

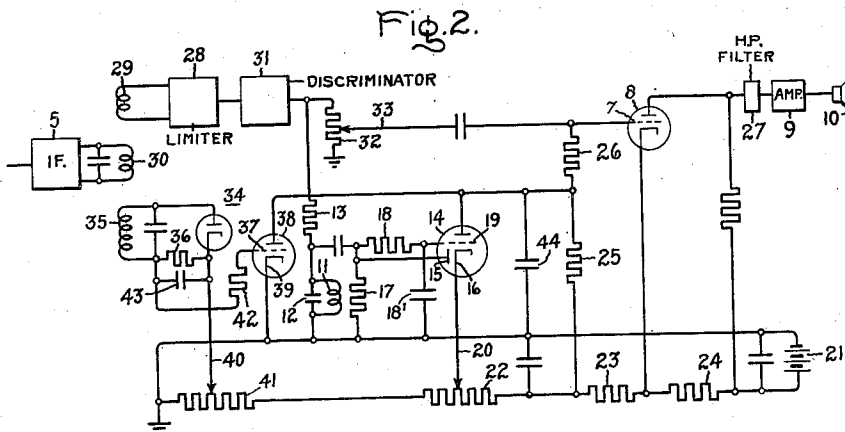
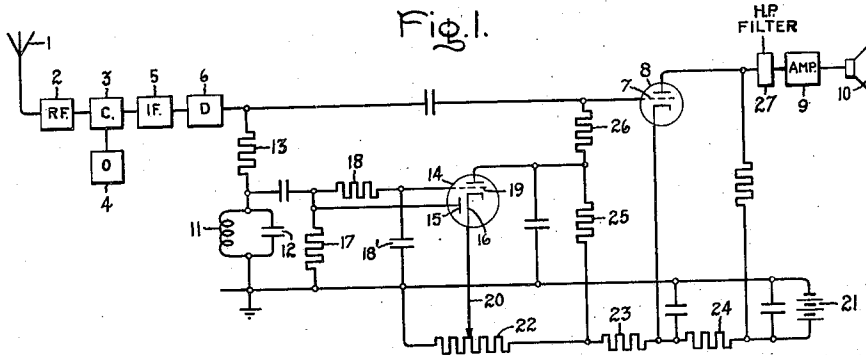
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SELECTIVE CARRIER OFF NOISE SUPPRESSION CIRCUIT

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SELECTIVE CARRIER OFF NOISE
SUPPRESSION CIRCUIT

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1 Claim. (Cl. 250—6)

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My invention relates to noise suppression circuits for radio receivers and it has for its primary object to provide a new and improved radio frequency circuit in which a reproducer connected therewith is inoperative when no signals are being received and is connected for the reproduction of a desired signal only when a keying or selecting signal is likewise received.

It is customary in receivers for use as emergency communication equipment and in which a message is received at irregular intervals to include in the receiver circuit a noise suppression, or squelch, circuit which operates to silence the reproducer of the receiver in the absence of a received carrier, thus to prevent the reproduction of noises present in the receiver circuits. It has been found, however, that such noise suppression or squelch circuits, when operated by an incoming carrier, are likewise responsive at times to spurious and undesired signals such as those produced by diathermy apparatus which, in operation, radiates a signal of suitable frequency and other characteristics. It is an object of the present invention to provide a new and improved noise suppression circuit which silences a reproducer of a radio receiver in the absence of a carrier and which is responsive, not to the presence of a carrier alone, but also to a particular modulation frequency to permit reproduction of desired received signals.

It is another object of my invention to provide a new and improved noise suppression circuit for a radio receiver which is responsive both to a particular modulation frequency of a received carrier to permit reproduction of signals and to noise greater than a predetermined intensity to prevent reproduction of signals.

It is still another object of my invention to provide a new and improved selective communication system.

One of the features of my invention is the use, in conjunction with a noise suppression or squelch circuit in a radio receiver, of a frequency responsive circuit responsive to a particular modulation frequency to render inoperative the noise suppression circuit and to permit reproduction of desired signals.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which Fig. 1 diagrammatically represents a portion of the circuit of a radio receiver embodying my invention; Fig. 2 represents a modification of the circuit of Fig. 1 which is effective to silence a receiver in the absence of a carrier having particular modulation characteristics, as well as in the

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presence of undesired noises; and Fig. 3 is a diagrammatic illustration of a selective communication system embodying the features of the invention.

In the portion of the radio receiver circuit shown in Fig. 1, a high frequency carrier wave received at an antenna 1 is amplified in a radio frequency amplifier 2 and mixed in the usual converter 3 with oscillations from a local oscillator 4 to produce signals of intermediate frequency which are amplified in an intermediate frequency amplifier 5. The signals at the output of the amplifier 5 are demodulated in a demodulator 6 and supplied to the control grid 7 of an audio amplifier 8. Signals at the output of the amplifier 8 may be further amplified in audio amplifiers 9 and may be supplied to a signaling device, such as a loudspeaker 10. The elements of the receiver thus far described may be conventional in form and are indicated by the appropriately numbered rectangles and other symbols in Fig. 1. The receiver, moreover, may be adapted for the reception of either amplitude modulated carrier waves or wave length modulated waves, such as frequency modulated or phase modulated carrier waves.

The selective carrier off noise suppression circuit of my invention comprises a band pass filter which may be, for example, a parallel tuned circuit consisting of an inductance 11 and a capacitor 12 connected between ground and the output of detector 6 through a decoupling resistance 13. Signals of the frequency of the tuned circuit 11, 12 are rectified in the diode portion of a diode-triode vacuum tube 14, the signals being impressed between the diode anode 15 and the cathode 16. The rectified signals of the frequency of the tuned circuit 11, 12 are developed across an output resistor 17 and supplied through a filter comprising resistance 18 and bypass capacitor 18', which removes the A. C. component, to the control grid 19 of the triode section of the tube 14. The triode portion of the tube 14 is rendered normally conductive in the absence of any control signal by the adjustment of the potential of the cathode 16 relative to the potential of the grid 19 by means of an adjustable contact 20 on a potentiometer connected across a voltage supply indicated as a battery 21, the potentiometer comprising serially connected resistances 22, 23, 24. The small amount of current passed by the triode section of device 14 in the absence of a control signal produces a potential drop across the anode resistance 25, which potential is supplied through a resistance 26 to the control grid 7 of audio amplifier 8 to bias this amplifier to cutoff and to prevent the reproduction in the reproducer 10 of any noise or signal in the receiver circuits. The proper operating potential for the anode of the triode section of tube 14 is supplied from a

point intermediate resistances 22, 23 of the potentiometer. Operating potentials for the tube 8 are provided by the potential drop across resistances 23 and 24 of the potentiometer, the cathode of device 8 being connected to a point intermediate the resistances 23, 24; the anode being connected to the positive terminal of the battery 21, and the control grid 7 being connected to a point intermediate the resistances 22, 23.

The described carrier off noise suppression circuit is selective or frequency responsive in character. That is, in the absence of a received carrier wave modulated by the frequency to which the tuned circuit 11, 12 is resonant, the normally conductive triode portion of the tube 14, which operates as a switching tube or D. C. amplifier produces a potential drop across resistance 25 which biases the audio amplifier 8 to cutoff preventing the reproduction of any undesired signals or noise in the output circuits of the receiver. In the presence of a received carrier modulated by the controlling tone of the resonance frequency of the tuned circuit 11, 12, a potential is developed across resistance 17 through the action of the diode portion of the tube 14 to bias the triode portion of this tube to cutoff. No potential is then developed across resistance 25 and the audio amplifier 8 is operative to reproduce the audio signals appearing at the output of the demodulator 6. The circuit described, therefore, is a carrier off noise suppression device which is sensitive, not to the presence of a carrier in the receiver, but rather to the presence of the carrier plus a single frequency of the modulation of the carrier. This single frequency may be any audio frequency or may be a sub or supersonic frequency. Preferably, it is a relatively low frequency which permits filtering out from the output circuits of the receiver by a simple high pass filter 27.

One of the advantages of this particular type of selective carrier off noise suppression circuit is that it prevents opening of the noise suppression circuit by either random noise or by any undesired signals of the frequency of the carrier and which may be radiated, for example, by a transmitter which is associated with a different communication system, but which is operating on the same or nearly the same carrier frequency. The circuit likewise is insensitive to spurious signals, such as those produced by diathermy apparatus or other types of electrical equipment.

In the modification of my receiver circuit shown in Fig. 2, the noise suppression circuit there illustrated is responsive not only to a particular modulation frequency to permit reproduction of signals in the output circuits, but likewise is responsive to undesired noise signals having characteristics different from those of desired signals which may be present when both the carrier and selecting or keying signal are being received. In Fig. 2 elements corresponding to elements of the circuit of Fig. 1 are given corresponding reference numerals. The receiver circuit therein depicted is of the type adapted for the reception of a carrier wave, which is modulated in phase or frequency, and it comprises a limiter 28 having an input circuit 29 coupled to the output circuit 30 of the intermediate frequency amplifier 5. The high frequency carrier waves, after being subjected to amplitude limitation in the limiter 28, are demodulated in a detector or discriminator 31 and the audio frequency signals are reproduced across an output resistance

32. The resistance 32 may be a volume control potentiometer having an adjustable arm 33 for supplying audio signals to the control grid 7 of the output or audio amplifier 8. The demodulation signals are likewise supplied through the decoupling resistance 13 to the tuned circuit 11, 12. Potentials developed across the tuned circuit are impressed across the electrodes of the diode portion of the vacuum tube 14 to provide, as in the circuit of Fig. 1, a negative potential which biases the control grid 19 of the triode portion of the tube 14 to cutoff, reducing the potential drop across resistance 25 and permitting amplification in the audio amplifier 8 of the signals supplied to the grid 7.

The means for silencing the output circuits of the receiver of Fig. 2 in the presence of undesired noise signals having modulation characteristics differing from those of the desired signals are similar to those described and claimed in my Patent 2,261,643, assigned to the assignee of the present application. This means comprises a diode detector circuit 34 which has a tuned input circuit 35 coupled to the tuned output circuit 30 of the intermediate frequency amplifier 5. The output of the detector of the circuit 34 appears across a diode load resistance 36, the potentials across the resistance 36 being supplied to the grid 37 of a triode control amplifier 38. The anode current of amplifier 38 flows through the resistance 25 and is effective to produce a negative potential at the grid 7 to bias the audio amplifier 8 to cutoff. The cathode 39 of triode amplifier 38 is maintained at ground potential, while the cathode of the diode detector of the circuit 34 is provided with an adjustable positive bias by means of a variable contact 40 on a resistance 41 in the potentiometer connected across the battery 21.

In the absence of a received carrier, a positive bias is supplied to control grid 37 of the amplifier 38 through the resistances 36 and 42 connected between the grid 37 and the variable contact 40 so that during such periods this circuit is likewise effective to bias the audio amplifier 8 to cutoff to prevent reproduction of undesirable noises in the output of the receiver. When a carrier of the desired frequency is received a unidirectional potential due to the rectification of the carrier is developed across load resistance 36 and the diode rectifier circuit to oppose the positive threshold bias supplied to the control grid 37 from the tap 40. By adjustment of the position of tap 40 when a carrier of desired strength is received, the triode 38 is rendered non-conductive so that no current from this triode flows through resistance 25 to prevent translation of signals by the amplifier 8. If this carrier is frequency modulated with a selected tone of the frequency to which the resonant circuit 11, 12 is tuned, the current flow through resistance 25 due to the triode section of tube 14 is likewise cut off so that the audio amplifier 8 is rendered operative.

If it is assumed that a carrier of desired intensity and modulated with the proper keying tone is being received and that undesired noise is likewise being received, the noise suppression circuit which includes the diode detector circuit 34 is operative to prevent translation of these undesired noises. Such undesired noises have modulation characteristics of both desired and undesired types. That is, when the receiver circuit is adapted for reception of a frequency or phase modulated carried wave, noise appears

as amplitude modulation of this carrier wave. This amplitude modulation noise is rectified by the diode of the diode detector circuit 34 and reproduced across the diode load resistance 36. The by-pass capacitance 43 connected across load resistance 36 is sufficiently small that this composite circuit has a relatively short time constant so that negative peaks of the undesired amplitude modulations are rectified and supplied to the control grid 37 of the amplifier 38 to cause pulses of anode current to flow through the resistance 25 and bias the audio amplifier tube to cutoff. Preferably, the capacitor 44 connected across the resistance 25 is sufficiently large that the composite circuit has a relatively long time constant. As a result, the pulses of current flowing through resistor 25 maintain a negative voltage across capacitor 44 which maintains device 8 non-conducting as explained more fully in my above-mentioned patent. In this fashion, undesired noises are not reproduced across the resistance 25 to operate the audio amplifier 38 in accordance with their positive peaks. Instead, the pulses of anode current in device 38 caused by undesired noise amplitude modulations of a received carrier wave maintain a charge on capacitor 44 which biases device 8 to cut-off.

The magnitude of an incoming carrier wave which is permitted to bias the control amplifier 38 to cutoff is determined by adjustment of contact 40 on biasing resistor 41. Adjustment of this contact establishes a threshold level for this portion of the squelch circuit. Similarly, the intensity of the audio control signal of the frequency of the tuned circuit 11, 12, which is required to operate the selective portion of the noise suppression circuit, is determined by adjustment of the contact 20 on resistance 22.

From the foregoing description, it is apparent that the circuit of Fig. 2 requires the fulfillment of two conditions before the output circuits of the receiver will open to translate audio signals, namely, the presence of a control tone of the resonance frequency of the tuned circuit 11, 12 to establish a voltage across this circuit, and the absence of undesired amplitude modulations on the incoming phase or frequency modulated carrier wave.

The selectivity feature of my improved carrier off noise suppression circuit permits the construction of an improved communication system in which various receivers may be responsive to different control frequencies and a transmitter is supplied with a means for selecting the modulation control frequency transmitted. Such a system is shown schematically in Fig. 3 in which the transmitter 45 having an output antenna 46 is provided with a plurality of oscillator circuits illustrated as the three circuits 47, 48, 49, each tuned to a different frequency F_1 , F_2 , F_3 and which may be selectively connected to modulate the output carrier wave of the transmitter by means of a key 50. The system may include a corresponding number of receivers 51—53, each including, respectively, a corresponding tuned circuit 54—56 tuned to the same frequency as a selected one of the plurality of oscillator circuits 47—49. This system provides muting of the receivers 51—53 at all times when the key 50 is not connected to the one of the tuned circuits 47—49 to whose frequency the corresponding circuit 54—56 of the receiver is tuned. To this end each of the receivers 51—53 includes the selective carrier-off

noise suppressor circuit of Fig. 1. In this way, each of the receivers 51—53 is sensitive or responsive to its own control frequency only. The keying arrangement of the transmitter 50 may likewise include a contact position 57 in which all control tones are transmitted at one time so that communication between the transmitter 45 and all of the receivers at the same time is permitted. Such a system is particularly desirable for use in emergency communication equipment, such as in police receivers, where it is desirable to establish communication either with a particular one of the receivers or with all of the receivers at the same time.

In the foregoing description, the tuned circuit 11, 12 is shown as a simple tuned circuit. However, any other type of filter circuit of the sharp band pass type may be substituted, if desired.

While I have shown particular embodiments of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made and I aim in the appended claim to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

A receiver for carrier waves modulated by desired signals and a keying signal comprising means for demodulating said waves to reproduce signals therefrom, means for amplifying said demodulated signals comprising a first electron discharge device having a control electrode, a resistance connected to said control electrode, a pair of electron discharge devices having their output circuits serially connected with said resistance and, the output currents of said devices producing across said resistance a biasing voltage for said electrode to render said amplifier inoperative, a tuned circuit connected to the output of said demodulating means, said circuit being tuned to the frequency of said keying signal, means responsive to voltages developed across said tuned circuit to reduce the current flowing in one of said pair of devices, and means responsive to a received carrier wave to reduce the current flowing in the other of said pair of devices, whereby said biasing voltage is reduced and said first device is rendered operative to amplify said signals.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,941,067	Armstrong	Dec. 26, 1933
2,023,458	Yolles	Dec. 10, 1935
2,037,456	Burnside	Apr. 14, 1936
2,112,686	Barton	Mar. 29, 1938
2,152,515	Wheeler	Mar. 28, 1939
2,162,901	Van Dyck	June 20, 1939
2,233,384	Feldman	Feb. 25, 1941
2,250,596	Mountjoy	July 29, 1941
2,261,643	Brown	Nov. 4, 1941
2,296,101	Foster	Sept. 15, 1942
2,344,618	Koch	Mar. 21, 1944
2,368,778	Purington	Feb. 6, 1945
2,367,327	Beers	Jan. 16, 1945
2,392,672	Koch	Jan. 8, 1946