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VACUUM TUBE OSCILLATOR

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Fig. 1.

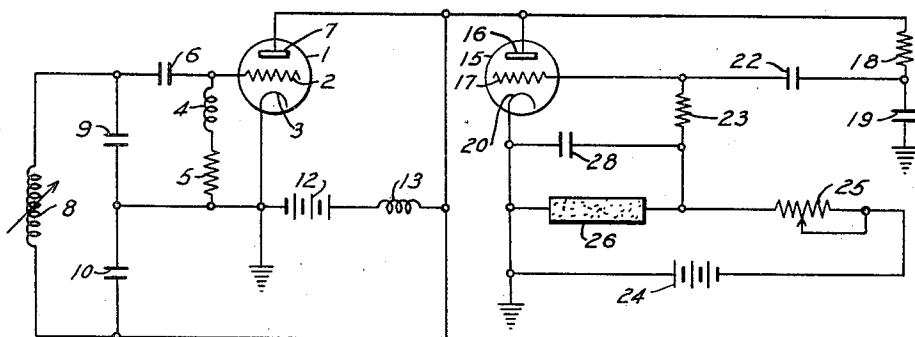
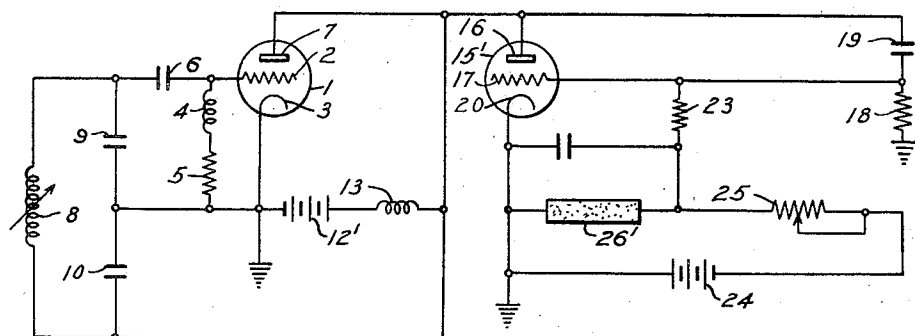


Fig. 2.



WITNESSES:

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VACUUM TUBE OSCILLATOR

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6 Claims. (Cl. 250—36)

This invention relates to vacuum tube oscillators, and more particularly to control circuits for maintaining frequency stability under conditions having an adverse influence thereon.

Various factors influence the frequency stability of vacuum tube oscillators, and among these the relative humidity of the atmosphere plays an important part. Recent advances in the art have resulted in substantial improvement as to frequency stability when the frequency change is due to variations of the supply voltage, the load or the ambient temperature. However no suitable device or circuit has so far been designed to compensate for the frequency change caused by a variation of humidity. The change in relative humidity can have a greater effect on the frequency than almost any other variable in that it affects every part of the circuit. This is especially true of capacitor tuned circuits where an increase of humidity also causes an increase of the dielectric constant of the air. Obviously, an increase in the dielectric constant changes the capacity of the condenser, and such change results in a considerable shift in frequency.

Devices which are intended to compensate for frequency variation due to humidity in one form effect compensation in the capacity of the tuned circuit by mechanical expedients; whereas other compensators heretofore used utilize a mechanical corrective movement of the main or an auxiliary tuning condenser. The disadvantage of such devices resides in the fact that additional parts needed in the oscillatory system introduce complications, and mechanical actions are sluggish and unreliable.

The primary feature of the present invention is that the compensation as to frequency of the vacuum tube oscillator is accomplished purely by small voltage variations in a control circuit, which is not directly a part of the main oscillatory circuit.

Another feature of this invention is that a reactance tube is utilized for the control of the oscillator, and that the compensation for changes in the oscillator circuit due to humidity is effected in the control tube circuit.

Third, a particular advantage of compensation in accordance with this invention is that small voltage changes result in comparatively large variation of the apparent reactance produced by the reactance tube. Furthermore, the humidity responsive element need only have simple resistance variation with humidity to produce a corresponding change in conductivity. In this

manner all mechanical movements are entirely eliminated.

Other features and advantages will be apparent from the following description of the invention pointed out in particularity by the appended claims and taken in connection with the accompanying drawing, in which:

Figure 1 is a schematic circuit diagram of a vacuum tube oscillator and a control tube producing an apparent inductive reactance; and

Fig. 2 is a circuit diagram similar to Fig. 1 wherein the control tube produces an apparent capacitive reactance.

Referring to the drawing, the circuits shown in Figs. 1 and 2 represent, by way of example, a standard type of oscillator coupled to a "reactance tube." The latter is utilized to vary the frequency of the oscillator in that the plate resistance effectively shunts the tank circuit of the oscillator and has a leading or lagging current whereby it reflects a reactance into the tank circuit. Circuits of this type are well known in the art and have been described by Travis in the Proceedings of the Institute of Radio Engineers, vol. 23, 1935. They are at the present time used in one form or another in the automatic frequency control of button tuned superheterodyne-type radio receivers.

Referring to Fig. 1, the oscillator tube 1 includes between grid 2 and cathode 3 the grid load impedance in the form of a choke coil 4 in series with a resistor 5. Coupled to the grid of the tube, by means of condenser 6, and also to the anode 7 of tube 1 is the inductance 8. Capacitors 9 and 10 in series across the inductance 8 form a dividing network, the center tap of which, at the junction point of the condensers mentioned, terminates at the cathode 3 of the tube 1. The anode potential is supplied by the battery 12 connected between cathode 3 and the anode 7 in series with a suitable impedance in the form of an inductance 13. By way of example, the oscillator herein shown is of the type known as the Colpitts oscillator, described in U. S. Patent No. 1,624,537. It is to be understood that the control circuit in accordance with this invention may also be used in connection with any other type of oscillator.

Coupled to the oscillatory circuit is the reactance tube 15, the anode 16 of which connects directly to the anode 7 of the tube 1. The grid 17 is coupled to the anode 16 through a resistance-capacity phase shifting network comprising the resistor 18 and the capacitor 19 in series, between anode 16 and ground. Since the resistor terminates at the anode of the reactance tube it

is at anode supply potential and the grid 17 must be coupled, by means of a blocking condenser 22, to the junction point of the resistor 18 and condenser 19. The grid circuit is completed to the cathode by the grid resistor 23 which connects to a voltage divider comprising resistors 25 and 26 in parallel with the bias supply battery 24. The positive terminal of this battery is connected to the cathode 20. The connection of the grid resistor 23 to the junction point of the resistors 25 and 26 is bypassed by the capacitor 28.

The resistor 26, indicated here in the form of a bar, has the property of changing its conductivity—that is, its resistance—with changes in the relative humidity of the atmosphere. Such a resistor may consist of deliquescent or hygroscopic materials which readily absorb moisture and present considerable change in electrical resistance with respect to moisture content. It was found that lithium chloride or beryllium chloride exhibit such properties. A resistor made of lithium chloride had a resistance variation from 800,000 ohms to 2,000 ohms for a humidity variation from zero to 100%.

The circuit of Fig. 2 is practically identical with that of Fig. 1, except for the change in position of the resistor 18 and condenser 19. For this reason, similar component parts other than the resistor 18 and the condenser 19 are marked with identical reference characters bearing primary indices. The grid coupling condenser 22 may be omitted, in the circuit of Fig. 2, because the grid is now isolated from the high direct-current potential produced by the battery 12' by the phase-shift condenser 19.

The operation of the circuit will be described with reference to Fig. 1. Let it be assumed that the oscillator has a certain predetermined frequency which may be set to a desired number by varying the inductance 8, and that it is desired to maintain this frequency. The bias on the grid 17 of the control tube depends on the current flow through resistors 25 and 26. This bias is so adjusted that the reactance reflected into the tank circuit together with the reactance of the inductance 8, gives the desired frequency of oscillation: as mentioned before, the ohmic value of the resistance 26 changes with humidity. Therefore, an increase in the relative humidity causes the value of the resistor 26 to decrease. A decrease of this value will lower the voltage drop across resistor 26 caused by the current flowing through the resistors 25 and 26. The lowering of the voltage across resistor 26 changes the bias on the grid 17. This results in a displacement of the operating point of the tube along the grid voltage-plate current characteristic curve which produces a change in the apparent reflected reactance. Since this apparent reactance is in parallel with the inductance of the oscillator circuit, the total circuit inductance is lowered with a corresponding increase in frequency. By proper proportioning of the values of the resistors 26 and 25, the correct operating point can be obtained, so that the normal lowering of the oscillator frequency caused by an increase of humidity can be offset by a corresponding lowering of the circuit inductance to the correct value.

With respect to Fig. 2, the operation is very similar, except that the lowering of the resistance 26' will produce a change of reactance of the tube 15' which is reflected as a capacity reactance on the oscillatory circuit, producing a

decrease of frequency. This type of connection will be necessary when certain components are so affected as to produce an increase of frequency with changes of humidity.

Obviously, a reverse change, that is a decrease of humidity of the atmosphere will have the inverse effect. The change of apparent reactance will tend to compensate for the change in the oscillator circuit produced by a decrease of humidity.

I claim as my invention:

1. In an oscillator control circuit, a vacuum tube oscillator, a reactance tube coupled thereto for controlling the frequency of the generated oscillations, means for maintaining the frequency of said oscillations at a substantially constant value irrespective of changes of relative humidity tending to alter the frequency of said oscillator comprising means for automatically controlling the effective reactance of said tube upon variations in humidity in a compensative sense of reactance value with respect to the effect of said variations of humidity on said oscillator.

2. In an oscillator control circuit, a vacuum tube oscillator having component elements determining the frequency of oscillations, certain of said elements being subject to variations with change in the relative humidity of the atmosphere whereby the frequency of said oscillator departs from a constant value, means for maintaining the frequency of said oscillator substantially constant over changes in relative humidity comprising a reactance tube coupled to said oscillator, an electrical circuit for said tube for producing predetermined apparent reactance value, and means in said circuit responsive to humidity variations for changing said apparent reactance compensatively with respect to the change in certain of said component elements due to variation in relative humidity.

3. In an oscillator control circuit, a vacuum tube oscillator having component elements determining the frequency of oscillations, certain of said elements being subject to variations with change in the relative humidity of the atmosphere whereby the frequency of said oscillator departs from a constant value, means for maintaining the frequency of said oscillator substantially constant over changes in relative humidity comprising a reactance tube having an anode, cathode and control electrode, a circuit interconnecting said control electrode and cathode including means for applying a biasing potential to said control electrode whereby the apparent reactance produced by said tube with respect to the oscillator may be varied, resistance means in said circuit whose value is dependent upon relative humidity for changing said biasing potential automatically upon variation of humidity thereby producing an apparent reactance in a sense compensating the effect of humidity tending to alter the value of said component elements.

4. In an oscillator control circuit, a vacuum tube oscillator having component elements determining the frequency of oscillations, certain of said elements being subject to variations with change in the relative humidity of the atmosphere whereby the frequency of said oscillator departs from a constant value, means for maintaining the frequency of said oscillator substantially constant over changes in relative humidity comprising a reactance tube having an anode, cathode and control electrode, comprising a source of bias potential, a voltage dividing network thereacross, a resistance element in said

network whose resistance value is dependent upon relative humidity, a connection for said control electrode to the junction point between said resistance elements whereby the voltage for said electrode is automatically varied with variation in the conductivity of said resistance element, said variation being in such direction as to compensate the effect of humidity tending to alter the effective value of said component elements.

5. The combination in accordance with claim 4 in which said resistance element comprises a composition including lithium chloride.

6. The combination in accordance with claim 4 in which said resistance element comprises a composition including beryllium chloride.

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