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C. G. KEMP ET AL

1,950,731

RECEIVER

Filed Dec. 11, 1931

Fig. 1

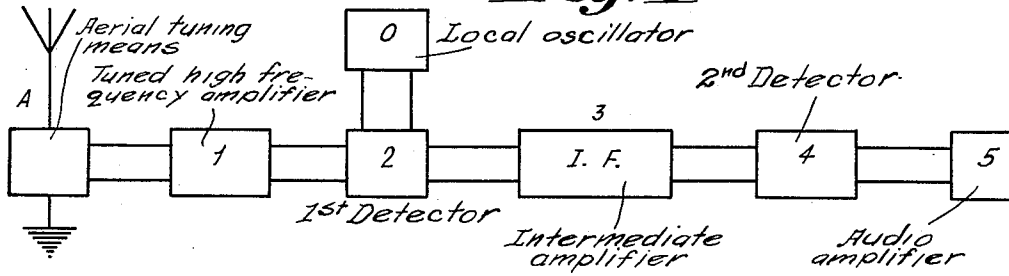


Fig. 2

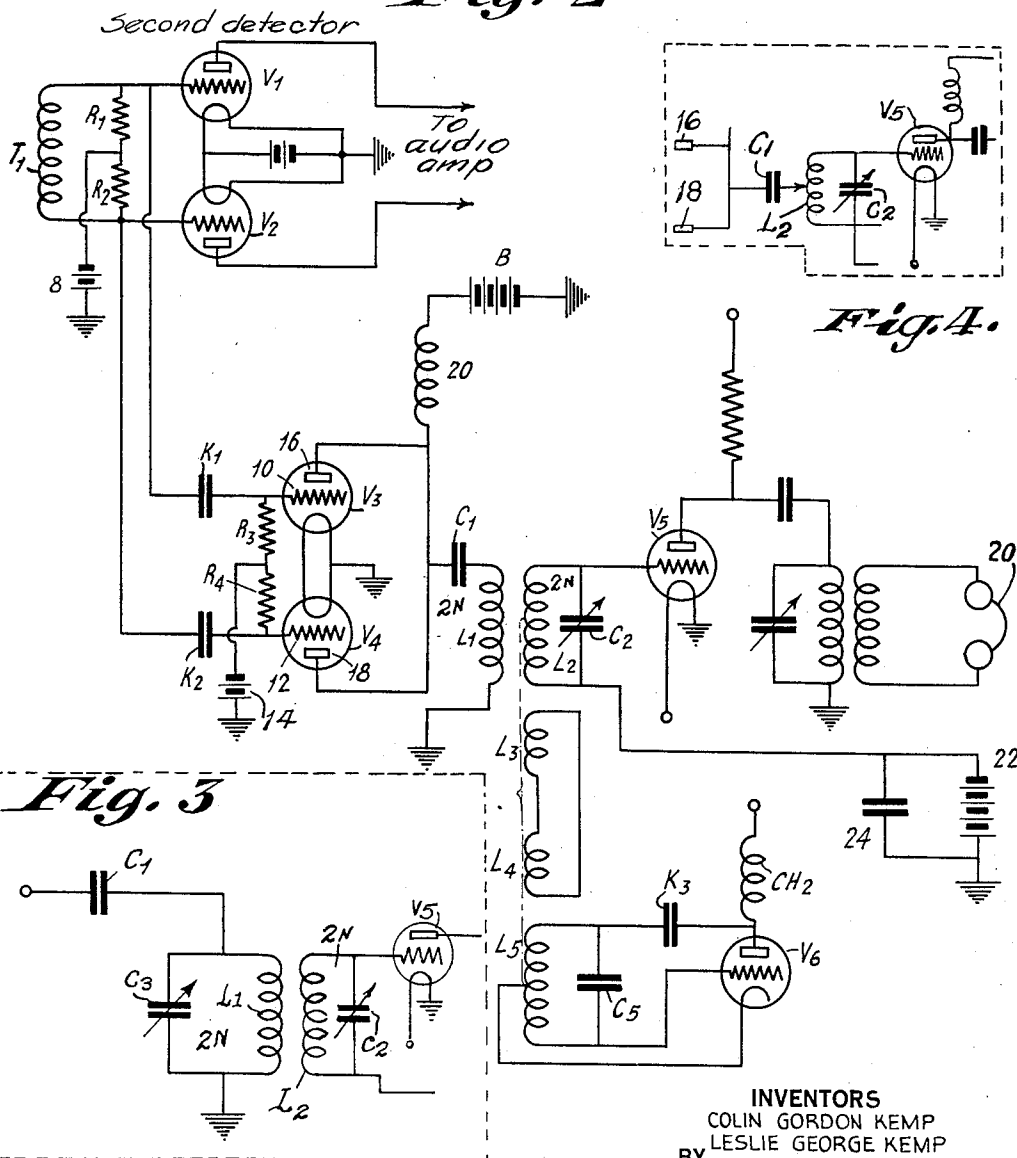


Fig. 4.

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1,950,731

RECEIVER

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In Great Britain December 2, 1930

4 Claims. (Cl. 250—20)

This invention relates to high frequency receivers and more particularly to radio receivers of the kind in which the incoming carrier wave signal frequency is changed, after amplification, if desired, to another predetermined frequency at which it is amplified prior to detection to separate the modulation from the carrier. A very common example of a radio receiver of this kind is the so-called super-heterodyne receiver in which a received carrier wave is changed, after amplification, if desired, to an intermediate frequency at which it is amplified in what is usually a fixed tuned multi-stage amplifier, the output from which is detected to separate the modulation from the carrier.

It will be appreciated that in such receivers the intermediate frequency amplifier must amplify a frequency band whose width will be determined by the modulation band width desired to be received. Moreover, since the intermediate frequency amplifier is almost always a fixed tuned amplifier it is necessary very accurately to adjust the local oscillator or other tuning device or devices utilized to change the carrier wave frequency in order that the signal carrier wave may be changed to a frequency corresponding to the middle frequency of the frequency band over which the intermediate frequency amplifier operates.

In practice considerable difficulty is experienced in adjusting a local oscillator or its equivalent with the accuracy necessary to insure that the received carrier wave shall be changed to a frequency exactly equal to the middle frequency of the frequency band over which the intermediate frequency amplifier operates. One method which has been proposed to obviate this difficulty has been to introduce a second oscillation from a local oscillator which is tuned exactly to the middle frequency of the intermediate frequency amplifier and to adjust the beat frequency created in the intermediate frequency amplifier by the normally provided local heterodyne until the said beat frequency synchronizes with the frequency of the said second oscillator, a pair of telephones being connected across the output of the receiver to enable this adjustment to be made. This method possesses the disadvantage that the beat note at audio frequency which is produced when the adjustment is being made is superimposed upon the speech or other signal currents due to the signal modulation. As a result in many practical cases adjustment can only be made during intervals in signal traffic, and this in commercial

installations may cause delay during periods of heavy traffic.

The principal object of the present invention is to provide a ready means whereby the device for changing a signal frequency to a predetermined frequency in a receiver of the frequency changing type may be accurately adjusted even while signals are actually being received and substantially without giving rise to any disturbances.

According to this invention energy from the intermediate frequency amplifier of a high frequency receiver of the frequency changing type is fed to a branch circuit and combined, after frequency multiplication, if desired, with locally generated oscillations of a frequency which is in fixed proportion to the desired intermediate frequency, the resultant beat being detected and indicated or observed.

Preferably, the branch circuit comprises one or more stages of frequency multiplying detectors, as described in the specification accompanying co-pending application No. 508,440, filed January 13, 1931, and the local oscillator associated with said branch circuit is tuned to generate an oscillation of a frequency corresponding to the desired intermediate frequency multiplied by the multiplication ratio of the frequency multiplying detector, the combining circuit being, of course, similarly tuned to the multiplied frequencies.

The invention is illustrated diagrammatically in the accompanying drawing, which shows one way of carrying out the invention. In the drawing:

Figure 1 shows diagrammatically a receiver as disclosed in the application referred to above; Figure 2 shows one circuit arrangement for carrying out the present invention; while,

Figures 3 and 4 show modifications of a portion of the circuit in Figure 2.

The drawing illustrates part of a super-heterodyne receiver comprising signal receiving means, such as an aerial A and tuning means, a tuned high frequency amplifier 1 for amplifying the received carrier wave, a first detector 2 associated with a local heterodyne O for changing the output of the high frequency amplifier to a predetermined intermediate frequency, an intermediate frequency band filter amplifier 3 for amplifying the intermediate frequency band, a second detector 4 fed from the output of the intermediate frequency amplifier, and an audio frequency amplifier 5 fed from the output of the second detector. The arrangement as so far described is, of course, the well known super-heterodyne arrangement. The second detector

may conveniently comprise a pair of valves $V_1 V_2$ arranged in push-pull, the grid circuits of said valves being connected together through the usual leak resistances $R_1 R_2$, the junction point of which is connected to the common cathode connection through a bias battery 8 of such value that, in conjunction with the leak resistances, it causes the triodes to act as rectifiers. The output from the intermediate frequency band amplifier 3 is transformer coupled to the second detector, the secondary T_1 of the coupling transformer having its ends connected between the grids of the triodes in said second detector, as shown in Fig. 2. The grids of the triodes $V_1 V_2$ are also connected each through a coupling condenser $K_1 K_2$ respectively to the grids 10 and 12 respectively of the valves $V_3 V_4$ in a frequency doubling detector. These triodes $V_3 V_4$ have their cathodes grounded and their grids connected together through a pair of leak resistances $R_3 R_4$. The junction point of these resistances is connected by way of ground to the cathodes of said tubes through a bias battery 14 of such value that in conjunction with the leak resistances the triodes are caused to act as detectors of the grid bias full wave type. The anodes 16 and 18 respectively of these triodes are connected together and the junction point is connected through a choke 20 to a source of anode potential B, which may be common for the whole receiver. Since the control grids are connected in push-pull relation and the anodes are connected in parallel, the second harmonic of the frequency applied to the control grids will appear in the anode circuit. The common anode point is also connected from earth either:

1. As shown in Figure 2 through an acceptor circuit consisting of a fixed condenser C_1 and an inductance L_1 in series, said acceptor being tuned to a frequency $2N$ which is double that of the midfrequency N of the intermediate band frequency amplifier, or,

2. Through a portion of the inductance of a parallel resonant circuit composed of an inductance L_2 and adjustable capacity C_2 in parallel and tuned to a frequency $2N$, as shown in Figure 4, or,

3. Through an acceptor circuit, the inductance L_1 of which forms a portion of the whole inductance L_1, L_2 of a parallel resonant circuit, both of said circuits being tuned by means of adjustable capacities C_3 and C_2 to a frequency $2N$ as shown in Fig. 3.

The coil in the acceptor circuit in the first of these arrangements, or the parallel resonant circuit in the other arrangement, is effectively coupled to a circuit comprising an inductance L_2 and a condenser C_2 in parallel, see Figs. 2 and 3, said circuit being effectively shunted across the grid and cathode of a triode V_5 .

The input circuit $L_2 C_2$ of the triode V_5 is tuned to a frequency equal to twice the middle frequency of the intermediate frequency band amplifier and the said input circuit contains a bias battery 22, preferably shunted by a condenser 24, said battery being of such value that the triode V_5 detects. The output circuit of this triode contains or is coupled to a circuit containing a pair of telephones 20 or other indicating device. The input circuit $L_2 C_2$ is also coupled through an aperiodic coupling circuit consisting of a pair of coils $L_3 L_4$ in series to a local oscillation generator operating at a frequency equal to twice the middle frequency of

the intermediate band frequency amplifier. This local oscillation generator may be of any convenient form, for example, it may consist of a triode V_6 whose grid is connected to its anode through a blocking condenser K_3 in series with a resonant circuit $L_5 C_5$ tuned to a frequency equal to twice the middle frequency of the intermediate band frequency amplifier, the midpoint of the inductance L_5 in the said tuned circuit being connected to the cathode in the usual way and the valve anode being connected to the source of anode potential through a suitable choke CH_2 .

The operation of the arrangement is as follows:

The received carrier wave is amplified in the high frequency amplifier, heterodyned to an intermediate frequency, amplified at that frequency in the intermediate band frequency amplifier, detected in the second detector, and the resulting modulation amplified in the low frequency amplifier and thence utilized in any convenient way, e. g., fed to a land line. The frequency doubling detectors V_3, V_4 in the branch circuit gives full wave rectification of the intermediate frequency fed to its input and the resultant double frequency impulses are passed to the input circuit of the detecting valve V_5 whose output circuit contains the indicating telephones. In the input circuit of this detector we superimpose the output from the specially provided local oscillator. So long as the double intermediate frequency output from the frequency double detector is equal to the frequency from the specially provided local oscillator, there will be zero beat in the indicating telephones and the oscillator O of the receiver is adjusted until this occurs. It will be seen that the beat frequency which will exist until the adjustment is correct will be quite inaudible in the main signal circuit and in consequence accurate adjustment may be effected at any time without risk of interference with signal traffic.

Having thus described our invention and the operation thereof, what we claim is:

1. Means for determining when a receiver which includes an intermediate frequency amplifier is in tune comprising, a signal modulation detector consisting of two valves in push-pull for detecting the output from the intermediate frequency amplifier to separate the signal modulation, a branch circuit containing a frequency multiplying detector comprising two valves in push-pull, said two valves having their grid circuits in parallel with the grid circuits of the valves in the signal modulation detector, an additional detector having input and output circuits, means for applying frequency multiplied detected impulses from the output circuit of said frequency multiplying detector to the input circuit of said additional detector, means for superimposing in the said input circuit of said additional detector locally generated oscillations, and indicating means coupled with the output circuit of said additional detector.

2. An arrangement as claimed in claim 1 in which the locally generated oscillations are superimposed in the input circuit of the last named detector through the medium of substantially aperiodic coupling means.

3. Means for determining when a heterodyne receiver comprising a local oscillator and an intermediate frequency amplifier having a pair of thermionic detectors connected in push-pull arrangement is in tune including, a pair of ther-

mionic tubes symmetrically arranged, capacitive means for connecting the control electrode of each of said last named tubes to a control electrode in a different one of the tubes in said detector stage, a connection between the output electrodes of said last named tubes, an inductance connected between said last named connection and the cathodes of said tubes, a thermionic rectifier having its input circuit inductively coupled to said last named inductance, indicating means connected with the output circuit of said thermionic rectifier, a thermionic oscillation generator having inductively coupled input and output electrodes, and a link circuit inductively coupling said oscillation generator to the input circuit of said rectifier.

4. Receiving means comprising signal responsive means, a source of local oscillations connected therewith to produce a beat note, an intermediate frequency amplifier connected with said source and with said responsive means, signal demodulating means connected with said intermediate frequency amplifier and with a utilization circuit, and means for determining when the beat note produced is at the center of the frequency band to which the intermediate frequency amplifier is tuned without disturbing the operation of said receiver comprising, a thermionic tube having control grid and cathode coupled to the input circuit of said demodulator to divert energy at the beat frequency therefrom, a circuit for biasing the control grid of said tube to such a value that said tube acts as a rectifier, a circuit tuned to double the frequency of said intermediate frequency band connected to the anode and cathode of said tube, a second source of local oscillations and an indicator coupled with said last named circuit of said last named tube, and means for tuning the frequency determining circuit of said last named oscillator to such a value that the combination of the oscillations produced thereby with the energy in the output circuit of said last named tube produces a zero beat note when the signal responsive means and the first local oscillator are tuned to such a value that the beat note resulting therefrom is at the center of the frequency band of the intermediate frequency amplifier.

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