

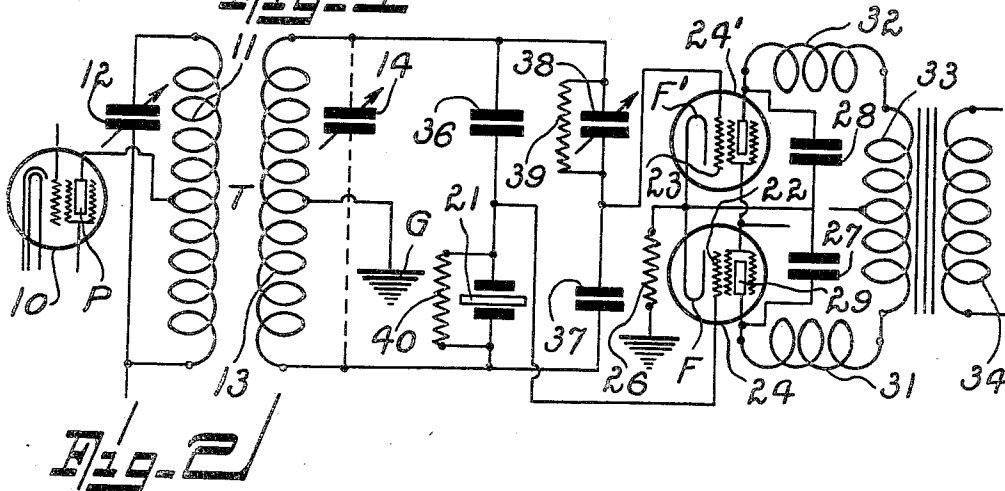
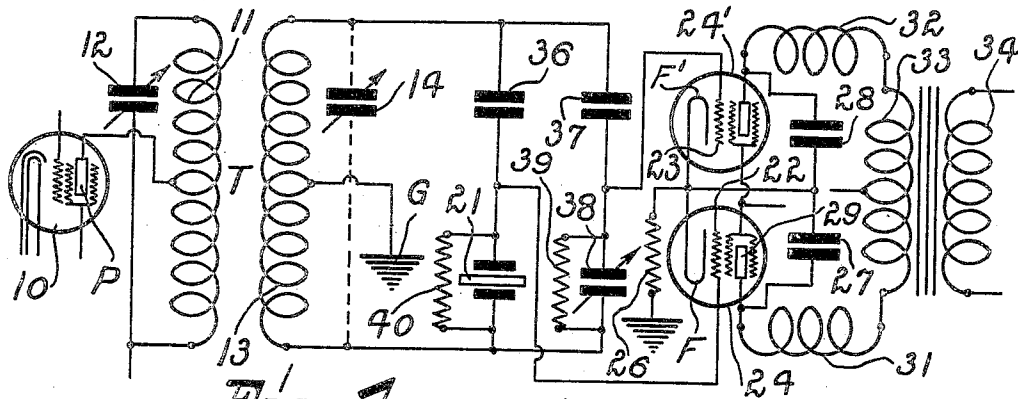
Nov. 7, 1939.

G. K. BARGER ET AL

2,178,552

RADIO RECEIVING CIRCUITS

Filed April 22, 1936



INVENTOR
GEORGE K. BARGER
SIEGFRIED HANSEN
BY
Smith & Tuck
ATTORNEYS

UNITED STATES PATENT OFFICE

2,178,552

RADIO RECEIVING CIRCUITS

George K. Barger and Siegfried Hansen,
Seattle, Wash.

Application April 22, 1936, Serial No. 75,849

7 Claims. (Cl. 250—20)

Our invention contemplates a new method of obtaining extremely high selectivity, without the necessity of attenuating the side bands. Thus, high selectivity obtained by this method cannot impair the fidelity of the received signal.

This desirable result is accomplished by a new type of detector or demodulator which is the subject of this specification.

This demodulator, when used as the second detector of an otherwise conventional superheterodyne, will limit the reception of a station to a very small range on the tuning dial, say approximately to 100 cycles. By our circuit, such extreme selectivity is obtained without the attenuation of sidebands which has heretofore made highly selective receivers impracticable for the reproduction of speech or music, or any signal other than low speed C. W. telegraphy.

A mathematical analysis shows that, in addition to its characteristic of extreme selectivity, our circuit is capable of producing demodulation of the received signal entirely without the introduction of audio-frequency distortion. This is not true of any circuit known to have been in use up to the present time.

Because of the high selectivity, this circuit produces an interstation noise-level much lower than the conventional receiver, without the necessity of providing special noise suppression circuits. Since this low noise level results from high selectivity, rather than from a special trigger circuit, the receiver will have no threshold value; that is, the noise level is greatly reduced without the drawback of eliminating the reception of weak stations.

The object of our invention is to enhance the selectivity of a radio receiving circuit, thus improving the separation of stations in adjacent channels and reducing the effect of natural and man-made electrical interference; while simultaneously producing absolutely distortionless demodulation, thus improving rather than impairing the quality of the received signal, when compared with the output of the conventional receiver.

In a superheterodyne receiver, we replace the apparatus commonly known as the second detector with an electrical network including a piezo-electric device; and with two vacuum tubes operating in conjunction with this network.

While we are aware that the utilization of piezo-electric devices in radio receiving circuits has heretofore been disclosed to the art, the particular circuits of our invention have not thus far been revealed.

The term push-pull wherever used herein, denotes opposite polarity, opposite phase, or a phase difference of 180 electrical degrees, all of which are synonymous when referring to single phase alternating currents or voltages.

In the accompanying drawing we have disclosed several circuits of our invention, including the piezo-electric device wherein:

Figure 1 is an illustration of our invention including the piezo-electric device to offer low impedance to the carrier component of the impressed signal.

Figure 2 is a modification of Figure 1.

In the circuit disclosed in Figure 1, we have shown a portion of the usual superheterodyne circuit including the last stage I. F. amplifier tube as 10. The output of this tube consists of the I. F. carrier and associated side bands as generated by the first detector or translator (not shown), and in this instance the natural frequency of the I. F. amplifier is adjusted to 175 kc.

Electrically connected to the plate P of the tube 10, we utilize a standard 175 kc. transformer T having the primary coil 11, and its variable condenser 12, and a secondary coil 13. The secondary coil 13 may or may not be tuned by the condenser 14, at option. The secondary coil 13 of the transformer T has its center tapped and grounded at G and feeds the electrical network composed of condensers 36, 37, and 38, the piezo-electric crystal 21 and the grid leaks 39 and 40. In the present circuit the condensers 36 and 37 are each 50 micromicrofarads, while the condenser 38 is adjusted to be equal to the static capacity of the crystal 21 and its electrodes. The grid leaks which provide for direct current bias on the detector tubes are each one megohm. When the receiver is adjusted so that the I. F. carrier resonates the crystal 21, the operation of this network is such that the carrier frequency impressed on the grid 22 of detector 24 is 180 degrees out of phase with the carrier impressed on the grid 23 of detector 24'. Simultaneously, the side-band frequencies impressed on grid 22 are in phase with the corresponding frequencies impressed on grid 23. As a consequence of this, the audio frequency output of detector tube 24 will be 180 degrees out of phase with the audio frequency output of detector tube 24'. Hence, these outputs will be additive in the push-pull primary 33 of the audio transformer and will appear in the secondary 34 of this transformer. When the receiver is very slightly readjusted so that the I. F. carrier no longer resonates the crystal, the carrier and side-bands impressed on grid

22 will all be in phase with the corresponding carrier and side-bands impressed on grid 23. As a result the audio output of tube 24 will be in phase with the audio output of tube 24', and these outputs will be subtractive in the push-pull primary 33. Hence, no audio output will appear in the secondary 34. The system comprising the R. F. chokes 31 and 32 and the fixed condensers 27 and 28 is included to filter out various R. F. components which appear in the output of the detectors. The resistor 26 provides the bias required on the cathodes F and F' for operation of the tubes as detectors. DC voltages required for operation of the other electrodes in the tubes are supplied from a separate source in the usual way. If A. V. C. is desired in the receiver, its control voltage is obtained from the resistor 26.

Figure 2 shows a modified form of the circuit shown in Figure 1 wherein the positions of condenser 37, and condenser 38 and grid leak 39 are reversed.

Interference caused by the side-bands of stations in adjacent channels is limited by the use of our circuits. In circuits in use at the present time, this interference appears as an audio output of low intensity but containing all of the original intelligibility. When our circuits are used this interference appears as inverted frequencies of even lower intensity.

Although a superheterodyne circuit has been used to illustrate the operation of our invention, this must not be construed to mean that no other circuit could be used in conjunction with our invention. For example, our invention is well adapted for point to point communication on a single frequency, using a neutrodyne or other tuned R. F. receiver. Also, if future development of the art produces a device having the selectivity of piezo-electric crystal combined with adjustability, then our invention could be used with a tuned R. F. circuit for ordinary reception.

Having thus fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. In a system for receiving and demodulating waves modulated in amplitude, a method comprising selecting from the received signal energy a portion, reversing the phase of the carrier of said portion with respect to its original phase while leaving the phase of the side-bands unaltered, thereby reversing the phase of the envelope of said portion, separately demodulating said portion and an equal portion of the received signal energy, and combining in opposition the two demodulated portions.

2. In a system for receiving and demodulating waves modulated in amplitude, a method comprising selecting from the received signal energy a portion, reversing the phase of the side-bands of said portion with respect to their original phase while leaving the phase of the carrier unaltered, thereby reversing the phase of the envelope of said portion, separately demodulating said portion and an equal portion of the received signal energy, and combining in opposition the two demodulated portions.

3. In a system for receiving and demodulating electric carrier waves, a method comprising se-

lecting from the received signal energy a portion, reversing the phase relations between the carrier and side-bands of said portion, thereby reversing the phase of the envelope of said portion, separately demodulating said portion and an equal portion of the received signal energy, and combining in opposition the two demodulated portions.

4. An electric circuit comprising a source of alternating current, an impedance connected across said source and having a center-tap, two other circuits in parallel across said source, one comprising an impedance and a sharply resonant piezo-electric device in series and having a common terminal, the second comprising the two impedances in series and having a second common terminal whereby the potentials of said two common terminals with respect to said center tap are in phase for frequencies of said source other than the natural frequency of said piezo-electric device and are in opposite phase for frequencies of said source substantially equal to the natural frequency of said piezo-electric device.

5. An electric circuit comprising a source of alternating current, an impedance connected across said source and having a center-tap, two other circuits in parallel across said source, one comprising an impedance and a sharply resonant piezo-electric device in series and having a common terminal, the second comprising two impedances in series and having a second common terminal whereby the potentials of said two common terminals with respect to said center-tap are in opposite phase for frequencies of said source other than the natural frequency of said piezo-electric device and are in phase for frequencies of said source substantially equal to the natural frequency of said piezo-electric device.

6. In a radio receiver for obtaining high selectivity, comprising amplifying and frequency changing circuits and two opposed detector circuits having input and output terminals, means for reversing the phase of the envelope of the modulated carrier wave applied to the input terminal of one of said detector circuits, said means comprising a reactance upon which the said modulated carrier wave may be impressed said reactance having terminals to which are connected a voltage divider, said voltage divider comprising an impedance and a sharply resonant piezo-electric device in series, the common point between said impedance and said piezo-electric device being connected to the aforesaid detector input terminal.

7. In a radio receiving circuit including a carrier and associated side-bands, the combination with a plurality of electron tubes having their output terminals connected in opposition, of means for securing a demodulated output from said tubes, a sharply resonant device in said circuit, and means for applying signals of the same frequency as the resonant device to the control electrodes of said electron tubes in opposite phase and means for applying frequencies other than the resonant frequency of said resonant device to said control electrodes in the same phase.

GEORGE K. BARGER.
SIEGFRIED HANSEN.