

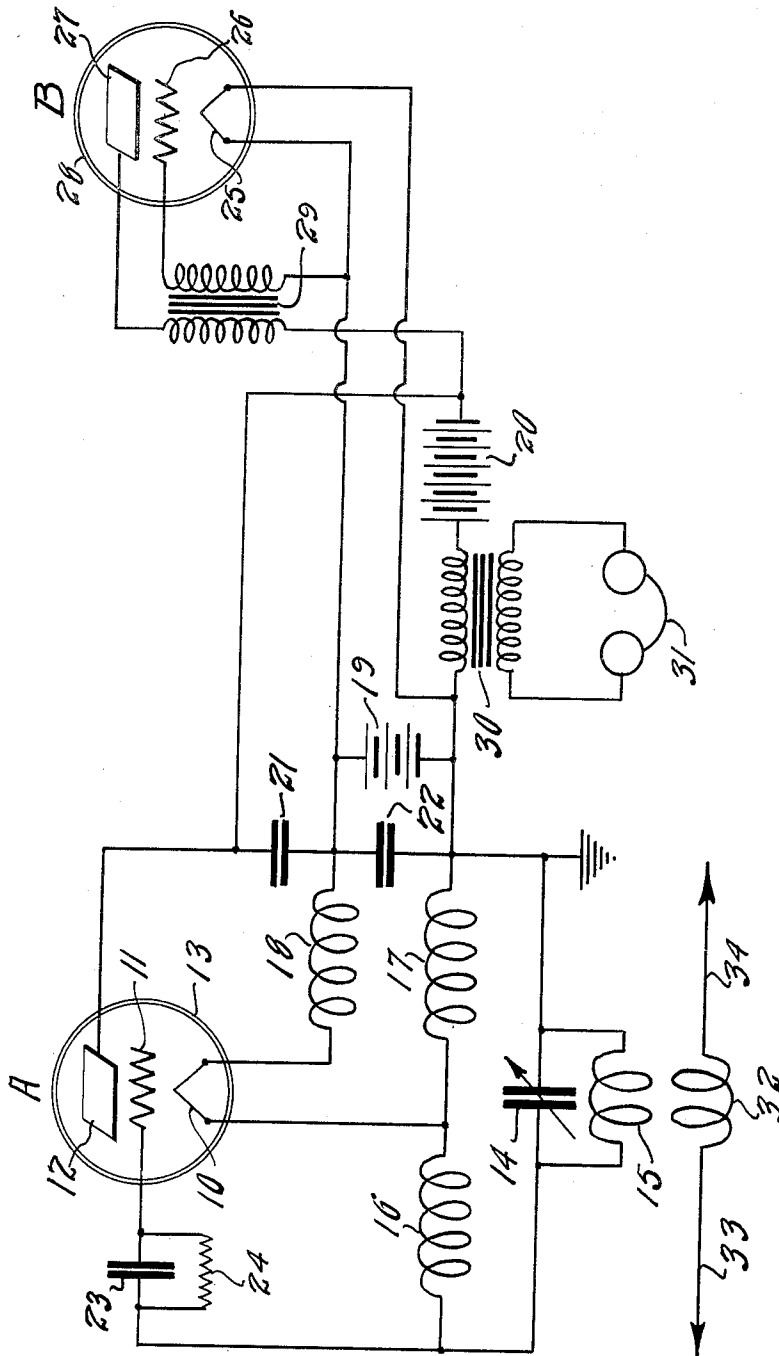
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P. S. EDWARDS ET AL

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ULTRA SENSITIVE RELAY

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ULTRA SENSITIVE RELAY

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The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes, without the payment to us of any royalty thereon.

This invention relates to relays and more particularly to relays of extreme sensitivity.

An object of the invention is to provide a relay of extreme sensitivity capable of indicating small changes in the dielectric surrounding the circuit constituting a part thereof or changes in an external circuit associated therewith.

Another object of the invention is to provide a circuit comprising a self-modulating radio frequency oscillator with means for varying the modulating rate thereof, and a fixed audio frequency oscillator connected in the output circuit of the radio frequency oscillator to provide a common responsive indicating system, whereby the extent of the varying means results in corresponding variations in beat frequency between the respective oscillators.

A further object of the invention is to provide a self-modulated radio frequency oscillator having connected with the output circuit thereof, a fixed audio frequency oscillator and an indicating means associated therewith adapted to indicate the beat frequencies corresponding to the difference in frequencies of the modulating rate and the fixed audio rate.

Other objects of the invention will appear from the following description taken in connection with the drawing which forms a part of this specification and in which:

The drawing is a comprehensive schematic view illustrating the various circuits that go to make up the present invention.

Referring to the drawing for more specific details of the invention, A represents generally a radio frequency circuit of a constant frequency type comprising an ordinary vacuum tube having a filament 10, a grid 11 and a plate 12 enclosed in an evacuated envelope or container 13. Connected to the input and the output circuits of the tube is a low loss tank circuit comprising a large variable capacity 14 and a small inductance 15.

The value of this capacity and inductance largely determines and controls the frequency at which the tube oscillates.

High frequency choke coils 16 and 17 having a relatively large number of turns are connected to the filament 10 and are adapted to produce two driving electromotive forces approximately 180° out of phase. The geometric sum of these electromotive forces produces and maintains in the tank circuit a very heavy oscillating current. Another choke coil 18 is connected to the filament and serves to maintain it at a high potential with respect to the ground.

The electrical supply from the tube comprises a filament battery 19 and a plate battery 20, both of which are maintained at ground potential and connected in the circuit are bypass condensers 21 and 22. These are of large value and thus permit high frequency circulation in the circuit.

A blocking condenser 23 and a leak resistance 24 are connected in the grid circuit. The value of these is so selected that the high frequency oscillations will periodically charge the condenser up to a certain value and then discharge through the leak resistance 24 to the ground. The frequencies of this periodic discharge are dependent upon the value of the condenser 23 and the resistance 24 provided other values of the circuit are constant. Thus, for a large value of the grid leak, the frequency is low and the grid of the tube is strongly biased. The plate current, as a result of this bias, consequently is very small and will remain so until some internal cause affects the circuit.

It is thus apparent that a decrease in value of the grid resistance will increase the frequency of the periodic discharge, that the amplitude of the high frequency oscillations cannot reach high value and that the bias decreases. This is followed by an increase of the plate current, it of course, being understood that a decrease in the value of the blocking condenser produces the same effect.

The filament and plate battery 19 and 20 which supply the radio frequency oscillator also supply an audio frequency oscillator des-

ignated generally at B. The audio frequency oscillator comprises a vacuum tube having a filament 25, a grid 26 and a plate 27 enclosed in an evacuated envelope or container 28. This tube derives its audio frequency oscillating period from the constants of an associated transformer 29. The plate output circuits of the radio frequency oscillator and the audio frequency oscillator are connected to the primary of a transformer 30 in the secondary of which is connected a pair of telephones 31.

Inductively coupled to the tank circuit is an external circuit comprising a loading coil 32 and conductors 33 and 34. This circuit is tuned close to the frequency of the tank circuit. Any cause affecting the reactance of this circuit will effect the reactance of the tank circuit and hence the plate current.

When the modulated frequency of the circuit A is adjusted to the same frequency as the circuit B so that the two frequencies are identical, there are no beats present between the two musical notes. As soon, however, as the external circuit of the radio frequency oscillator is affected by some external cause as, for instance, changes in the reactance of the circuit by the presence of foreign matter in the surrounding media, the modulating frequency of the circuit A is changed and a beat appears in the secondary of the transformer 30. The frequencies of this beat note can be easily measured and the magnitude of the cause affecting the external circuit determined.

When the modulated frequency of the circuit A is adjusted to the frequency of the circuit B, there are no beats present in the telephone. When, however, the external circuit comprising the loading coil and conductors is affected by causes tending to vary its reactance, the reactance of the tank circuit, including the condenser 14 and inductance 15 also vary, and consequently varies the rate of modulation which in turn by reason of such changes produces beat notes in the telephones 31, corresponding to the difference in frequencies of the A and B circuits.

It is obvious that the output of the transformer 30 may include impulse relays responsive to certain beat frequencies and that such means may be utilized to perform working functions.

While preferred embodiments of the invention have been described, it is to be understood that these are given as examples of the underlying principles of the invention, and since these may be incorporated in other specific mechanical structures, we do not intend to be limited to those shown except as such limitations are clearly imposed by the appended claims.

Having thus described the various features

of our invention, what we claim as new and desire to secure by Letters Patent is:—

1. A method comprising generating radio frequency oscillations modulated at a predetermined rate, varying the rate of modulation, generating audio oscillations of fixed frequency, and measuring the difference between the modulations of the radio frequency oscillations and the audio frequency oscillations.

2. A method comprising generating radio frequency oscillations modulated at a predetermined rate, generating audio frequency oscillations of the same pitch as the normal pitch of the modulation of the radio oscillations, intermodulating the modulated radio frequency oscillations with the audio frequency oscillations, varying the pitch of modulation of the radio frequency oscillations to produce a beat note, and measuring the frequency of the beat note to determine the magnitude of the variation.

3. A circuit comprising a self-modulated radio frequency oscillator, means for varying the frequencies of the modulations, a fixed audio frequency oscillator and means connecting the radio frequency oscillator with the audio frequency oscillator for indicating the variable differences of frequencies generated in the respective oscillators.

4. A circuit comprising an audio modulated radio frequency oscillator, means for varying the frequencies thereof, a fixed audio frequency oscillator having the same pitch as the normal pitch of the modulating audio frequency of the radio frequency oscillator, and means interconnecting said oscillators for indicating the difference between the audio modulations and the audio frequencies.

5. A circuit comprising a self-modulated radio frequency oscillator, means for varying the pitch of modulation, a fixed audio frequency oscillator, means for intermodulating the pitch of the modulation with the audio frequency oscillations, and indicating means associated therewith to measure the beat corresponding to the difference in the frequencies of the modulated radio frequency and the fixed audio frequency.

6. A circuit comprising means for generating self-modulated radio frequencies, means for generating audio frequencies, a common output circuit connecting said generators, means for intermodulating the modulated radio frequencies and the audio frequencies in said common output circuit and means connected in said circuit for indicating the differences between the modulated radio frequencies and the audio frequencies.

7. A circuit comprising a self-modulated radio frequency oscillator, means for varying the pitch of said self-modulations, a fixed audio frequency oscillator, means connecting the output of the radio frequency oscillator with the audio frequency oscillator for intermodulating the said self-modulations and the

audio frequency oscillations and means for indicating a variation in the frequencies of the pitch of modulation.

8. In an electric circuit a vacuum tube having a filament, grid and plate, a low loss oscillating circuit of small inductance and large capacity connected across the grid and plate, a plurality of radio frequency choke coils connected between the filament and grid on one side and filament and plate on the other, producing across the oscillating circuit a driving electromotive force, means to modulate the high frequency oscillations at audio frequency, a fixed audio frequency oscillator tube connected in the output circuit of the radio frequency oscillator and means connected in the output circuit for measuring the difference in the audio frequencies occurring in the tubes.

9. A circuit comprising a vacuum tube hav-

ing a filament grid and plate, a low loss tank circuit comprising a low inductance and large capacitance connected across the grid and plate, means to produce high frequency oscillations in the tank circuit comprising two coils placed respectively between the filament and each of the cold electrodes of the tube, means to modulate the high frequency at audio frequency by a blocking effect, a fixed audio oscillator tube comprising a filament, grid and plate, connected in the output circuit of the first mentioned tube, and means associated therewith for measuring the difference in the beat note between the first and second mentioned audio frequencies.

In testimony whereof we affix our signatures.

PAUL S. EDWARDS.

CONSTANTIN D. BARBULESCO.

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