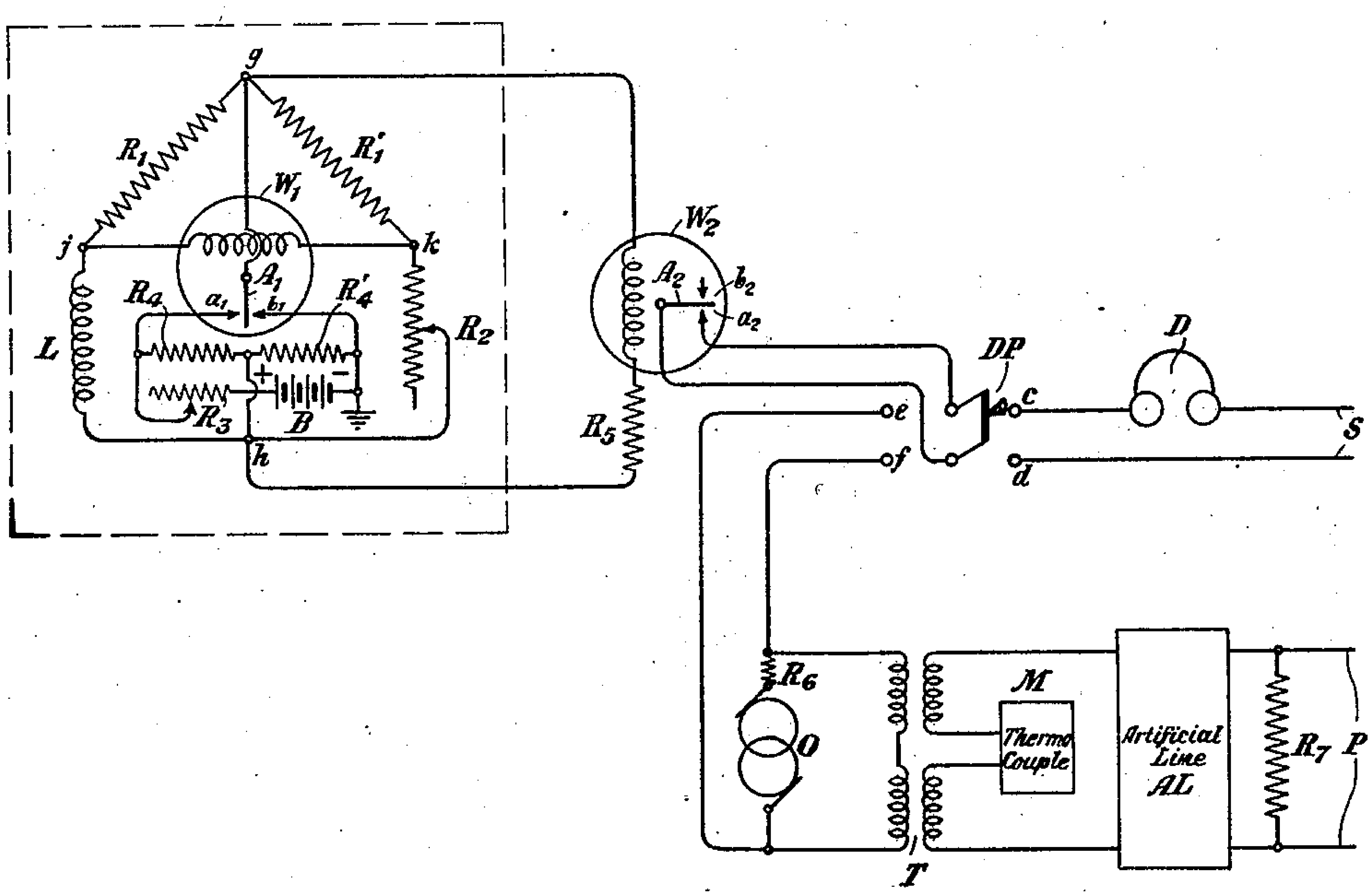
June 11, 1929. D. K. GANNETT 1,716,438

TESTING SYSTEM

Filed Sept. 17, 1927



INVENTOR.
D. K. Gannett
BY
ATTORNEY

Patented June 11, 1929. 1,716,438

UNITED STATES PATENT OFFICE.

DANFORTH K. GANNETT, OF JACKSON HEIGHTS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TESTING SYSTEM.

Application filed September 17, 1927. Serial No. 220,135.

This invention relates to electrical systems, and particularly to circuits for testing, calibrating and varying the frequencies of electrical vibrators.

One of the objects of this invention is to provide an arrangement for calibrating the periodicity of a vibrator or other source of low frequency oscillations by the agency of a detector device such as telephone receiver, which object may be accomplished by impressing on the detecting device current of a definite frequency interrupted at the periodicity intended for the vibrator and then adjusting the periodicity of the vibrator to equal that intended therefor.

Another object of this invention is to provide a system in which an alternating current of any frequency may be interrupted by a device such as an electrical vibrator at any periodicity, the device such as the vibrator being adjustable so that the alternating current may be interrupted thereby at any periodicity within definite and predetermined limits.

Other objects and features of this invention will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawing which shows one embodiment of the invention given herein merely for the purpose of illustration.

Referring to the drawing, an electrical vibrator is shown enclosed in a box determined by dotted lines. This electrical vibrator includes a bridge arrangement in which the arms are resistances R_1 and R_1', fixed in magnitude and preferably of equal magnitude, a resistance R_2 of variable magnitude and an inductance L of a suitable time constant. One of the diagonals of the bridge includes the winding of a polar relay W_1 which, when the bridge becomes unbalanced, controls the movement of an armature A_1 between fixed contacts a_1 and b_1. This movement controls the polarity of a D. C. potential which is to be applied to the other diagonal of the bridge, to be described hereinafter. A battery B or other source of direct current potential is connected in series with a variable resistance R_3. The negative terminal of the battery may, if desired, be grounded as shown. To resistances R_4 and R_4', which may be of any desirable magnitudes, but which are preferably of equal magnitudes, are connected across the terminals of the battery B and the variable resistance R_3, which are in series relationship. The point common to resistances R_4 and R_4' is directly connected to the point h which is common to the arms of the bridge, resistance R_2 and inductance L. The positive terminal of battery B is connected to the fixed contact a_1 of polar relay W_1 through the variable resistance R_3, and the negative terminal of the battery B is directly connected to the fixed contact b_1 of said polar relay. The latter diagonal of the bridge includes in parallel relationship with the circuits just described, the winding of another polar relay W_2 which similarly controls the movement of an armature A_2. Armature A_2 may vibrate between contacts a_2 and b_2. A resistance R_5 may, if desired, be interposed in series with the winding of polar relay W_2, as shown, in which event the latter diagonal of the bridge includes not only the winding of the polar relay W_2 but also the resistance of definite magnitude R_5.

A double-pole double-throw switch DP may be thrown to close either contacts c and d or contacts e and f. Contacts c and d are in series with a detecting device shown herein as a telephone receiver D and a source of alternating current (not shown), connected to the leads S, preferably of any frequency, such as a thousand cycles, interrupted at a definite periodicity, such, for example, as twenty times per second. The midcontacts of the double-pole double-throw switch DP are in series with armature A_2 and fixed contact a_2 of the polar relay W_2. Contacts e and f of the double-pole double-throw switch are connected in series with a source of current O of any definite frequency and with a resistance R_6. The source of current O may be of any desired frequency which may be the same as the frequency of the current impressed upon detecting device or telephone receiver D by the source connected to leads S, i. e., a thousand cycle alternating current. Yet it is to be distinctly understood that the frequency of the current of source O may have any other value, within the scope of this invention.

The primary of a transformer T is connected to the source of current O through the resistance R_6. The secondary of the transformer T is connected in series with a device M which may be any well known device for measuring current magnitudes, such, for example, as a thermocouple. The secondary winding of the transformer T is also connected to an artificial line AL of any well known type, this artificial line preferably including well known series and shunt resistance elements. The artificial line AL may also be adjustable in its impedance characteristic in order to be suitable in providing different losses between the secondary winding of the transformer T and the output circuit P. The artificial line is terminated in a resistance R_7 so that the impedance of the system may be made equal to the impedance looking into the output circuit P, thereby substantially minimizing losses due to reflection.

As has already been stated, the polar relay W_1 has an armature A_1 which is adapted to vibrate between the fixed contacts a_1 and b_1. The contact a_1 is connected to the positive terminal of the battery B through the variable resistance R_3, and the other contact b_1 is connected to the negative terminal of the battery B. Accordingly, the armature A_1 is connected to positive battery or negative battery as the armature A_1 closes contact a_1 or contact b_1. The potential of the battery B minus the potential due to the flow of current through the resistance R_3, is applied to the terminals of resistances R_4 and R_4' in series relationship. Inasmuch as armature A_1 is connected to point g common to resistances R_1 and R_1' and inasmuch as the point common to resistances R_4 and R_4' is connected to point h common to inductance L and resistance R_2, current will flow through resistance R_1 and inductance L, and through resistances R_1' and R_2, in one direction or the other, depending upon whether armature A_1 closes contact a_1 or contact b_1, as will be more fully described hereinafter.

In the arrangement of the apparatus of the vibrator shown herein, current will flow through two parallel paths in one direction or the other, these paths including resistance R_1 and inductance L, and resistance R_1' and resistance R_2. If a difference of potential exists between point j at the junction of resistance R_1 and inductance L, and point k at the junction of resistances R_1' and R_2, a current will flow in one direction or the other through the winding of the polar relay W_1, which will tend to move its armature from one contact to the other, or vice versa. At the same time, current will be established in the winding of the polar relay W_2 which will correspondingly vibrate the armature A_2 between the contacts a_2 and b_2.

The principles underlying the operations of the vibrator shown herein will be better understood from the following description: Let it be assumed that the armature A_1 of the polar relay W_1 is resting against one of the contacts, for example, contact a_1. Accordingly, a positive potential will be applied to point g which is common to resistance R_1 and R_1' and a much lower positive potential which may, in the illustrated case, be half of the potential applied to point g, will be applied to the point h common to the inductance L and resistance R_2. A current is immediately established through the resistance R_1' and R_2. A small current will also flow through resistance R_1, winding of the polar relay W_1 and resistance R_2, this current tending to hold the armature A_1 against contact a_1. This latter current, would, of course, maintain a steady value if the inductance L were not interposed as an arm of the bridge.

Moreover, as soon as armature A_1 closes contact a_1, a current starts to build up in the circuit of resistance R_1 and inductance L. Due to the time constant of inductance L, it will take an appreciable length of time for this current to build up to its maximum value. When the current through inductance L reaches a predetermined value, however, the winding of the polar relay W_1 will become oppositely polarized, whereupon the armature A_1 will leave contact a_1. At the instant that this takes place, the energy stored in the inductance L begins to discharge through the other arms of the bridge and this discharge current may further aid in leading the armature A_1 away from contact a_1.

As soon as armature A_1 closes contact b_1, current will flow through the resistances R_2 and R_1' and through resistance R_2, the winding of the polar relay W_1 and resistance R_1, in a direction opposite to the direction of current in these elements when armature A_1 closes contact a_1, as described hereinabove. The current through the winding of the polar relay W_1 will tend to hold armature A_1 against contact b_1. The potential now applied to inductance L is in a direction opposite to that of the previous instance, so that the current residing in inductance L begins to decay until it falls to zero and then begins to build up in the opposite direction. As current through the inductance L reaches a predetermined value (in the opposite direction), the armature A_1 of the polar relay W_1 will leave contact b_1. Again the energy stored in the magnetic field of the inductance L will be discharged, and so it continues.

It is to be observed that as the potential applied to points g and h changes in polarity, the current flowing through the winding of the polar relay W_2 will bring about the movement of the armature A_2 from one of its contacts, such as a_2, to the other of its contacts b_2, and vice versa. Resistance R_5 is interposed in the path including the winding of the polar relay W_2 in order that the current flowing therethrough may be controlled in magnitude. The vibration of armature A_2 between contacts a_2 and b_2 may be employed as a means for interrupting an alternating current of a definite frequency such, for example, as the alternating current transmitted by the source O.

The potential of the direct current source B, may, as is well known, vary between definite limits, depending upon the state of charge of the source. Obviously, as the charge of the source decreases, the potential thereof will normally decrease so that a smaller current may normally be established through resistance of a definite magnitude. In order to overcome the defects in operation which may be introduced by a varying potential in the source, the resistance R_3 in series therewith is made adjustable. As the source becomes discharged, thereby decreasing its normal operating potential, the magnitude of the resistance R_3 may be decreased and, conversely, as the potential of the source increases, the magnitude of the resistance R_3 may be increased.

It is also to be observed that resistance R_2 is variable, this resistance controlling the periodicity of the vibrator. As the magnitude of the resistance R_2 is increased in value, a smaller current flows therethrough and, consequently, a briefer period of time is required for the current through inductance L to reach a value sufficient to bring about the operation of the polar relay W_1. It is therefore apparent that, as the resistance R_2 is increased in magnitude, the periodicity of the vibrator is also increased and, as the resistance R_2 is decreased in magnitude, the periodicity of the vibrator is correspondingly decreased. The polar relay W_2 brings the armature A_2 in vibration at the established periodicity of the vibrator.

It is also to be noted that by changing the magnitude of resistance R_2 from one value to another, the periodicity of the vibrator may be changed from one frequency to another frequency. In other words, if the resistance R_2 were adjusted to establish a frequency of, for example, twenty cycles, then by decreasing the magnitude of resistance R_2 by a definite amount, the periodicity of the vibrator may be changed to, for example, sixteen cycles.

To calibrate the vibrator with respect to frequency, the double-pole double-throw switch DP should be thrown so as to close contacts *c* and *d*. As has already been stated, a source of alternating current of, for example, one thousand cycles and an interrupter for interrupting this alternating current at a definite period, for example, twenty times per second, become connected to the leads S. By so throwing switch DP, the armature A_2 and contact a_2 will then be in series with the detector or telephone receiver D and with the leads S. If the frequency of vibration of the vibrator does not equal the frequency of interruption of the source connected to the leads S, beats will be heard in the detecting device or telephone receiver D. By varying the magnitude of the resistance R_2 in the bridge of the vibrator, it becomes possible to bring the frequency of the vibrator very closely to the frequency of interruption of the source connected to the leads S. Of course, by changing the magnitude of the resistance R_2 by a definite amount, the frequency of the vibrator may be changed by a corresponding amount, as has already been stated.

When the switch DP closes contacts *e* and *f*, then the armature A_2 and contact a_2 become connected in series with the source of alternating current O and with the resistance R_6. In this event, the current of source O will be interrupted in accordance with the frequency of vibration of armature A_2, i. e., the frequency of the vibrator. Inasmuch as the source O is connected to the transformer T, current of the source O, as interrupted by the armature A_2 of polar relay W_2, will be transmitted to the output circuit P through the artificial line AL and the terminating resistance R_7. The magnitude of resistance R_6 should be such that the device M will indicate that current of the proper magnitude is being transmitted to the output circuit P through the artificial line AL and terminating resistance R_7. The resistance R_6 functions also to prevent the destruction of the armature of a generator due to the flow of current of an excessive value therethrough.

It will thus be apparent that by manipulating switch DP to close contacts *c* and *d*, the frequency of the vibrator may be adjusted to the same value as that of an interrupter connected to leads S. In the particular illustration given herein, the frequency of the vibrator is made to equal the frequency of interruption of an alternating current source. Moreover, by having switch DP close contacts *e* and *f*, an arrangement is effected for interrupting current of the same frequency or of a different frequency at the periodicity of the vibrator. Such an interrupted current may be used, for example, for testing purposes in voice frequency toll ringing circuits.

While this invention has been shown in one particular embodiment merely for the purpose of illustration, it is to be distinctly understood that the general principles of this invention may be applied to other and widely varied organization without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. The method of calibrating the periodic-

ity of a vibrator by means of a detecting device, which consists in impressing on said detecting device current of a definite frequency interrupted at the periodicity intended for the vibrator, and adjusting the periodicity of the vibrator to equal the periodicity intended therefor.

2. The method of calibrating a vibrator of adjustable periodicity to a predetermined periodicity, which consists in transmitting current of definte frequency, interrupting the current of definite frequency at the predetermined periodicity, and bringing the vibrator to a periodicity equal to the periodicity of interruption of the transmitted current.

3. The method of bringing a vibrator of adjustable periodicity to a predetermined periodicity, which consists in interrupting current of a definite frequency at the predetermined periodicity, and changing the periodicity of the vibrator equal to the predetermined periodicity of interruption of said current.

4. The method of bringing a vibrator of adjustable periodicity to a predetermined periodicity, which consists in interrupting current of definite frequency at the predetermined periodicity, determining whether the periodicity of the vibrator equals the periodicity of interruption of the current of definite frequency, and adjusting the periodicity of the vibrator to equal the periodicity of interruption of the current of definite frequency.

5. The method of adjusting the vibratory period of a vibrator to a predetermined vibratory period, which consists in interrupting current of high frequency at the predetermined periodicity, comparing the predetermined periodicity with the vibratory period of the vibrator, and adjusting the vibratory period of the vibrator until it is in synchronism with the predetermined periodicity.

6. The method of adjusting the vibratory period of a vibrating element of a predetermined periodicity, which consists in impressing upon an electrical circuit in alternating current of definite frequency, interrupting the impression of said alternating current on said electrical circuit at the predetermined periodicity, opening and closing the electrical circuit at the period of said vibrating element, and adjusting the vibratory period of said vibrating element until in synchronism with the predetermined periodicity.

7. The method of adjusting the vibratory period of a vibrating element to a predetermined periodicity, which consists in impressing on an electrical circuit an alternating current of definite frequency, interrupting the impression of said alternating current on said electrical circuit at the predetermined periodicity, opening and closing the electrical circuit at the period of said vibrating element, and indicating whether the vibratory period of said vibrating element equals the predetermined period.

8. The method of adjusting the vibratory period of a vibrating element to a predetermined periodicity, which consists in impressing on an electrical circuit an alternating current of definite frequency, interrupting the impression of said alternating current on said electrical circuit at the predetermined periodicity, opening and closing the electrical circuit at the period of said vibrating element, indicating whether the vibratory period of said vibrating element equals the predetermined period, and adjusting the vibratory period of said vibrating element so as to be synchronous with the predetermined periodicity.

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

DANFORTH K. GANNETT.