

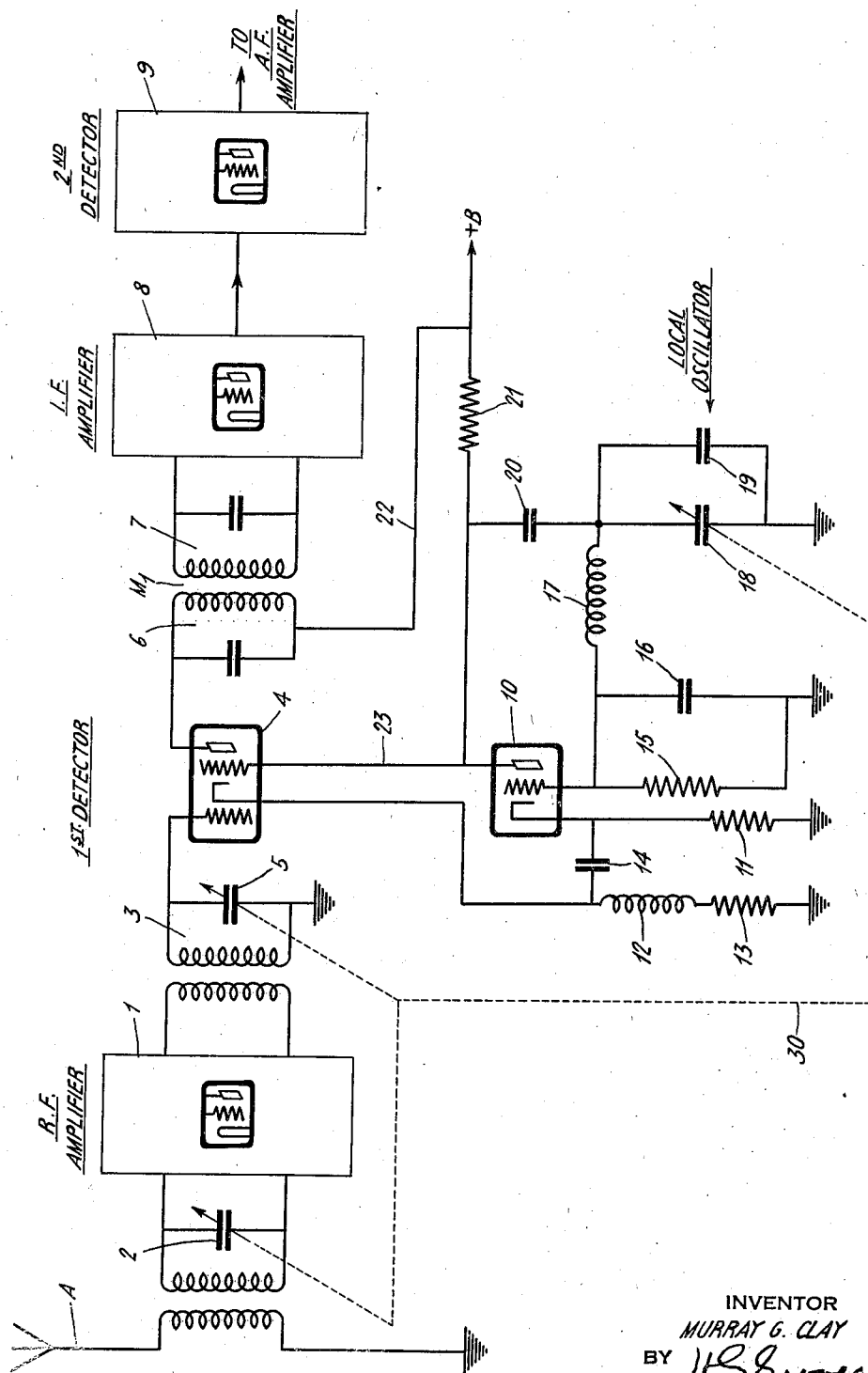
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SUPERHETERODYNE RECEIVER CIRCUIT

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SUPERHETERODYNE RECEIVER CIRCUIT

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My present invention relates to heterodyne networks, more particularly to converter networks adapted for use in superheterodyne receivers.

One of the main objects of the present invention is to improve the converter network of a superheterodyne receiver in such a manner that the effect of the converter tube upon the local oscillator, which effect manifests itself in a reduction in the local oscillator voltage, is considerably reduced at the low frequency end of the receiver tuning range.

Another important object of the invention is to provide a converter network for a superheterodyne receiver, which network includes a first detector tube and a local oscillator tube, the local oscillator voltage being impressed upon the first detector tube through the cathode of the latter and the first detector tube exhibiting a loading effect upon the local oscillator at the low frequency end of the operating tuning range of the network whereby the voltage from the local oscillator decreases as the network is tuned towards the low frequency end of the tuning range; the network including a coupling between a screen grid electrode in the first detector and the plate circuit of the local oscillator whereby the effect of said first detector at the low frequency end of the tuning range is greatly minimized and the conversion gain considerably increased at the low frequency end.

Another object of the invention is to provide in combination with a radio frequency amplifier and a first detector of a superheterodyne receiver, a local oscillator which is connected to the first detector so as to impress oscillator voltage upon the cathode and the screen grid of the first detector, the effective oscillator voltage characteristic being complementary to that of the radio frequency amplification characteristic over the tuning range of the receiver whereby the converter characteristic is flat.

Still other objects of the invention are to improve the efficiency of converter networks, and more especially to provide a converter network for a superheterodyne receiver which is not only reliable in operation, but economically constructed and assembled.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

Referring now to the accompanying drawing, the circuit diagram thereon schematically shows a receiver of the superheterodyne type. The receiver comprises the usual signal collector, such

as a grounded antenna circuit A. The signal collector is coupled to a radio frequency amplifier 1 which may include one or more stages of tuned radio frequency amplification. The numeral 2 represents the tuning condensers of the radio frequency amplifier 1, and it will be understood that if more than one amplifier is used a plurality of tuning condensers will be used.

The output of the amplifier 1 is impressed upon the tunable input circuit 3 of the first detector tube 4. The input circuit 3 includes a variable tuning condenser 5, and the low alternating potential side of the input circuit 3 is grounded. The plate circuit of the detector tube 4 includes a resonant circuit 6 which is tuned to the operating intermediate frequency, and the circuit 6 is coupled, as at M₁ to the resonant input circuit of the following intermediate frequency amplifier 8. The circuit 6 and the following circuit 7 are both tuned to the common intermediate frequency, and may be of the band pass type.

The amplified intermediate frequency is demodulated, or rectified, by the second detector 9, and the detected energy is then utilized in a subsequent audio frequency amplifier and then reproduced. These networks are, of course, conventional in nature, and are well known to those skilled in the art. It is to be understood that the receiver may be of the multi-range type, but the circuit details of such a type of receiver are omitted in order to preserve simplicity of disclosure. Those skilled in the art are fully aware of the manner of changing the circuit connections in the radio frequency amplifier, first detector and local oscillator networks to utilize the receiver in more than one frequency band.

The tube 4, functioning as the converter tube, is of the screen grid type. The local oscillator voltage is impressed upon it by feeding the local oscillator voltage to the cathode and screen grid electrodes. The local oscillator tube 10 is shown as of the triode type. The cathode of the tube 10 is connected to ground through a resistor 11, and the cathode of tube 4 is connected to ground through a path which includes the coil 12 and the resistance 13. The oscillator voltage is fed from the cathode of tube 10 to the cathode of tube 4 through a path which includes condenser 14, the condenser being connected between the cathode sides of coil 12 and resistor 11.

The control grid of tube 10 is connected to ground through a path which includes the resistor 15, the resistor being shunted by a condenser 16. The tunable oscillator circuit comprises the coil 17 connected between the grid side of condenser 16 and the plate side of the variable tuning condenser 18. A padding condenser 19 is connected in shunt with the tuning condenser 18, and the condenser 20 connects the

anode of tube 10 to a point intermediate coil 17 and the tuning condenser 18.

The plate of tube 4 is maintained at a proper positive potential by connecting it to a source of positive voltage B through a path which includes the lead 22. The anode of tube 10 and the screen grid electrode of tube 4 can be energized with voltage from the same source B by connecting the screen grid of tube 4 to the plate lead of tube 10 through a lead 23, and then connecting both electrodes to the source B through a resistor 21. The resistor 21 is given a magnitude such that the voltages for the plate of tube 10 and the screen grid of tube 4 receive proper reduced positive voltage.

Local oscillations are created in the specific oscillator circuit shown by virtue of the coupling path which includes the condenser 16. This type of oscillator circuit is of the "ultra-audion" type. As pointed out before the locally created oscillations are fed to the detector tube 4 through the condenser 14. They are also fed to the tube 4 through the path including lead 23. With the constants properly chosen for the oscillator circuit the loading effect of the first detector tube 4 and its circuits upon the local oscillator circuit at the low frequency end of the receiver tuning range will be greatly reduced.

It has been found in practice that when the tuning condensers 2, 5, and 18, shown uncontrolled by the dotted lines 30, are adjusted to tune the receiver through a given frequency range, the output of the local oscillator steadily decreases until it becomes feeble at the low frequency end of the tuning range. Without considering the theoretical aspects of this loading phenomenon it is sufficient to point out that the loading effect is due to the first detector network upon the oscillator network. The feeding of oscillator voltage to the screen grid electrode is found to greatly minimize this loading effect, and there is secured an increased translation, or conversion, gain at the low frequency end of the receiver tuning range. In other words, the effective oscillator voltage impressed on the first detector tube 4 is increased.

The increased conversion gain secured with this arrangement, which is due to the higher effective oscillator voltage on the converter tube, permits the usage of a higher converter bias thereby improving the overload characteristic of the first detector. The bias for the signal grid of tube 4 is obtained by the voltage drop across resistor 13. It has been found, for example, that a circuit using this invention with 170 volts on the screen of tube 4 develops a bias of about 10 volts when the resistor 13 is given a magnitude of about 10,000 ohms, the signal input to circuit 3 being about 4.2 microvolts.

The following magnitudes of the circuit elements of a specific circuit embodying the invention are given to illustrate the invention. The values are merely illustrative, and are not to be considered as limiting:

Voltage of B=250 volts
Voltage on screen of tube 4=100 to 170 volts
Voltage on plate of tube 10=100 to 170 volts
Coil 12=2 mh.
Resistor 13=10,000 ohms
Oscillator grid bias resistor 11=300 ohms
Grid stabilizer resistor 15=50,000 ohms
Condenser 14=0.005 mfd.
Condenser 20=0.005 mfd.
Resistor 21=25,000 ohms

The present invention will be found of advantage where it is desired to compensate for a radio frequency amplifier 1 having a rising amplification characteristic with increase in tuning frequency. By proper choice of the circuit constants the effective oscillator voltage impressed on the detector 4 may be made to have a falling output voltage characteristic as the oscillator frequency increases.

Such an oscillator characteristic will complement, or compensate, for the rising radio frequency amplifier characteristic, and the voltage produced in the circuit 6 will thereby remain substantially constant over the tuning range of the receiver.

By interchanging the condenser 16 and variable condenser 18, and appropriate choice of constants, the effective oscillator voltage characteristic can be made to rise with increase of oscillator frequency. Such a characteristic can be used to complement a radio frequency amplifier characteristic which falls with increase in signal frequency. In both cases of oscillator voltage characteristic the oscillator voltage is impressed on the cathode and screen of the detector 4. The signal voltage is impressed on the input grid; the I. F. voltage appearing in circuit 6 will be substantially uniform over the receiver tuning range.

Hence it will be seen that by employing the present circuit arrangement the effective oscillator voltage impressed on the converter tube can be increased at the low frequency end of the tuning range. This is of especial advantage in the frequency ranges above the broadcast range, as the loading phenomenon described above is marked in such ranges. The invention is not limited to the specific oscillator circuit shown, since other types of local oscillator networks may be employed. However, the specific type of oscillator shown enables one to obtain the characteristics described. Again, it is to be understood reduction of the voltage from the source B can be accomplished by inserting a resistor of proper size in the screen lead 23.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my 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 my invention, as set forth in the appended claims.

What I claim is:

1. In a receiving circuit of the superheterodyne type, a converter network including a first detector tube provided with cathode, control grid, screen grid and anode electrodes, a tunable signal input circuit connected to the control grid electrode, an output circuit resonant to a beat frequency connected to the anode, a local oscillator including a tube provided with a tunable oscillator circuit and arranged to produce oscillations of a desired frequency, means for tuning said tunable signal circuit and said tunable oscillator circuit over frequency ranges constantly differing by said beat frequency, and means whereby the loading effect of the detector tube upon the local oscillator at the low frequency end of said frequency ranges is substantially reduced, said means comprising connections for impressing the local oscillator voltage upon both the cathode and the screen grid of said first detector tube.

2. In a receiving circuit according to the invention defined in claim 1, wherein the means for impressing the local oscillator voltage on said

first detector tube comprises a direct connection from the oscillator anode to the detector screen grid and a coupling condenser connected from the cathode of the oscillator to the cathode of the detector.

3. In combination, in a radio receiver of the superheterodyne type, a radio frequency amplifier network having a predetermined amplification characteristic adapted to vary with frequency in a predetermined sense, a first detector network including a tube provided with a screen grid electrode, means for tuning said amplifier and detector over a desired signal frequency range, a local oscillator network including a tube provided with a tunable circuit adapted to be adjusted over a desired oscillation frequency range, said oscillator having a response characteristic complementary to that of the amplifier, and coupling means between the local oscillator and detector for impressing the oscillator voltage of said local oscillator upon both the cathode and the screen grid of said detector tube whereby the intermediate frequency output voltage of the detector is substantially constant over said signal frequency range.

4. In combination, means for receiving radio signals, a local oscillator, a modulator for modulating the received signals with the oscillations produced by said local oscillator, said modulator comprising a vacuum tube provided with a screen grid to which a constant positive potential is applied, and means for feeding the locally produced oscillations to the modulator comprising

a direct connection from the anode of the oscillator to the screen grid of the modulator and a connection from the cathode of the oscillator to the cathode of the modulator through a coupling condenser.

5. In a receiving circuit of the superheterodyne type, a converter network including a first detector tube provided with cathode, control grid, screen grid and anode electrodes, a grid biasing resistor connected between cathode and ground, a tunable signal input circuit connected between the control grid electrode and ground, an output circuit resonant to a beat frequency connected to the anode, a local oscillator including a tube provided with cathode, grid and anode electrodes, a grid biasing resistor connected between the cathode and ground, a tunable oscillator circuit connected between the oscillator grid and ground and arranged to produce oscillations of a desired frequency, means for tuning said tunable signal circuit and said tunable oscillator circuit over frequency ranges constantly differing by said beat frequency, and means for impressing the local oscillator voltage on said first detector tube without producing a loading effect of the detector upon the local oscillator, said means comprising a direct connection from the oscillator anode to the detector screen grid and a connection through a coupling condenser between the high potential points of the biasing resistors connected to the cathodes of the oscillator and the detector.

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