April 9, 1935. H. O. PETERSON 1,997,012

HETERODYNE CIRCUITS

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Fig. 1

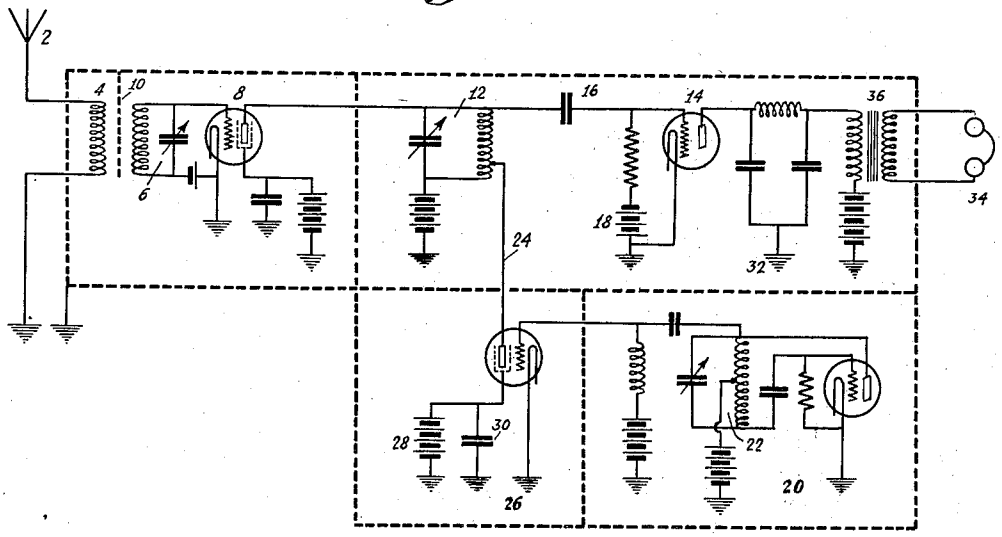
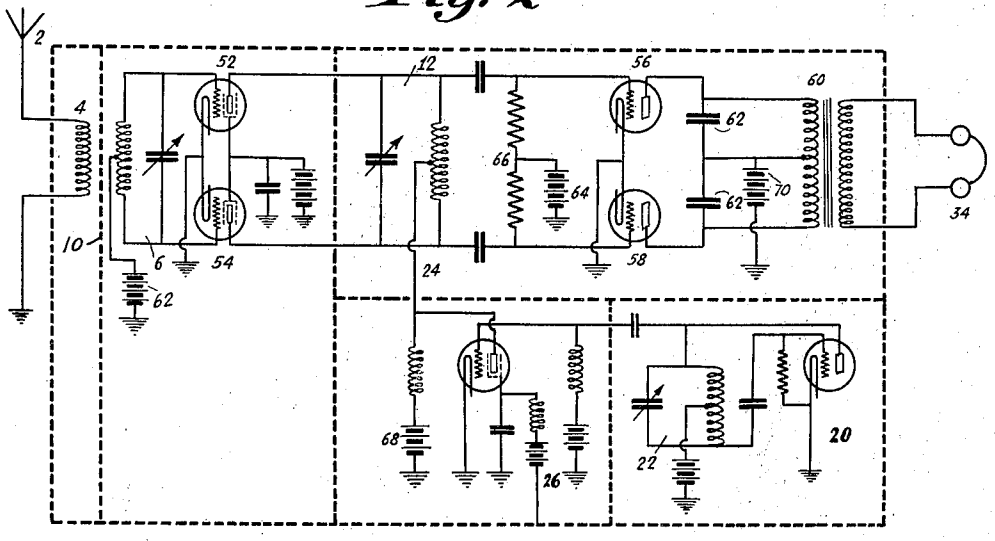



Fig. 2




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## HETERODYNE CIRCUITS

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5 Claims. (Cl. 250—20)

This invention relates to the combination of energies having different frequencies, and more particularly to heterodyne circuits.

It is frequently necessary to combine energies in order to obtain resulting energy of different frequency, particularly in modulation and in heterodyning. In heterodyning, the frequencies involved are usually relatively closely adjacent, so that the tuned circuits for each of the frequencies, unless reactively insulated in some fashion, are apt to affect one another during the tuning of one or the other. With short wave energy this difficulty is quite marked, even if the frequencies are not close. It is a primary object of my invention to prevent coupling between such circuits, so that they may be independently tuned, and this I do by coupling one of the circuits to the combining means through an untuned or detuned coupling tube.

When dealing with very high frequencies the capacitive coupling between the electrodes of the coupling tube may become appreciable, and in such case I find that this objection may be overcome by the use of a screen-grid tube as a coupling tube, in order to improve the reactive insulation.

It may prove desirable, in some cases, to utilize a harmonic of the local oscillator frequency for combination with the received energy, and in such case the practice heretofore has been to let the detector tube which is used to combine the received and locally generated energies also function as a harmonic generator for the locally generated energy. In accordance with my invention, for this purpose I merely bias the coupling tube sufficiently to cause it to generate the desired harmonic which is to be fed to the heterodyne detector.

My invention is described more in detail in the following specification, which is accompanied by a drawing in which Figure 1 is a wiring diagram for a heterodyne receiver employing my invention; and Figure 2 is a modification in which the receiver circuits are symmetrical pushpull circuits.

Referring to Figure 1 it will be seen that energy is collected on an antenna circuit 2, and coupled through a coil 4, to the resonant input circuit 6 of an amplifier tube 8. A grounded astatic shield 10 may be provided between the coil 4 and the circuit 6 in order to prevent capacitive coupling therebetween. The anode of the tube 8 is connected to a resonant circuit 12, which, like the circuit 6, is tuned to the frequency of the desired signal. This resonant circuit 12 acts as an output circuit for the amplifier tube 8, and also as an input circuit for the heterodyne detector or combining tube 14, which is given an asymmetric characteristic by means of a blocking condenser 16, and a source of high negative bias potential 18. The energy with which the received energy is to be heterodyned is generated in a local oscillator 20, the resonant output circuit 22 of which is tuned to the frequency of the locally generated energy. This circuit is coupled to the control electrode of the detector tube 14, preferably by a lead 24 connected to the lower potential side of the resonant circuit 12.

Now, in accordance with my invention, the means connecting the oscillator 20 with the heterodyne detector includes an untuned coupling tube, here numbered 26. As shown, the resonant circuit 22 is connected to the control electrode of the coupling tube 26, and the anode of the coupling tube is connected to the lead 24 and thence to the resonant circuit 12 and the control electrode of the detector tube 14. The tube 26, may be considered as untuned, or, including circuit 12, as, detuned. When dealing with very high frequency energy the tube 26, as well as the amplifier tube 8, may preferably be of the screen-grid type. As is customary, the screen-grid of the tube 26 is polarized at the proper potential by a battery 28, but is connected directly to ground, with respect to radio frequencies, by a blocking condenser 30.

The anode of the detector tube 14 may include a high pass filter 32 for by-passing the radio frequency components of the detected energy, and the output, if an audio frequency, is translated in any suitable translating device 34, here shown coupled to the anode circuit of the tube 14 by a transformer 36. It should be understood that in the case of a superheterodyne receiver the output from the detector 14 may be an intermediate frequency, which then is further amplified in an intermediate frequency amplifier, before the final detection and translation.

It will be noticed that the various stages of the apparatus are shielded to prevent mutual interference, and the necessity for this shielding increases with the frequencies being handled.

If a harmonic of the local oscillator frequency is to be employed in the heterodyne detector the negative bias of the tube 26 is made sufficiently high to give the tube an asymmetric characteristic, in order to provide harmonics in its output.

In order to provide symmetrical receiving circuits it is often desirable to employ pushpull amplifier and detector stages. In such case the local

oscillator may readily be connected symmetrically to the pushpull input circuit of the heterodyne detector, which provides considerable insulation against mutual reaction between the tuning of the oscillator and the tuning of the receiver circuit. However, at very high frequencies I find that this alone is not sufficiently preventative, and that my invention may be applied to this type of circuit with equally good results. An arrangement illustrating this is shown in Figure 2, in which the antenna circuit **2** is coupled through a coil **4**, provided with a grounded astatic shield **10**, to the resonant input circuit **6** of a pushpull amplifier stage using the amplifier tubes **52** and **54**. The anodes of these tubes are connected in series by the resonant circuit **12**, which acts as a pushpull output circuit for the amplifier tubes **52** and **54**, and as a pushpull input circuit for the heterodyne detector tubes **56** and **58**. The anodes of the detector tubes are connected in series to an output coil **60**, which is coupled to a translating device **34**. Condensers **62** may be used to by-pass the radio frequency components of the detected energy.

The control electrodes of the tubes **52** and **54** are biased by a potential source **62**, which is connected to the midpoint of the coil of the input circuit **6**, while the detector tubes **56** and **58** are biased for detector action by a source **64**, which is coupled to the midpoint of the resistance **66**. The anodes of the tubes **52** and **54** are polarized from a potential source **68**, which is connected to the midpoint of the coil of the circuit **12**, and the anodes of the detector tubes **56** and **58** are polarized by a source **70**, connected to the midpoint of the output coil **60**. The oscillator **20** is connected through a coupling tube **26** and a lead **24** to the midpoint of the coil of the resonant circuit **12**. This being a zero potential point with respect to the received frequency, there is an immediate reduction in the tendency for reactive coupling between the circuit **12** and the oscillator circuit **22**, and any remaining tendency is counteracted by the reactive insulation between these circuits which is provided by the coupling tube **26**.

In this case the tube **26** need not be a screen-grid tube, and preferably is not a screen-grid tube because it is desirable to provide a tube of lower impedance than is obtainable in the ordinary screen-grid tubes, for the reason that the tube is coupled to the mid potential point of the coil of the circuit **12**, and must feed that circuit with considerable energy. However, if a low impedance screen-grid tube is available it may well be used.

As before, the control electrode of the tube **26** is biased from a suitable source of biasing potential, the magnitude of which determines whether or not the coupling tube **26** is to act also as a harmonic generator.

In the claims which follow I shall use the term "untuned" to mean either untuned or detuned, broadly, that is, an electron emission tube arranged primarily, not for amplification, but rather for reactive insulation.

I claim:

1. In combination a source of radio frequency energy, shielding means for said source, a second source of radio frequency energy, the frequency of said last named source differing from the frequency of said first named source, shielding means for said last named source, a thermionic device for combining energies from both of said sources, shielding means for said last named device, an aperiodic screen grid thermionic device for coupling one of said sources to said combining device, and shielding means for said coupling device.

2. Means for demodulating a signal modulated high frequency carrier comprising, thermionic means responsive to said carrier, thermionic rectifying means coupled to said carrier responsive means, a thermionic oscillation generator, and means for coupling said thermionic responsive means and said thermionic oscillation generator to said rectifying means and for preventing reaction between said means comprising a screen grid thermionic tube having its input electrodes coupled through an untuned circuit to said generator and its output electrodes coupled to said rectifier, and separate shielding means for said rectifying means, for said generator, and for said coupling tube.

3. In combination, a signal source of energy, another source of energy comprising an oscillation generator, a device for combining said energies, a path coupling said signal source to said device, and another path including a screen grid tube for coupling said oscillation generator to said device, and separate individual shielding means for said sources, said screen grid tube and said device.

4. In combination, in a heterodyne receiving circuit, an antenna, an electron discharge device having input and output circuits tuned to the incoming frequency, said input circuit being coupled to said antenna, said output circuit including an inductance, a detector, an oscillation generator, a connection from one end of said inductance to said detector, and a connection from a point intermediate the ends of said inductance to said oscillation generator, said last connection including an untuned screen grid coupling tube for preventing reaction between said oscillation generator and said output circuit.

5. In combination, a signal source of energy, an oscillation generator, a circuit tuned to the frequency of said signal source comprising an inductance, a device for combining the energies from said signal source and said oscillation generator, a connection from said signal source and from said device to the same terminal of said inductance, and a connection including a screen grid tube from a point intermediate the ends of said inductance to said oscillation generator.

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