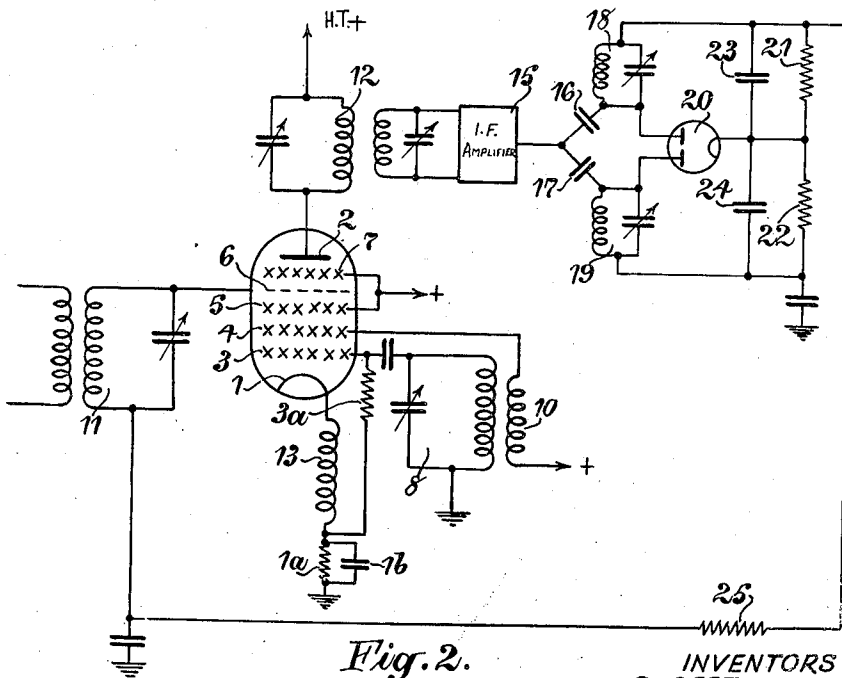
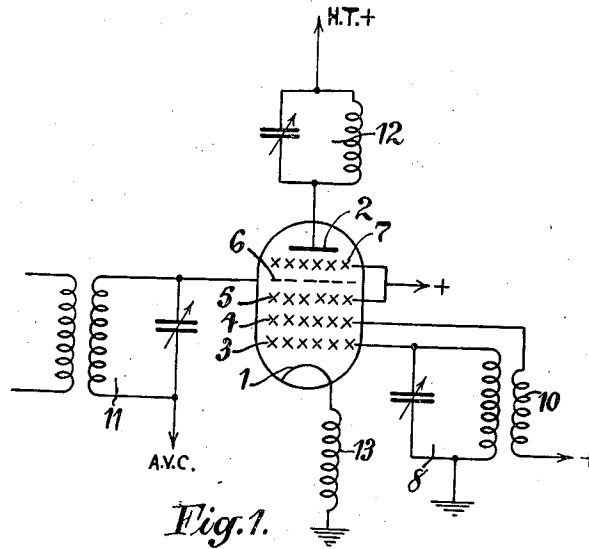


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THERMIONIC VALVE CIRCUIT

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## THERMIONIC VALVE CIRCUITS

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This invention relates to thermionic valve circuits of the superheterodyne type in which local oscillations generated by a valve are "mixed" by the said valve with other oscillations such as received signals, whereby oscillations of an intermediate frequency are obtained. The invention is generally applicable to circuits of this kind employing single valve frequency changers or mixing valves, such as heptode valves or triode-hexode valves.

When employing single valve frequency changers in circuits in which the biasing potential of the signal grid of the valve is varied either by the application of potentials derived from an automatic volume or gain control circuit or by a manual control, it is found that as the bias on the signal input grid is increased or diminished there is a tendency for the frequency of the local oscillations to vary, which it is thought may be due to the mutual conductance which exists between the signal grid and the oscillator anode of the valve. It is found that a change in the frequency of the local oscillations for a given change in bias under the same oscillator conditions is approximately proportional to the mutual conductance aforesaid.

This variation of drift in frequency is manifested in the case of a receiver employing an automatic volume or gain control circuit in two ways; firstly, as a received signal increases or diminishes in strength so the receiver wanders in and out of tune, and secondly, when tuning in a short wave station the gain control voltage will increase as resonance is approached and so tend to drag the oscillator more rapidly towards or away from resonance, rendering tuning difficult when receiving strong signals. It is generally found that the tendency for frequency drift is more pronounced when receiving short wave signals than when receiving medium or long wave signals.

It is, therefore, one of the objects of the present invention to provide an improved circuit in which the disadvantages referred to above are substantially overcome.

According to one feature of the invention, a thermionic valve circuit is provided in which local oscillations are produced and mixed with received signals in a single valve frequency changer, the biasing potential of the signal grid of which is adapted to be varied, and in which there is arranged in the cathode lead of the said valve an inductance, the nature and value of which is so chosen as to substantially prevent

frequency drift of the local oscillations when the biasing potential is varied.

The actual value of the inductance may vary according to particular requirements and in most cases the correct value of the inductance can readily be found by experiment. It is possible that the introduced inductance functions to avoid frequency drift by causing an equal and opposite change of effective inductance-capacity to that introduced by a change of bias on the signal grid of the valve and whilst the exact function of the coil may not be definitely understood, it has, however, been ascertained that the introduction of the inductance as aforesaid substantially prevents frequency drift as will be more readily appreciated by results obtained on a practical test and as set forth hereinafter.

In addition, it is found that frequency drift of the local oscillations may occur as the result of an increase in the mains voltage. An increase in the positive voltage applied to the screening grids of a heptode valve, or an increase in the positive voltage applied to the oscillator-anode, or an increase in the negative signal grid bias voltage, all produce an increase in the frequency of the local oscillations. Since these voltages vary simultaneously when there is an increase in the mains voltage, it follows that such increase will be accompanied by a large increase in the frequency of the local oscillations. It is, therefore, a further object of the invention to provide an improved circuit with a view to preventing or reducing frequency drift due to variation of the mains voltage. In this application of the invention it must be understood that gain control cannot be applied to the frequency changer valve, in which case gain control if required must be applied to a subsequent valve. According therefore to a further feature of the invention, a thermionic valve circuit is provided in which local oscillations are produced and mixed with received signals in a single valve frequency changer and in which there is arranged in the cathode lead of said valve an inductance the nature and value of which is so chosen as to substantially prevent frequency drift of the local oscillations due to varying mains voltages.

Further the invention may be applied for obtaining automatic frequency control without the use of an additional valve shunted across the local oscillator circuit. In this case automatic frequency control potentials derived in known manner may be applied to the signal grid of a heptode, the cathode of which is provided with a relatively large inductance.

In order that the said invention may be clearly understood and readily carried into effect the same will now be more fully described with reference to the accompanying drawing in which:—

Fig. 1 illustrates a circuit arrangement according to one feature of the invention embodying a heptode frequency changer, and

Fig. 2 illustrates a circuit similar to that shown in Fig. 1 as applied for automatic frequency control.

The circuit shown in Fig. 1 indicates only the frequency changer circuit of a superheterodyne receiver which as shown comprises a heptode valve having a cathode 1, an anode 2 and a series of grids arranged between the cathode and anode indicated by the reference numerals 3, 4, 5, 6 and 7. The first grid 3 is coupled to earth through a local oscillator circuit 8 comprising a coil shunted by a variable condenser, whilst the second grid 4 is connected, through a coil 10 which is inductively coupled to the coil 8 of the local oscillator circuit in known manner, to a source of positive potential, the second grid 4 thus functioning as the oscillator anode. The grids 5 and 7 are conductively connected together and connected to a suitable source of positive potential whilst the grid 6, which functions as the signal grid, is connected to a tunable input circuit 11 to which are applied gain control potentials derived in known manner from an automatic volume control circuit or from a manual control. The anode 2 is connected through a tuned output circuit 12 to a source of high tension current not shown. On applying a variable biasing potential to the signal grid 6, it is found that the frequency of the local oscillator tends to vary, and in accordance with the present invention, such drift in frequency is substantially overcome by inserting between cathode and earth an inductance coil 13. As above stated, the required value of the coil is best found by experiment, but in one particular instance a coil comprising four closely wound turns on a half-inch diameter form was found suitable for the purpose in view. This coil was employed in a circuit containing an American heptode valve of the 6A8 type. When only three turns were used, the drift was reduced but was still objectionable, whilst when five turns were used, over-compensation resulted and drift occurred in the opposite direction. In this circuit it was found that at a frequency of 18 megacycles and with input voltages of 5, 50, 500 and 5000 microvolts and with no inductance coil in the cathode lead, the frequency varied 0, +4, +15, +22 kilocycles respectively, but with a cathode coil of the above mentioned construction, the frequency variation was only 0,  $-\frac{1}{4}$ ,  $-\frac{1}{4}$ , +1 kilocycle. It will be appreciated from these figures that the introduction of the cathode coil substantially overcomes frequency drift over a wide range of input voltages.

Where the invention is employed for the purpose of avoiding or reducing frequency drift due to variation in the mains voltage, a coil is introduced between cathode and earth, that is to say, in the same position as the coil 13 in the accompanying drawing, but such coil is somewhat larger than the coil 13 (the required value being found by experiment and being determined by the extent to which the mains voltage is likely to vary), so that an increase in the negative bias applied to the signal grid of the valve, due to varying mains voltage, causes due to the provision of the coil a decrease in the frequency substantially equal and opposite to the increase in-

troduced by the corresponding rise in the screening grids and oscillator-anode voltage. Thus by the use of a cathode coil the local oscillator frequency may be rendered substantially independent of mains voltage fluctuations. It must, however, be understood that in this example of the invention the biasing potential applied to the signal grid must not be subjected to an automatic volume control action or to a manual control for volume control purposes and that if such a control is required it must be applied elsewhere in the circuit.

Fig. 2 illustrates the application of the invention for the purpose of correcting for frequency drift due to a change in the temperature of components and allied causes and for the purpose of obtaining automatic frequency control. As shown in Figure 2, a heptode valve is connected in circuit in the manner indicated in Figure 1 and elements shown in Figure 2 which correspond to the elements shown in Figure 1 have similar reference numerals. In Figure 2 the cathode 1 is self-biased in the usual way by a resistance 1a shunted by a by-pass condenser 1b whilst the oscillator grid 3 is also biased by a resistance 3a. The output circuit 12 is coupled in the conventional way to an intermediate frequency amplifier shown in block form at 15, an anode of a valve in the intermediate frequency amplifier being connected through condensers 16 and 17 to two tuned discriminator circuits 18 and 19 which are connected to the anodes of a double diode detector valve 20, the cathode of which is connected between two resistances 21 and 22 shunted by condensers 23 and 24 respectively. The discriminator circuits and associated elements function so that according to the particular degree by which the receiver lacks resonance either due to a change in the temperature of components or to mistuning of the receiver, so potentials are developed across the resistances 21 and 22, the algebraic sum of which is applied through a resistance 25 to the signal grid 6 through the tuned input circuit 11. The coil 13 in the present instance is somewhat larger than the coil 13 employed in Figure 1 and may comprise ten closely wound turns on a half-inch diameter form. The coil is of a sufficient size to cause a relatively small change in bias to produce a large change of frequency in the opposite direction to that in which frequency change would normally occur due to the change in temperature of the components. Thus the arrangement shown in Figure 2 may be employed to overcome a frequency drift due to variation of the temperature of components and allied causes and also serves automatically to correct for mistuning of a receiver. The arrangement shown in Figure 2 is advantageous compared with existing automatic frequency control circuits since in these cases the control potentials derived from the diode 20 are usually fed to a valve shunted across the local oscillator circuit to vary the effective impedance of the valve. In the present case automatic frequency control is obtained without the use of a valve shunted across the local oscillator circuit. As an indication of the variation in frequency which may be obtained by using the relatively large cathode coil above referred to, it may be mentioned that with a signal grid bias of -3, -4.6, and -5.2 volts, a frequency variation of the local oscillator of 0, -40, -120 kilocycles, respectively, can be obtained.

We claim:

1. In a superheterodyne receiver of the type

comprising a frequency changer tube provided with an oscillator section, a signal input grid, an output electrode and a common cathode, a signal input network coupled between the said grid and cathode, a network tuned to a local oscillation frequency operatively associated with said oscillator section, means for adjusting the potential difference between the grid and cathode, an inductive reactance disposed in the tube space current path and connected to said cathode, said reactance having a magnitude sufficient to prevent frequency drift of said oscillation network upon adjustment of said potential difference.

2. A superheterodyne receiver comprising a tube provided with a cathode, output electrode and at least three cold electrodes therebetween, a signal input network coupled to one of the cold electrodes, a local oscillator network coupled to the cathode and the other two cold electrodes, an output circuit, resonant to the frequency difference of the signal and oscillation frequencies, coupled to the output electrode, means varying the direct current potential of at least one of the tube electrodes, and a reactive impedance connected to the tube cathode, said impedance having a magnitude sufficient to cause a substantial frequency change of said oscillator network upon variation in said potential.

3. A superheterodyne receiver comprising a tube provided with a cathode, output electrode and at least three cold electrodes therebetween, a signal input network coupled to one of the cold electrodes, a local oscillator network coupled to the cathode and the other two cold electrodes, an output circuit, resonant to the frequency difference of the signal and oscillation frequencies, coupled to the output electrode, means varying the direct current potential of at least one of the tube electrodes, and a reactive impedance connected to the tube cathode, said impedance having a magnitude sufficient to cause a substantial frequency change of said oscillator network upon variation in said potential, said varying means being the direct current voltage supply source of the receiver, said impedance being an inductance, and said frequency change being such as to prevent frequency drift of said oscillator network.

4. A superheterodyne receiver comprising a tube provided with a cathode, output electrode and at least three cold electrodes therebetween, a signal input network coupled to one of the cold electrodes, a local oscillator network coupled to the cathode and the other two cold electrodes, an

output circuit, resonant to the frequency difference of the signal and oscillation frequencies, coupled to the output electrode, means varying the direct current potential of at least one of the tube electrodes, and a reactive impedance connected to the tube cathode, said impedance having a magnitude sufficient to cause a substantial frequency change of said oscillator network upon variation in said potential, said varying means comprising a network for deriving from the said output circuit a direct current voltage of a magnitude and polarity depending upon the resonance state of said signal input network.

5. A superheterodyne receiver comprising a tube provided with a cathode, output electrode and at least three cold electrodes therebetween, a signal input network coupled to one of the cold electrodes, a local oscillator network coupled to the cathode and the other two cold electrodes, an output circuit, resonant to the frequency difference of the signal and oscillation frequencies, coupled to the output electrode, means varying the direct current potential of at least one of the tube electrodes, and a reactive impedance connected to the tube cathode, said impedance having a magnitude sufficient to cause a substantial frequency change of said oscillator network upon variation in said potential, said potential varying means being connected to vary the potential of said one cold electrode, and the varying means comprising a network deriving a direct current voltage from said output circuit in response to a frequency change of the signal energy developed therein.

6. In a superheterodyne receiver of the type comprising a frequency changer tube provided with an oscillator section, a signal input grid, an output electrode and a common cathode, a signal input network coupled between the said grid and cathode, a network tuned to a local oscillation frequency operatively associated with said oscillator section, means for adjusting the potential difference between the grid and cathode, an inductive impedance disposed in the tube space current path and connected to said cathode, said impedance having a magnitude sufficient to prevent frequency drift of said oscillation network upon adjustment of said potential difference, said adjusting means comprising an automatic gain control circuit, and said impedance being an inductance.

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