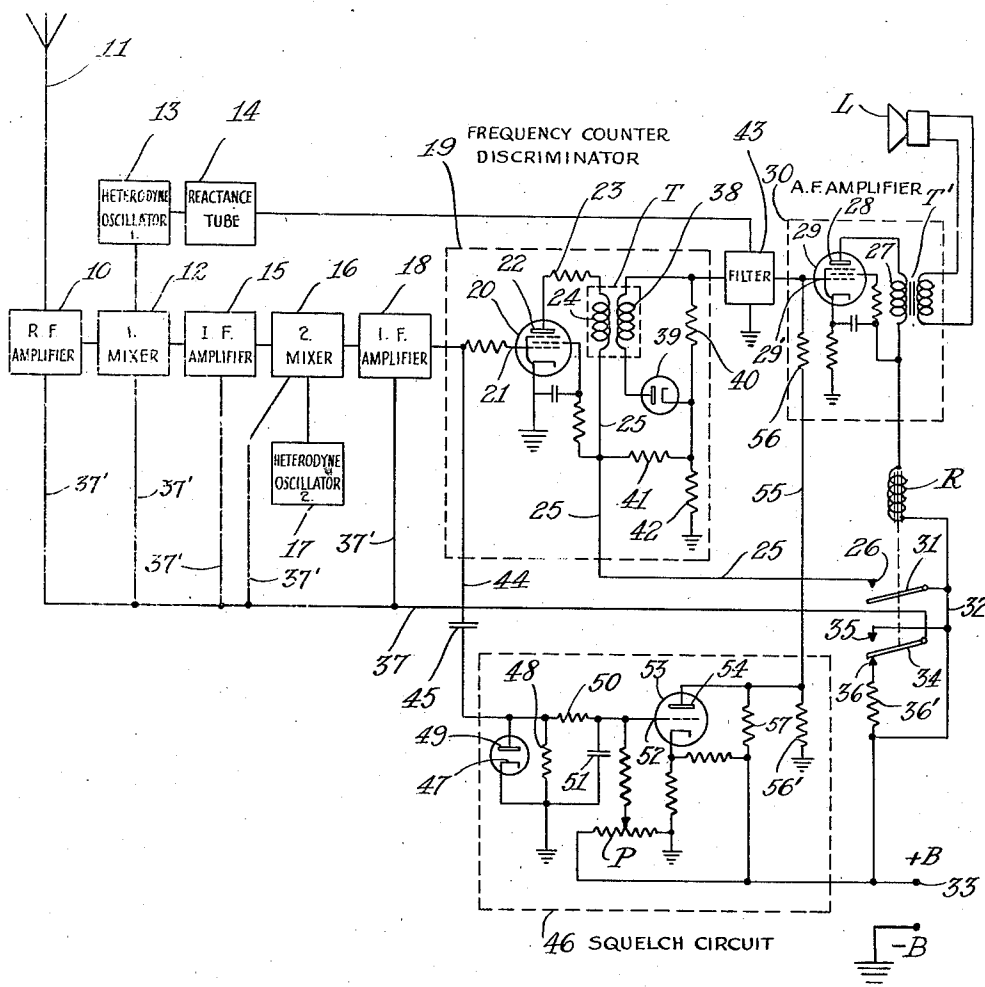


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J. M. JADRAQUE ET AL
FREQUENCY MODULATION RECEIVER

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FREQUENCY MODULATION RECEIVER

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The present invention relates to frequency modulation receivers and more particularly to frequency modulation receivers which include a squelch or muting system.

As is well known, the main purpose of squelch or muting systems is to suppress the output of the receiver when the incoming signal decreases to a predetermined value or fades out completely. Generally, the squelch systems are arranged to bias one or all amplifier tubes of the audio-channel to cut-off, when the intensity of the incoming signal drops below a predetermined threshold value, so that the receiver will remain in a standby condition with the audio-amplifier stage drawing no current from the supply source until the incoming signal increases to a value larger than the threshold of the squelch system.

However, in frequency modulation receivers including frequency counter discriminators of the type described in prior U. S. patent applications of Marc Ziegler et al., Serial No. 464,380, filed November 3, 1942, and of Marc Ziegler, Serial No. 477,990, filed March 4, 1943, the plate current of the counter tube is relatively large and, in fact, constitutes the major portion of the plate current drawn by the radio- and intermediate-frequency amplifier tubes of the receiver. Since in the known receivers, neither the counter tube nor the radio- or intermediate-frequency amplifiers are controlled by the squelch system, the main advantage of the receivers of the type referred to consists in the suppression of the disagreeable noise heard in the receiver output when the receiver is tuned from one station to another or when no carrier is present. The current consumption of the receiver during the period of standby is nearly the same as during reception, which is particularly disadvantageous in mobile receivers.

We have now found that the above drawback can be eliminated by inserting in the plate supply of one of the audio-amplifier tubes, a relay having one pair of contacts in series with the plate supply of the counter tube and another pair of contacts controlling the plate voltage of the radio- and intermediate-frequency amplifier stages, so that the counter tube is cut off and the plate voltage of the radio- and intermediate amplifier stages is considerably decreased when the squelch system blocks the audio-amplifier stage. Consequently, the current drain of the receiver is considerably lower during standby than during reception and in mobile installations batteries of smaller capacity can therefore be used.

An object of the present invention is to provide a frequency modulation receiver having a low current consumption during the standby period when no signal is present or when the

incoming signal drops below a predetermined value.

Other objects and advantages will hereinafter appear.

The drawing is a simplified, diagrammatic showing of a frequency modulation receiver constructed and operating in accordance with our invention.

In the drawing, the reference numeral 10 designates a radio-frequency amplifier provided with an antenna 11 and connected to a first mixer stage 12. A first heterodyne oscillator 13 provided with frequency controlling means in the form of a reactance tube 14 also is connected to the first mixer stage 12, the output circuit of which is coupled to an intermediate frequency amplifier 15. The first intermediate frequency amplifier is coupled to a second mixer stage 16 coupled to a second heterodyne oscillator 17, and the second intermediate frequency, generated in the output of second mixer 16 is amplified in a second intermediate amplifier stage 18 and is applied to the input of a frequency counter discriminator designated with the general reference numeral 19.

Discriminator 19 shown in the drawing is constituted by a compensated frequency counter similar to that fully described in the above-noted application of Marc Ziegler, Serial No. 477,990. The discriminator comprises a thermionic counter tube 20, the control grid 21 of which is connected to the output of second intermediate frequency amplifier stage 18, while the anode 22 of the tube is connected through a current limiting resistor 23 to one end of primary winding 24 of a transformer T. The other end of primary winding 24 is connected by means of conductor 25 to the make-contact 26 of a relay R. The winding of relay R is inserted in series with the primary winding 27 of audio-output transformer T' connected to the anode 28 of the amplifier tube 29 in the audio-amplifier stage 30, coupled by means of said transformer T' to a loudspeaker L.

Movable contact 31 of relay R is connected through conductor 32 to the positive pole 33 of a plate supply battery not shown in the drawing. Relay R is further provided with a movable contact 34 and fixed make and break contacts 35 and 36, respectively, the former being directly connected to conductor 32 and hence to the positive pole 33 of the supply battery, while the latter is connected to positive pole 33 through a voltage dropping resistor 36'. Movable contact 34 is connected by means of conductor 37 to the plate supply connections 37' of the radio-amplifier stage 10, intermediate-frequency amplifier stages 12 and 18, and mixer stages 12 and 16. Hence, relay R controls the plate tension of the radio- and intermediate-frequency stages of the

receiver in accordance with the position of movable contact 34.

The secondary winding 38 of transformer T is connected in a rectifier circuit arrangement including a diode rectifier tube 39 and load resistor 40. The junction point between diode cathode and load resistor 40 is connected to the junction point of two resistors 41 and 42, the former being connected to plate supply conductor 25, while the latter is connected to ground. The resistors thus constitute a potentiometer from which the compensating tension for the counter rectifier circuit is derived.

The junction point of load resistor 40 and secondary winding 38 of transformer T is connected to a filter 43 having two outputs, one being coupled to the control grid 29' of audio-amplifier tube 29, while the other is connected to reactance tube 14, so that the mean frequency of adjustable oscillator 13 is maintained on a predetermined frequency difference with respect to the mean frequency of the incoming signal.

The output circuit of intermediate frequency amplifier 18 is also coupled by means of conductor 44 and coupling capacitor 45 to a squelch system designated with the general reference numeral 46 and including a diode 47 closed on a load resistor 48. The anode 49 of diode 47 is connected to said coupling capacitor 45 and to filter circuit formed of a series resistor 50 and by-pass capacitor 51, so that a negative direct voltage proportional to the amplitude of the incoming signal is applied to control grid 52 of a squelch triode 53, the anode 54 of which is connected through conductor 55 and grid leak resistor 56 to control grid 29' of audio-amplifier tube 29. Anode 54 of squelch triode 53 is further connected to ground and to the positive pole 33 of the plate supply through resistor 56' and plate resistor 57, respectively. Control grid 52 of squelch triode 53 is connected to the movable arm of a potentiometer P inserted between positive pole 33 and ground and controlling the threshold of the squelch system, since for all signals generating a negative direct voltage lower than the positive bias applied to the grid 52 through potentiometer P, the plate current of triode 53 flowing through plate resistor 57 will generate a relatively high negative bias voltage at control grid 29' of audio-amplifier tube 29 so that no signal will be reproduced by loud-speaker L. At the same time, relay R is rendered inoperative due to the considerable decrease in plate current of audio-amplifier tube 29, and movable arm 31 disconnects the plate supply for countertube 20. Simultaneously, a lower plate tension is applied to the radio mixer and intermediate-frequency amplifier stages of the receiver, since these stages are connected to the positive pole 33 of the plate supply through voltage dropping resistance 36'.

Therefore, during standby periods, the current drain of the receiver is very low, and may constitute only a third of the current drawn during reception. Nevertheless, the sensitivity of the receiver is still sufficient to operate squelch system 46 as soon as the intensity of the incoming signal increases above the threshold, since frequency modulation receivers are designed to saturate the limiter of frequency counterstage with signals as low as 0.1 microvolt.

As soon as the intensity of the incoming signal increases to a value above the threshold of the squelch system, squelch triode 53 is biased to cut-

off by the negative voltage at its control grid 52. Consequently, the high negative bias is removed from control grid 29' of audio-amplifier tube 29, the plate current of which operates relay R, so that movable contact 31 completes the plate supply circuit of countertube 20, while movable contact 34 is moved to make-contact 35, thus connecting the full plate supply voltage to the radio frequency mixer and intermediate frequency stages of the receiver.

While we have indicated and described a system for carrying our invention into effect, it will be apparent to one skilled in the art that our invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of the invention, as set forth in the appended claims.

We claim:

1. In a receiver for frequency modulated signals comprising radio-frequency amplifying and heterodyning means connected to a frequency discriminator including a thermionic countertube, audio-amplifying and reproducing means connected after said frequency discriminator, means to produce a direct voltage substantially proportional to the amplitude of the incoming signal, means responsive to said direct voltage to render inoperative said audio-amplifying means at amplitude values of the incoming signal smaller than a predetermined value, and means operatively connected to said audio-amplifying means to render inoperative said frequency countertube and to simultaneously lower the plate voltage of said radio-frequency amplifying and heterodyning means at amplitude values of said incoming signal smaller than said predetermined value.

2. In a receiver for frequency modulated signals comprising radio-frequency amplifying and heterodyning means connected to a frequency discriminator including a thermionic countertube, audio-frequency amplifying and reproducing means connected after said discriminator and constituted of a thermionic audio-amplifier tube coupled to a loudspeaker, means connected after said heterodyning means to produce a direct voltage substantially proportional to the amplitude of the incoming signal, means responsive to said direct voltage to render inoperative said audio-amplifier tube at amplitude values of the incoming signal smaller than a predetermined value, an electromagnetic relay having a winding inserted in the plate supply circuit of said audio-amplifier tube, a set of make-contacts inserted in the plate supply circuit of said thermionic countertube, to render inoperative said countertube, at amplitude values of the incoming signal smaller than said predetermined value, and a set of make and break contacts having a movable contact arm connected to the plate circuit of said radio-frequency amplifying and heterodyning means, the make contact thereof being directly connected to the positive pole of the plate supply source and the break contact being connected to said positive pole through a voltage dropping resistor to simultaneously lower the plate voltage of said radio-frequency amplifying and heterodyning means when the amplitude of said incoming signal is smaller than said predetermined value.

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