PATENT SPECIFICATION

1,076,831

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in and relating to Variable Reactive Impedance Devices

We, THE BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W.1. do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to variable reactive impedance devices.

According to the present invention there is provided an oscillator comprising a transformer whose primary winding is connected in a resonant circuit which determines the frequency of oscillation of the oscillator, current injection means which includes first and second control devices each of which has one of its output terminals connected to a secondary winding of the transformer, and which, in operation, pass currents which tend to induce anti-phase currents in the primary winding, and modulating means for varying said frequency of oscillation by so varying the currents from the current injection means that the resultant induced current in the primary winding is varied.

In this specification a control device is a valve, transistor, and an output terminal of such a device can be the anode or cathode, in the case of a valve, or the emitter or collector in the case of a transistor, depending on the configuration of the circuit.

Preferably the transformer has a tapped secondary winding through which the variable-frequency oscillations generated by the oscillator are passed, these oscillations being passed through one part of the secondary winding in one sense and through another part of the secondary winding in the opposite sense.

An example of the invention will now be described with reference to the accompanying drawings in which:—

Fig. 1 is an explanatory diagram, and

Fig. 2 is a circuit diagram of an oscillator according to the invention.

In Fig. 1 a transformer 10 having a primary winding 11 and a centre-tapped secondary winding 12 is connected to receive alternating current from a source 13.

Two further sources 14 and 15 are each connected between the centre tap of the secondary winding 12 and one end of the secondary winding and are arranged to pass alternating current through the secondary winding in anti-phase to one another.

Each alternating current passed through the secondary winding 12 induces a voltage in the primary winding 11 and if the currents passed through the secondary winding 12 are unequal in amplitude a resultant induced voltage appears in the primary winding 11. The phase of each of the sources 14 and 15 is fixed relative to the phase of the source 13 and is so chosen that the resultant induced voltage is in phase or out of phase with the current from the source 13 depending on which of the currents from the sources 14 and 15 is of the larger amplitude.

The relation between the amplitudes of the current through and voltage across the primary winding 11 can be varied, whilst the amplitude of the voltage across the source 13 is kept constant, by varying the amplitude of the current from the source 14 relative to the amplitude of the current from the source 15.

Therefore the effective inductance seen from the terminals of the source 13 looking towards the primary winding 11 can be varied.

It will be readily apparent that the effective inductance can be made equal to the self-inductance of the primary winding 11 if the currents from the sources 14 and 15 are made equal in amplitude. The internal impedance of the sources 14 and 15 must of course be sufficient to ensure that the secondary circulating current, due to the primary current, is small.

The oscillator of Fig. 2 includes a first transistor 16 having its emitter connected to a frequency determining reactive circuit consisting of an inductive winding 18 and a variable capacitor 19, the reactive circuit being shunted by a resistor 17. The transistor 16 has a load resistor 20 across which the output from the transistor 16 appears, the output being applied to the emitter of each of two modulating transistors 21 and 22 by way of two capacitors 23 and 24.

The two collectors of the modulating transistors are connected to the two ends respectively of a further inductive winding 25 coupled to the winding 18. The inductive winding 25 has a centre tap leading the current from the transistors 21 and 22 through a pair of resistors 26 and 27 connected in series.

The voltage appearing across the two resistors 26 and 27 is applied to the base of a transistor 28 by way of a capacitor 29 and resistor 30, and is amplified by the transistor 28 before being applied from the collector of the transistor 28 through a resistor 32 and a capacitor 31 to the base of the transistor 16. The feedback provided by the capacitor 31 causes the circuit to oscillate and the frequency of oscillation is the resonance frequency of the reactive circuit consisting of the inductive winding 18 and the capacitor 19.

The load resistance 20 is large and consequently the amplitude of the alternating current from the transistor 16 to the two transistors 21 and 22 is substantially equal to the amplitude of the alternating current in the reactive circuit. The transistors 21 and 22 have emitter resistors 33 and 34 each of large resistance and consequently the sum of the alternating currents passing through the transistors 21 and 22 is substantially equal in amplitude to the alternating current from the transistor 16.

The inductive winding 25 is magnetically coupled to the winding 18 and although the amplitude of the sum of the alternating currents in the winding 25 is substantially equal to that of the alternating current from the transistor 16, the sharing of the current from the transistor 16 between the transistors 21 and 22 is determined by the relative potentials of the bases of the transistors 21 and 22. A change in the relative potentials of the bases of the transistors 21 and 22 thus causes a change in effective inductance of the inductive winding 18 and a change in the frequency of the generated oscillations. Frequency modulation of the generated oscillations may thus be effected by applying a modulating voltage between the bases of the transistors 21 and 22. The frequency in the absence of a modulating potential, that is the centre frequency, is determined by the bias applied to the base of each of the transistors 21 and 22 by a biasing circuit. The biasing circuit includes two resistors 35 and 36 and a source of biasing potential applied to the junction of the resistors 35 and 36 by way of a terminal 37.

In order to modulate the voltage generated, a modulating voltage is applied between terminals 38 and 39 coupled to the bases of the transistors 21 and 22 by way of a transformer 40.

It can be shown that for a sinusoidal modulating voltage the modulated voltage is distorted and has a centre-frequency shift and second, third and higher harmonics of the modulating voltage, the harmonics higher than the third being negligible. Of the harmonics the second is more significant than the third, but the distortion represented by the centre-frequency shift and by the second harmonic is substantially reduced by means of a diode 41 connected in series with a resistor 42 across the secondary winding of the transformer 40. The diode has a square law characteristic so complementary to that of the variable-frequency oscillator as substantially to cancel the second harmonic distortion of the modulated signal. Further improvement in reduction of distortion may be effected by providing one or more circuits, each comprising a diode in series with a resistor, the one or more circuits being connected in parallel with the circuit 41, 42. Preferably the diodes are of different type: for instance if 41 is a germanium diode the additional one may be a silicon diode.

In order to cancel the centre-frequency shift it can be shown that the impedance presented to the flow of alternating currents from the transformer 40 must equal the impedance presented to the flow of unidirectional current. In order to achieve this condition resistors 43 by-passed by capacitors 44 connect each end of the transformer 40 to the bases of the transistors 21 and 22.

Since a large degree of negative feedback is effected by each of the resistors 33 and 34, the emitters of the transistors 21 and 22 have substantially the same alternating potential as their bases. However the coupling capacitors 23 and 24 are effectively connected in shunt with the resistors 33 and 34 and consequently the degree of negative feedback decreases as the modulation frequency increases. The amplitude of the frequency swing of the generated voltage for a modulating voltage of given amplitude therefore depends on the frequency of the modulating voltage and increases as the frequency of the modulating voltage increases. In other words the sensitivity of the circuit depends on the frequency of the modulating voltage.

A switch 45 is connected in series with a capacitor 46 between the terminals 38 and 39 and in shunt with a variable resistive attenuator shown diagrammatically as the resistor 47.

When it is desired to keep the sensitivity independent of the frequency of the modulating voltage, the switch 45 is closed to connect the capacitor 46 across the variable attenuator 47 and the time constant of the capacitor 46 and attenuator 47 is adjusted to equal the time constant of the capacitor 23 and resistor 33, which in turn is equal to the time constant of the capacitor 24 and resistor 34.

A conventional limiter consisting of two diodes 48 and 49 shunted by a radio-frequency choke 50 is provided for limiting the amplitude of the generated oscillations which appear at an output terminal 51 connected to the junction of the resistors 26 and 27. The generated oscillations at the output terminal 51 are taken to an output amplifier (not shown) before being passed to the load for which they are intended. Alternatively, to keep the sensitivity independent of the frequency of the modulating voltage the capacitors 23 and 24 may each be replaced by a capacitor and inductor in series, so chosen that their reactance at the oscillator frequency is small, but at the modulating voltage frequency is high.

If desired, instead of applying modulating signals to the bases of both the transistors 21 and 22, as shown, a modulating signal may be applied to only one of these transistors. The total r.f. current in the two transistors 21 and 22 is in either case fixed, so that even when only one has a modulating signal applied to it the r.f. current in one will increase when the r.f. current in the other decreases.

The oscillator shown in Fig. 2 has a negative temperature coefficient and it is therefore desirable to house the oscillator in a constant-temperature enclosure.

WHAT WE CLAIM IS:—

1. An oscillator comprising a transformer whose primary winding is connected in a resonant circuit which determines the frequency of oscillation of the oscillator, current injection means which includes first and second control devices each of which has one of its output terminals connected to a secondary winding of the transformer, and which, in operation, pass currents which tend to induce anti-phase currents in the primary winding, and modulating means for varying said frequency of oscillation by so varying the currents from the current injection means that the resultant induced current in the primary winding is varied.

2. An oscillator according to Claim 1 wherein the first and second control devices are first and second transistors, and the current injection means includes a single a.c. generator coupled to both transistors, the transistors being so connected to the secondary winding that they tend to pass currents dependant on signals from the generator to the secondary winding, and the modulating means, in operation, applying a control signal to the transistors to vary the magnitude of the currents passed by the transistors.

3. An oscillator according to Claim 2 wherein the secondary winding is centre tapped, the two transistors being connected to opposite ends of the secondary winding to pass currents, through the two halves of the winding, which tend to induce anti-phase currents in the primary winding.

4. An oscillator according to Claim 2 or 3 wherein the a.c. generator includes the resonant circuit.

5. An oscillator according to any preceding claim wherein the modulating means includes a circuit for applying a sinusoidal modulating signal to the devices, the said circuit having a characteristic substantially complementary to the remainder of the oscillator, with regard to second harmonic signals of the modulating signal, so that any tendency of the oscillator to generate a modulated signal containing the said second harmonic signals is counteracted by a complementary distortion of the control signal applied to the devices.

6. A variable-frequency oscillator substantially as hereinbefore described with reference to Fig. 2 of the accompanying drawing.

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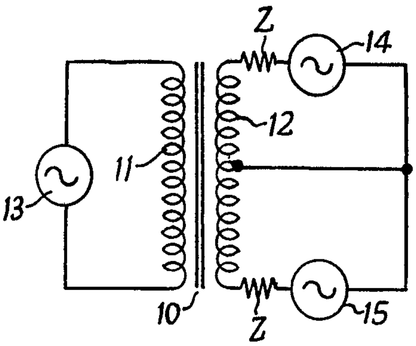
1,076,831 PROVISIONAL SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

Fig. 1.



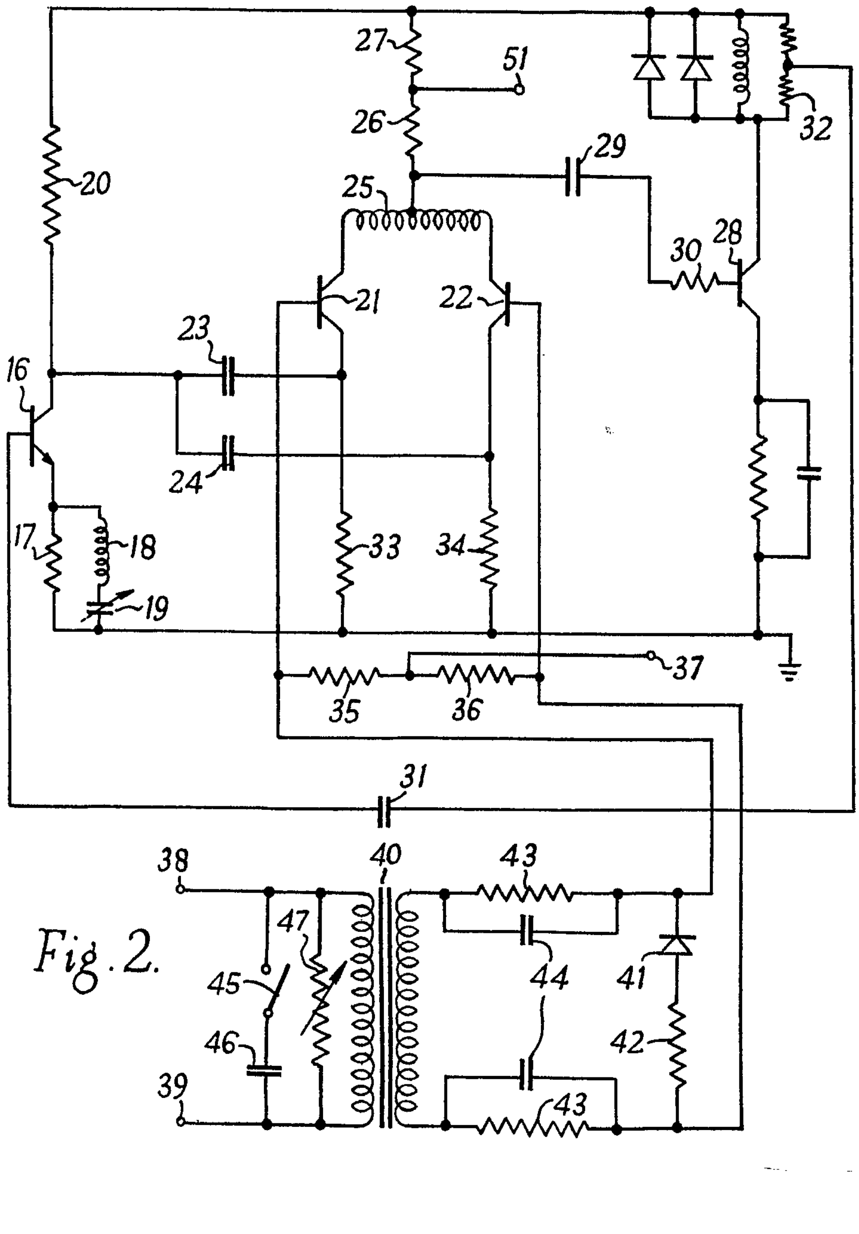


Fig. 2.

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1 SHEET
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Fig. 1.

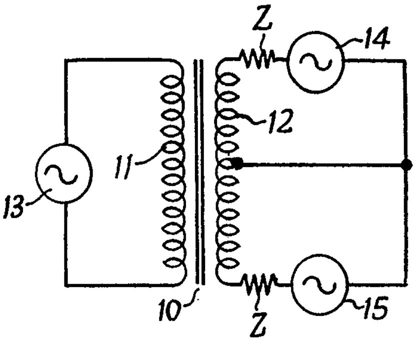

Fig. 2.