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TESTING SYSTEM

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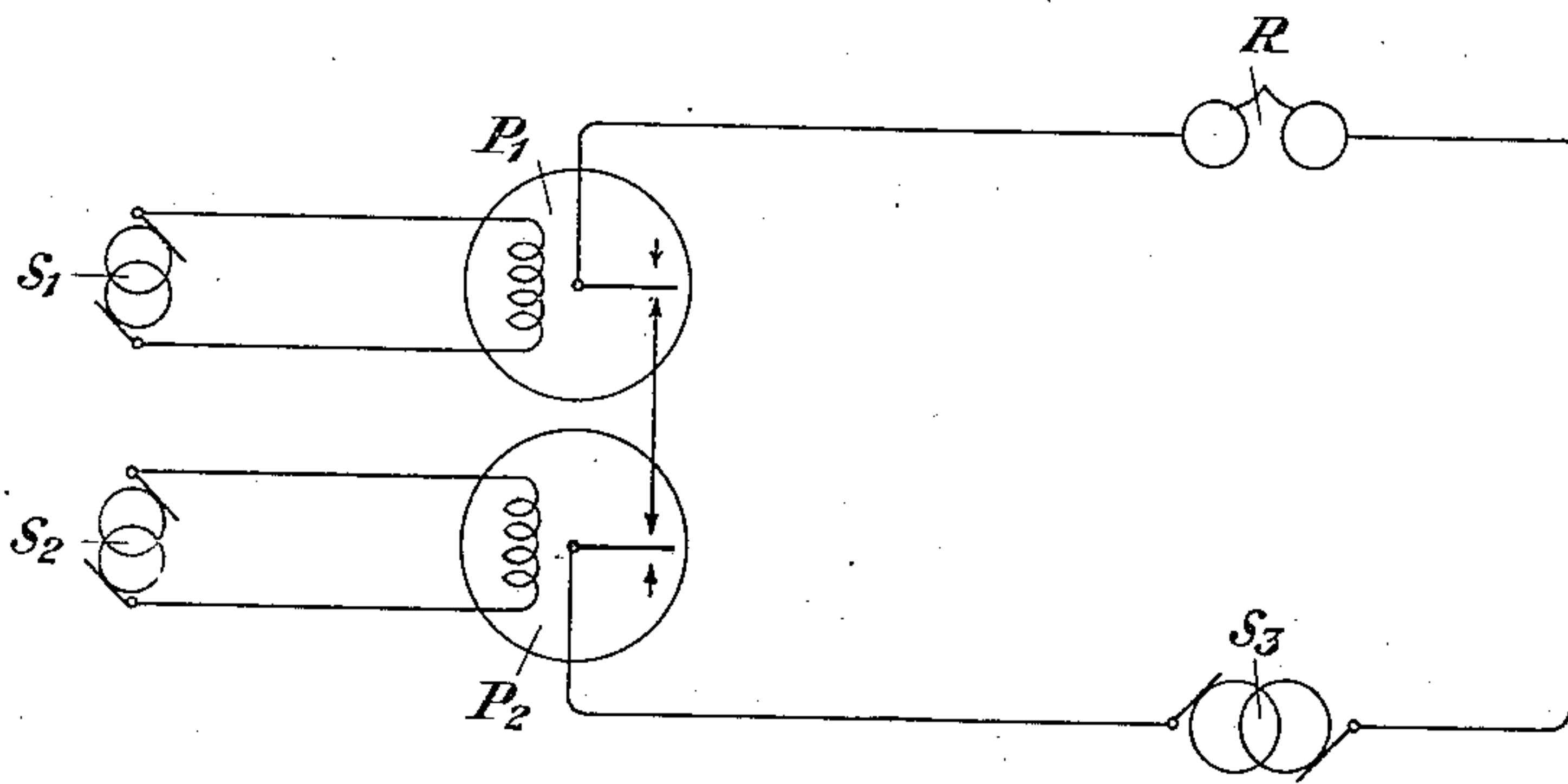


Fig. 1

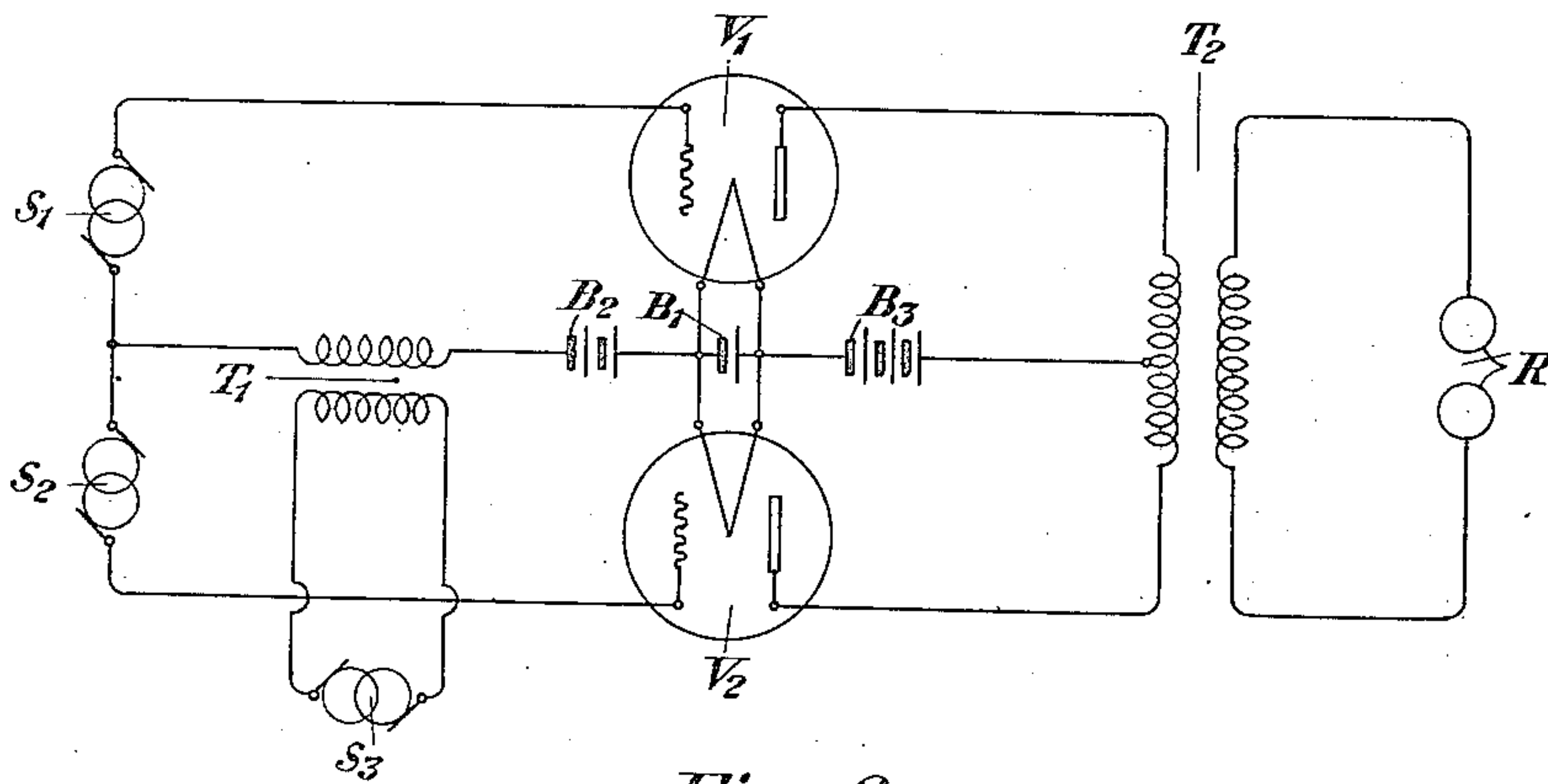


Fig. 2

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TESTING SYSTEM.

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This invention relates to electrical systems, and particularly to circuits for comparing the frequencies of currents of two or more electrical sources.

One of the objects of this invention is to compare two inaudible frequencies to determine whether they are equal. This object may be accomplished by means of a detecting device, such as a telephone receiver, upon which is impressed an audible frequency modulated successively by each inaudible frequency, the audible frequency being within the range of reception of the detecting device, such as the telephone receiver.

It is another object of this invention to permit two or more inaudible frequencies to modulate or otherwise modify the current of the audible frequency in accordance with the currents of two or more inaudible frequencies which are to be compared to determine whether these frequencies are in synchronism, a detecting device which detects the presence or absence of current of the audible frequency being employed to observe whether or not the frequencies to be compared are in synchronism.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing in which Figure 1 represents one embodiment of the invention employing polar relays, and Fig. 2 represents another embodiment of the invention employing vacuum tubes.

Referring to Fig. 1 of the drawing, two sources of current designated by the reference characters S_1 and S_2 are shown, the frequencies of these sources being below the range of audibility. Sources S_1 and S_2 may be vacuum tube oscillators, electrical vibrators, generators, or the like. Source S_1 is connected to the winding of the polar relay P_1 , the armature of polar relay P_1 vibrating between fixed contacts at the period of the current of the source S_1 . Source S_2 is connected to the winding of a polar relay P_2 , the armature of polar relay P_2 vibrating between fixed contacts at the period of the current of source S_2 . One of the fixed contacts of polar relay P_1 is directly connected to one of the fixed contacts of polar relay

P_2 . Another source of current is designated by reference character S_3 . This source of current may also be a vacuum tube oscillator, an electrical vibrator, a generator, or the like. One terminal of source S_3 is connected to a detecting device designated by the reference character R , the detecting device R being a telephone receiver or headset or any other device capable of detecting current of an audible frequency. The wave emitted by source S_3 is preferably a wave of an audible frequency which may easily be detected by the detecting device R . In other words, the frequency of a current of source S_3 lies within the range of audibility of the telephone receiver representing the detecting device of this invention. The detecting device R is connected in series relationship with the source S_3 between the armatures of polar relays P_1 and P_2 . Thus, the armatures of polar relays P_1 and P_2 are connected in a series circuit with the detecting device R and the source S_3 when the armature of polar relay P_1 closes its lower contact and the armature of the polar relay P_2 closes its upper contact. When the lower and upper contacts of polar relays P_1 and P_2 are closed by their respective armatures, current of the frequency of source S_3 is transmitted through the detecting device R , causing an audible sound. When either of the armatures of polar relays P_1 and P_2 opens the above mentioned series circuit, no current will flow through the detecting device R and, accordingly, there will be a period of silence.

If the currents emitted by sources S_1 and S_2 are of equal frequency, then the armatures of polar relays P_1 and P_2 will vibrate at the same frequency between their fixed contacts. Then, if the armatures of polar relays P_1 and P_2 are 180 degrees out of phase while vibrating at the same speed, pulses of current will pass through the detecting device R , the period of these pulses corresponding to the period of either of the sources S_1 or S_2 . Thus, if source S_1 transmits current of a frequency, for example, of 20 cycles per second, current will pass through the detecting device R in pulses of equal duration twenty times per second, the current of each pulse having a frequency corresponding to the frequency of source S_3 . A 180 degree phase difference between the armatures of polar relays P_1 and P_2 exists when the ar-

mature of polar relay P_1 closes its lower contact while the armature of polar relay P_2 closes its upper contact.

On the other hand, if the current of sources S_1 and S_2 are of equal frequency, causing the vibration of the armatures of polar relays P_1 and P_2 in synchronism and not out of phase by 180 degrees, then the circuit interconnecting source S_3 with the detecting device R will remain open so that no current passes through the detecting device R . Accordingly, there will be prolonged silence, no current, and particularly no current of an audible frequency, passing through the detecting device R . Thus, it will be apparent that the detecting device R may be employed to observe and compare the frequencies of the currents of sources S_1 and S_2 to determine whether these frequencies are substantially equal. If the frequencies of sources S_1 and S_2 are substantially equal, then there will be either a prolonged period of silence at the telephone receiver, acting as a detecting device, or there will be pulsations at regular intervals of equal duration at device R , the current of each pulsation being of an audible frequency within the range readily receivable by the detecting device R .

If, however, the frequencies of the currents transmitted by the sources S_1 and S_2 are not equal, pulsations of current will be transmitted through the detecting device R , these pulsations taking place at regular intervals, but having a duration which changes from instant to instant from zero to the entire length of the period of pulsation, the current passing through the detecting device R having a frequency within the audible range.

Thus, when sources S_1 and S_2 transmit currents which are not alike in frequency, the vibratory periods of polar relays P_1 and P_2 will differ from each other by an amount corresponding to the frequency difference between the currents of sources S_1 and S_2 , producing audible sounds at the detecting device R of varying durations. The audible period at the detecting device R under these conditions varies from one of silence to one of a strong warble, and gives an effect on the listener somewhat similar to simple beats between two audible frequencies of nearly equal periodicity. When the frequencies of sources S_1 and S_2 are different from each other, there can be no pulsating current through the detecting device R , in which pulsations take place at regular intervals and are of equal duration, as is the case when the armatures of polar relays P_1 and P_2 vibrate at the same frequency and are 180 degrees out of phase. There can be no prolonged period of silence at the detecting device R when the frequencies of the currents of sources S_1 and S_2 are different from

each other, as is possible when the armatures of polar relays P_1 and P_2 vibrate at the same frequency and are out of phase by an angle different from 180 degrees.

Fig. 2 of the drawing represents another embodiment of the invention for comparing the frequencies of two sources of current. These sources of current to be compared are designated in this embodiment by the same reference characters, S_1 and S_2 . The source of current of audible frequency is designated, as hereinabove, by the reference character S_3 , and reference character R designates the detecting device which may again be a telephone receiver, if desired. Two three-element vacuum tubes are shown in this embodiment of the invention, each vacuum tube including a plate, a filament and a grid. The filaments of vacuum tubes V_1 and V_2 are heated to electron-emitting temperatures by the current of a battery B_1 . The input circuit of vacuum tube V_1 includes the source S_1 , the grid and filament of vacuum tube V_1 , a battery B_2 and the primary winding of a transformer T_1 . The input circuit of vacuum tube V_2 includes the source S_2 , the grid and filament of vacuum tube V_2 , battery B_2 and the primary winding of transformer T_1 . The secondary winding of transformer T_1 is connected to the source S_3 . The output circuit of vacuum tube V_1 includes the filament and plate of vacuum tube V_1 , one-half of the primary winding of T_2 and a battery B_3 . The output circuit of vacuum tube V_2 includes the filament and plate of vacuum tube V_2 , the other half of the primary winding of transformer T_2 and battery B_3 . The detecting device R is connected to the secondary winding of transformer T_2 . Battery B_2 brings the grids of vacuum tubes V_1 and V_2 to suitable potentials with respect to the corresponding filaments. Battery B_3 provides suitable operating potentials for the plates of vacuum tubes V_1 and V_2 . These vacuum tubes act like modulators. The detecting device R may be employed to indicate when the frequency of the currents transmitted by sources S_1 and S_2 are equal, or not.

This invention provides arrangements for comparing the vibratory periods of two or more electrical sources. It will be understood, however, that while the frequencies of the electrical sources to be compared are described to be below the range of audibility, the invention is not necessarily limited in that respect, the general principles of this invention being also applicable to systems for comparing the vibratory periods of sources within or above the range of audibility.

It is to be understood that if the sources to be compared are adjustable in their frequency characteristics, the general principles of this invention may be employed to com-

pare these frequencies during the period of adjustment to determine when these frequencies become equal.

While this invention has been shown and described in certain particular embodiments merely for the purpose of illustration, it will be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. A series testing circuit comprising a first vibrating element which alternately opens and closes said circuit, a second vibrating element which also alternately opens and closes said circuit, a source of current of audible frequency, and a detecting device through which current of the audible frequency may pass for observation.

2. An electrical testing system for comparing the frequencies of two or more generators, each of said frequencies being outside the range of audibility, a generator of current of an audible frequency, and a detecting device interconnecting all of said generators providing audible means for comparing the frequencies of said first-mentioned generators to determine whether or not the frequencies of said first-mentioned generators are equal and in phase.

3. An electrical testing system comprising a telephone receiver, a source of current of a frequency within the range of audibility of said telephone receiver and in series therewith, and two vibrating elements whose vibratory characteristics are to be compared, each of said vibrating elements periodically interrupting the current of said source.

4. An electrical testing system comprising a detecting device which may be operated by current of an audible frequency, a source of current of audible frequency in series with said detecting device, two sources of current of inaudible frequencies, and two

polar relays, each polar relay having a winding which is connected to one of the sources of current of inaudible frequency, the armature of each polar relay periodically closing a fixed contact, the fixed contact of one polar relay being connected to the fixed contact of the other polar relay, the series circuit of said detecting device and said source of current of audible frequency being connected between the armatures of said polar relays.

5. An electrical testing system for comparing the frequency characteristics of two oscillators, each frequency being below audibility, an oscillator of current of an audible frequency, means to modify the current of the latter oscillator in accordance with the oscillations of the oscillators whose frequencies are to be compared, thereby producing current of an audible frequency appropriately interrupted, and an audible indicating device to indicate the presence of the resultant current of audible frequency.

6. An electrical testing system comprising a detecting device, a source of current of a frequency which is readily detected by said detecting device, and two or more vibrating elements whose vibratory characteristics are to be compared, pulsations of current of variable duration being indicated at said detecting device when said vibrating elements are not isochronous.

7. The combination of a detecting device such as a telephone receiver, a source of current of a frequency within the range of detection of said detecting device, and two electrical sources whose vibratory characteristics are to be compared, said detecting device indicating whether or not the frequency characteristics of said electrical sources to be compared are in isochronism.

In testimony whereof, I have signed my name to this specification this 16th day of September, 1927.

DANFORTH K. GANNETT.