to, signals in the region of adjacent channel signal frequencies, which may have center frequencies substantially 200 kc. on either side of the center frequency of a selected signal, may fall within the selectivity characteristic and, while intercepting the slope on either side of the pass band at relatively low amplitude levels, may cause an appreciable output and interference in the discriminator network and detector. In other words, a signal that is relatively low in amplitude with respect to the received signal may fall within the pass band of the signal selecting circuits and intercept the selectivity characteristic at a point of relatively sharp slope sufficient to provide a high output in the discriminator circuit and heavy interference.

It has been found that this interference may substantially be prevented by imparting to the selectivity characteristic of one or more of the signal selecting circuits, a reversal of slope such that the overall selectivity characteristic at the discriminator network output circuit and at the second detector has substantially a zero slope or horizontal portion on either side of a desired pass band and in the region of an adjacent channel or interference signal frequency. In a preferred embodiment of the invention, in accordance with this system, the signal output to the

audio frequency or second detector is made substantially zero in response to adjacent channel and other signals in frequency ranges on either side of the desired pass band.

The invention is particularly adapted for use in connection with the intermediate frequency amplifier of a superheterodyne receiver and other cascaded signal conveying circuits tuned to a preselected signal band, such as an intermediate frequency band about a predetermined center or mid-frequency.

In carrying the invention into effect in its present preferred form, in connection with an intermediate frequency amplifier, one or more of the successive tuned circuits, such as the primary or secondary circuit or both circuits of a tuned intermediate frequency coupling transformer, are provided with tunable rejection circuits effective to provide a reverse slope in one or both sides of the selectivity characteristic of the tuned circuit or circuits to which they are connected, the reversal of slope being to a degree sufficient to effect a flattening or reduction to substantially zero of the slope of the overall selectivity characteristic at the discriminator network, thereby to provide substantially zero response to a predetermined interfering signal or adjacent channel signals.

The invention will, however, be further understood from the following description 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 signal receiving system embodying the invention, and

Figures 2, 3 and 4 are curves showing selectivity characteristics at certain points in the receiving system of Fig. 1.

Referring to Fig. 1, an intermediate frequency amplifier 5 comprising tuned circuits 6 and 7 is connected at its output end with a frequency discriminator network 8 provided with a pair of balanced rectifiers 9 and 10, and at its input end to suitable tuning and signal receiving means including detector and oscillator elements as indicated at 11.

The intermediate frequency amplifier comprises a first stage amplifier tube 12 coupled through the tuned circuit 6 to a second stage amplifier 13. The circuits 6 may include the tuned primary and secondary windings of an interstage intermediate frequency coupling transformer 14, the selectivity characteristic of which is indicated by

the curve 15 in Fig. 2. It will be noted that the selectivity characteristic has substantially a flat top providing a predetermined pass band, and that the sides of the characteristic curve are sloped at points of intersection 16 and 17 with interference signal frequencies F_1 and F_2 which may be the center frequencies of adjacent signal channels. The center frequency of the desired signal channel is indicated at F_0 .

A third intermediate frequency amplifier stage comprises a tube 20 which is coupled to the second stage 13 through a similar tuned interstage coupling transformer 21 as is provided at 14. This is included in the circuit 7 which also includes a rejection circuit 22 on the primary side and a similar rejection circuit 23 on the secondary side, the said circuits being tuned to modify the selectivity characteristic 15 on each side in accordance with the selectivity characteristic 25 of Fig. 3, to provide reverse slopes 26 and 27 therein, with the frequencies F_1 and F_2 falling substantially in the center of the reverse slopes as shown.

A sufficient number of rejection circuits are provided in the signal channel preceding the discriminator network 8 to provide a reverse slope on one or both sides of the selectivity curve of one or more of the series of tuned circuits in order to impart a horizontal or substantially zero slope in the overall selectivity characteristic of the discriminator network 8.

The network 8 may be of any suitable type responsive to variation in frequency about a predetermined center or mean frequency, and in the present example comprises a circuit 30 tuned above and a circuit 31 tuned below the center frequency and coupled to the output circuit 32 of the last intermediate frequency amplifier stage 20. The rectifiers 9 are connected to the circuits 30 and 31 in balanced relation thereto and to a balanced output circuit comprising output resistors 33 and 34 connected in series between the rectifiers 9 and 10. The output circuits 35 and 36 may be connected to any suitable utilization means such as an audio frequency amplifier 37 followed by a loudspeaker device 38 as shown.

Referring to Fig. 4 along with the preceding figures, the selectivity characteristics 40 and 41 are those taken at the circuits 30 and 31 respectively showing the voltage output e_1 and e_2 for said circuits with variation in frequency above and below the center frequency F_0 .

It will be noted that the effect of the rejection circuits in the preceding signal conveying circuits is such that a portion 42 and a portion 43 in the slope of the overall characteristic is substantially flat or horizontal in predetermined frequency zones or in the region of undesired signal frequencies F_1 and F_2 . Thus the interference from adjacent channel or other predetermined interfering signal source is substantially eliminated by this system. It has been found that attenuation of a relatively high order may be obtained in this manner in a frequency modulation signal receiving system such that practically no adjacent channel interference is experienced in operation.

By varying the tuning, coupling and damping of the tuned circuits 22 and 23, the position of the zero slope portions 42 and 43 of the overall characteristics may be shifted.

I claim as my invention:

1. In a frequency modulation signal receiving system, the combination of a signal amplifier including a plurality of cascade-connected signal-

selecting circuits, means for coupling and tuning each of said circuits to provide a selectivity characteristic having a slope on either side of a predetermined passband, means for imparting to the selectivity characteristic of at least one of said circuits a reversal of slope of such degree that the overall selectivity characteristic of said circuits provides substantially zero slope in a frequency zone on at least one side of said passband, and a tuned frequency discriminator network coupled to the amplifier to utilize said selectivity characteristic to provide substantially zero output in said frequency zone.

2. In a frequency modulation signal receiving system, the combination of an amplifier having a plurality of tuned signal-selecting circuits, each of said circuits having a selectivity characteristic providing a slope on either side of a predetermined passband, a frequency discriminator network connected with said amplifier, and means for imparting to the selectivity characteristic of at least one of said circuits a reversal of slope of such degree that the overall selectivity characteristic of said circuits at the output of said discriminator network provides substantially zero slope in a frequency zone on either side of said passband.

3. In a frequency modulation signal conveying system comprising a plurality of tuned cascade-connected signal selecting circuits, the method of rejecting undesired frequency modulated signals which comprises causing the overall selectivity characteristic of said circuits to have substantially zero slope in the frequency range of an interfering signal.

4. In a frequency modulation signal conveying system comprising a plurality of tuned signal selecting circuits, the method of rejecting undesired frequency modulated signals which comprises imparting to at least one of said circuits a band pass selectivity characteristic, modifying the frequency response of said circuit to impart to said selectivity characteristic a reverse slope substantially centered in the frequency range of an interfering signal, and extending the degree to which said frequency response is modified to provide an overall selectivity characteristic for said circuits having substantially zero slope in said last named frequency range.

5. In a frequency modulation signal conveying system, the combination with a plurality of successive band pass circuits tuned to a common center frequency, of an absorption circuit coupled to one of said circuits and tuned to signals in a frequency range about a predetermined adjacent channel frequency for imparting to the selectivity characteristic of said last named circuit a reverse slope on at least one side thereof, means for controlling said absorption circuit to impart substantially a zero slope to the overall selectivity characteristic of said system in said frequency range, and a discriminator network coupled to the output end of said circuits and tuned for response to signals within the pass band thereof to effect substantially zero response and signal output in said adjacent channel frequency range.

6. In a superheterodyne frequency modulation signal receiving system, the combination of an intermediate frequency amplifier having a plurality of cascade connected tuned amplifier circuits responsive to signals in a predetermined frequency band having a predetermined center frequency, a frequency discriminator network coupled to said amplifier, a pair of rectifiers connected to said discriminator network providing

a balanced detector, and means for imparting to the selectivity characteristic of one of said amplifier circuits a reversal of slope effective to provide substantially zero slope in the overall frequency characteristic at the output of the discriminator network in the region of an interfering signal frequency.

7. In a superheterodyne frequency modulation signal receiving system, the combination of an intermediate frequency amplifier having a plurality of cascade connected tuned amplifier stages responsive to signals in a predetermined frequency band having a predetermined center frequency, a frequency discriminator network coupled to said amplifier, a pair of rectifiers connected to said discriminator network providing a balanced detector, a balanced output circuit connected with said rectifiers, and a pair of tuned absorption circuits coupled to certain of said first named circuits for imparting to the selectivity characteristic of at least one of said amplifier

stages a reversal of slope effective to provide substantially zero slope in the overall frequency characteristic at the output of the discriminator network in the region of an interfering signal frequency, thereby effectively to reduce the discriminator circuit output to zero in response to said interfering signal.

8. In a frequency modulation signal receiving system, the combination of an amplifier having a tuned signal-selecting circuit, said circuit having a selectivity characteristic providing a slope on one side of a predetermined passband, a frequency discriminator network connected with said amplifier, and means for imparting to the selectivity characteristic of said circuit a reversal of slope of such degree that the overall selectivity characteristic of said circuit at the output of said discriminator network provides substantially zero slope in a frequency zone on said one side of the passband.

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