No. 831,180. PATENTED SEPT. 18, 1906.

E. McGARVEY.

FREQUENCY METER.

APPLICATION FILED DEC. 7, 1904.

4 SHEETS—SHEET 1.

Fig. 1.

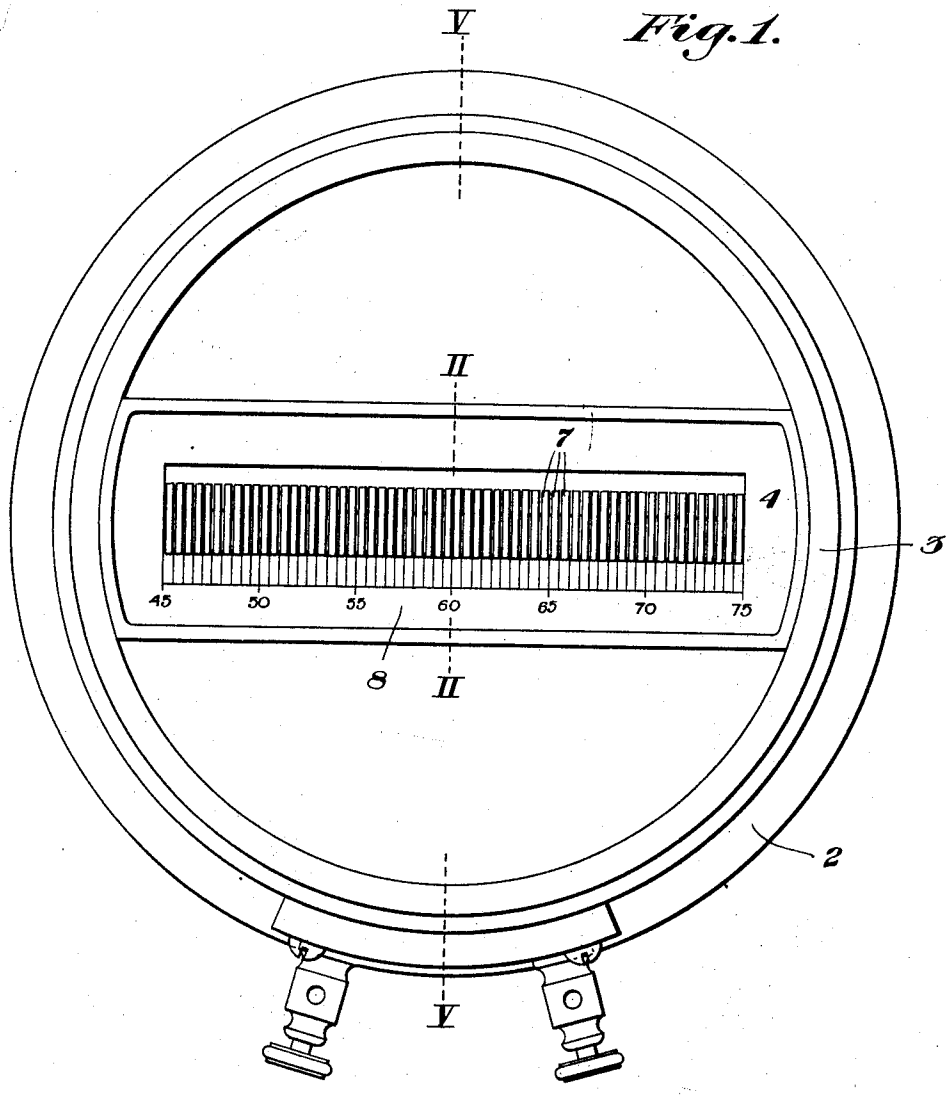
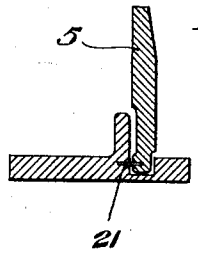


Fig. 2.



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Chas. S. Tipley

Inventor:
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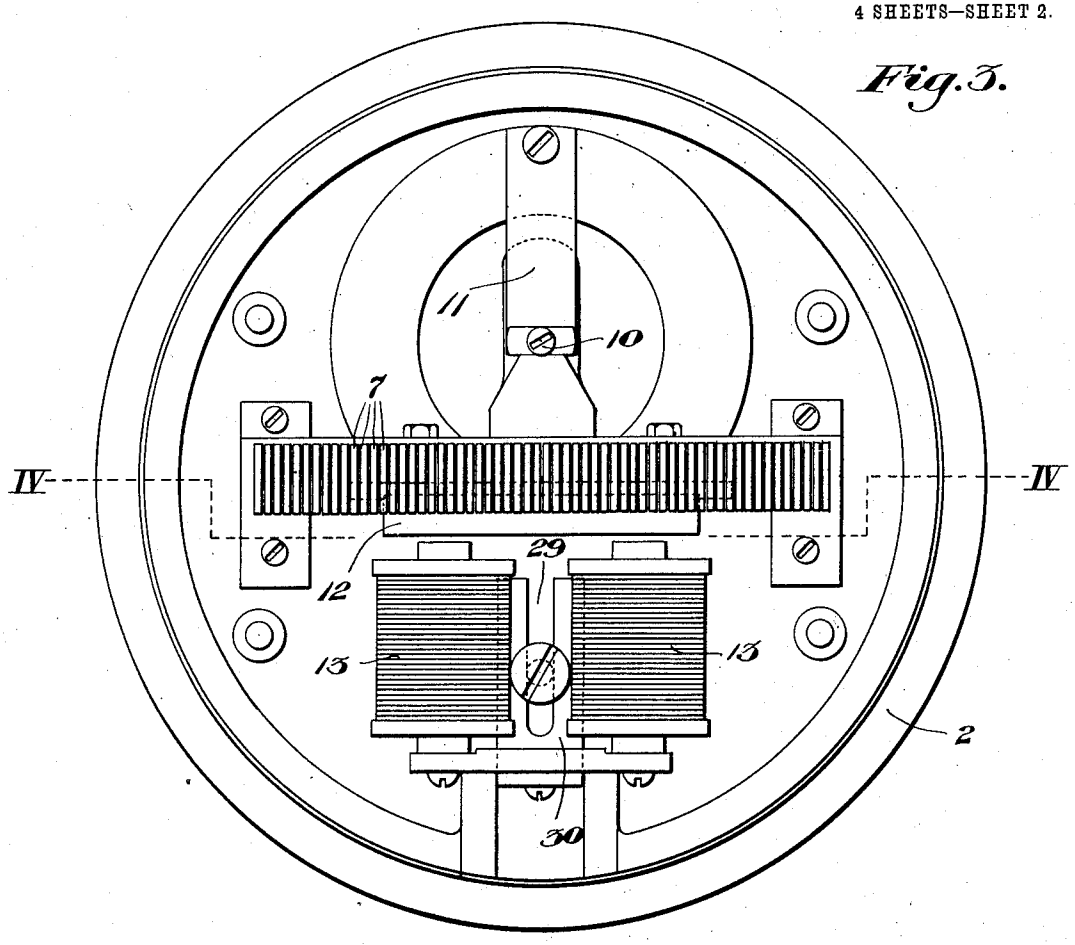
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4 SHEETS—SHEET 2.

Fig. 3.



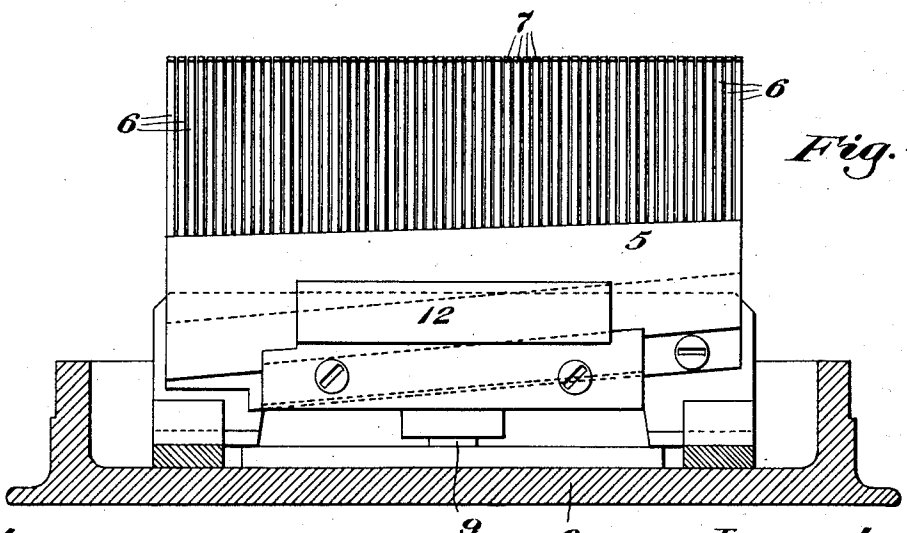


Fig. 4.

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4 SHEETS—SHEET 3.

Fig. 5.

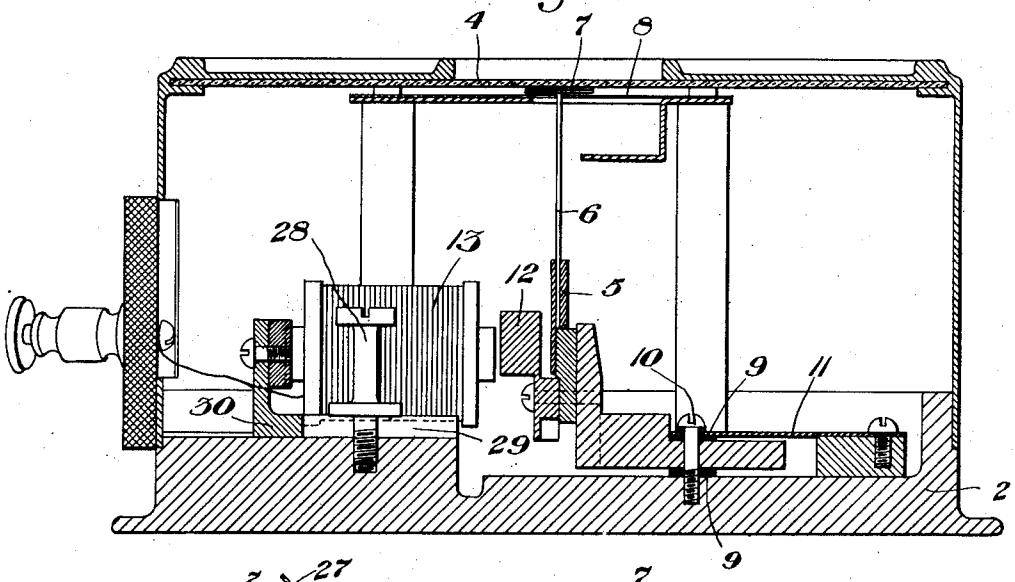


Fig. 6.

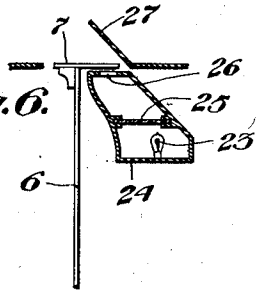


Fig. 7.

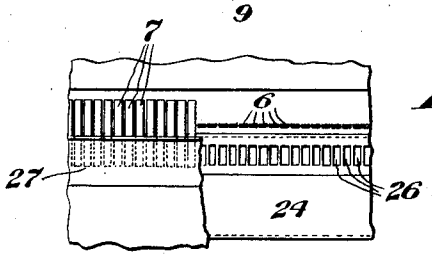


Fig. 8.

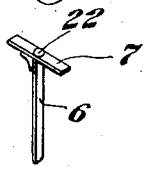
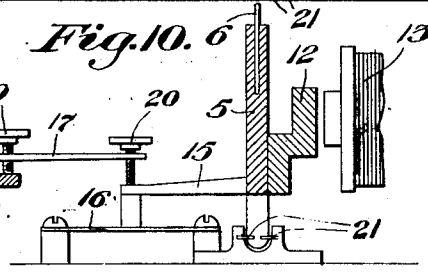


Fig. 9.

Fig. 10.



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4 SHEETS—SHEET 4.

Fig. 11.

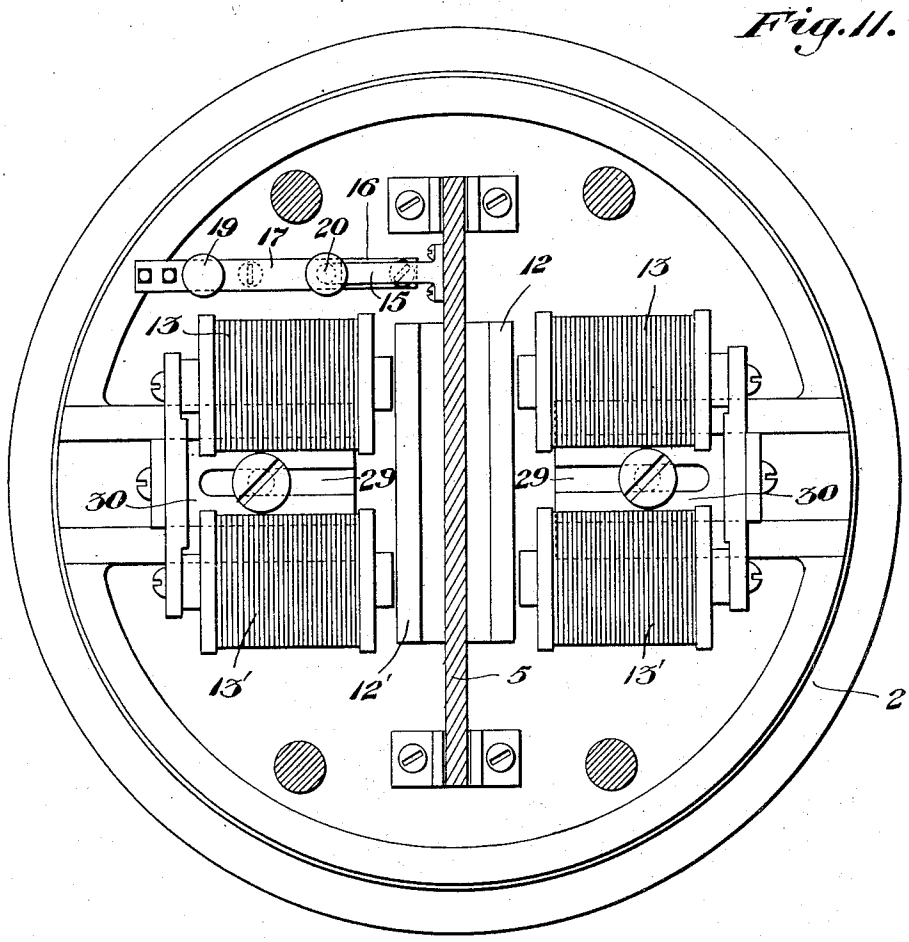
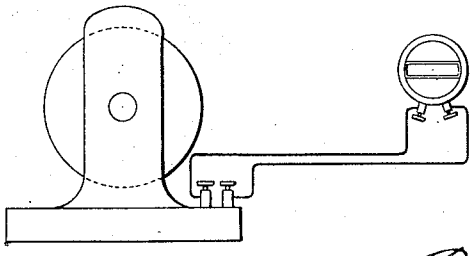


Fig. 12.



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UNITED STATES PATENT OFFICE.

EDWARD McGARVEY, OF BELLEFONTE, PENNSYLVANIA.

FREQUENCY-METER.

No. 831,180. Specification of Letters Patent. Patented Sept. 18, 1906.

Application filed December 7, 1904. Serial No. 235,875.

To all whom it may concern:

Be it known that I, EDWARD McGARVEY, a citizen of the United States, residing at Bellefonte, in the county of Center and State of Pennsylvania, have invented certain new and useful Improvements in Frequency-Meters, of which the following is a specification, reference being had therein to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a plan view of my improved frequency-meter. Fig. 2 is a detail cross-sectional view on the line II II of Fig. 1, showing one manner of mounting the reeds. Fig. 3 is a plan view with the cover removed, showing the interior construction. Fig. 4 is a vertical cross-section on the line IV IV of Fig. 3. Fig. 5 is a similar view on the line V V of Fig. 1. Fig. 6 is a cross-sectional detail view showing mechanism for producing a ray of light upon vibration of any one reed. Fig. 7 is a sectional plan view of this construction, showing the light-aperture, reed terminals, and reflector. Fig. 8 is a detail view of the upper portion of one of the reeds provided with a button of distinguishing color. Fig. 9 is a cross-sectional view similar to Fig. 5, showing a construction employing oppositely-located armatures for the purpose of synchronizing. Fig. 10 is a sectional detail view illustrating one manner of mounting the reed-bar and of controlling its vibration. Fig. 11 is a sectional plan view indicated by the line XI XI of Fig. 9. Fig. 12 is a diagrammatic view showing the application of my invention to a generator.

My invention refers to improvements in frequency-meters for indicating directly on a scale the frequency of an alternating circuit. The principle of the invention is based on the laws of harmonic vibration wherein reeds or strings having a natural rate of vibration when corresponding to an imposed or induced rate will vibrate actively in sympathy therewith.

Electricians, and particularly those in charge of alternating-current stations, have long recognized the need for an instrument which would indicate the frequency of the circuit accurately within one alternation. The reasons for this are:

First. On account of the proper speeding of the generator. This is essential from the fact that a system will work most satisfactorily and efficiently when running at the rate of alternation for which the system was designed, and more particularly so when the current is supplied to motors and other apparatus having coils which comprise an inductive resistance.

Second. Where a. c. generators are desired to run in parallel, it results in a saving of time to have an instrument which will indicate the frequency accurately over a sufficient range, so that the generators can be brought into step without resorting to the slow method connected with synchronizing-lamps.

My invention has a special advantage in that two such generators can be connected and will indicate their respective frequency on the same dial or scale, thus considerably facilitating the synchronizing operation.

Referring to the drawings wherein the invention is illustrated, 2 represents the base, of any suitable construction, preferably circular, and provided with upper faces adapted to receive and support the various portions, which are inclosed within a surrounding upper case 3, having an inserted glass 4, adapted to expose the indicating-reeds.

5 is the reed-bar, in which are rigidly mounted the reeds 6, of suitable material and arranged in graduated lengths, the dimensions thereof being such that the rate of vibration of the reeds will successively increase or decrease from one end to the other in the same general manner as the reeds of a musical instrument. The upper portions of the reeds are preferably provided with an indicating-semaphore 7 or other signal device adapted to show by contrast with the stationary reeds when any particular reed is vibrated, and these are arranged in relation to a graduated dial plate or scale 8. (Figs. 1 and 5.)

In the drawings I have shown the complete bar of reeds arranged, say, for a sixty-cycle circuit, the center reed opposite that point in the scale or dial marked "60" having a natural rate of vibration of, say, one hundred and twenty per second. This will correspond to sixty cycles from the fact that the machine now to be described is constructed with a non-polarized coil and will consequently operate on alternations instead of on the cycle, as it would if it were built with a coil and an armature suitably polarized. This reed having a rate of one hundred and twenty vibrations a second when the mechanism of the circuit connected to the instrument is exactly sixty cycles, will vibrate in

unison therewith and acquire sufficient amplitude to be plainly perceptible to the eye, while all other reeds of the bar having a different natural rate of vibration will remain quiescent. All of the reeds on the bar are tuned from left to right to a gradual increase in natural rate corresponding to varying frequencies and consequent rates of vibration imparted to the vibrating parts over a sufficient range for the purposes of the instrument, while the differences in vibratory rate to which the reeds are tuned is such as to insure a proper degree of accuracy in the reading.

The reed-bar 5 is mounted in any suitable manner, so as to be sensitive to the influence of magnetic force and in Fig. 5 is shown as mounted between cushioning-bearings 9, of rubber or other suitable material, being secured by screw 10, a pressure-spring 11 being provided to limit or restrain its movement. The reed-bar is provided with an armature-bar 12, rigidly secured to it in any suitable manner and located within the magnetic influence of coils 13. These coils are connected in series with the motor by means of the usual wires, the case being provided with binding-posts 14 for attachment therewith. Variations in potential, acting through the coils 13 at so many stated periods per second, will impart a vibration to the reed-bar 5 and reeds 6 at a corresponding rate per second, the reed-bar vibrating under the spring 11 as a fulcrum.

In Fig. 10 I have shown a construction where the reed-bar is provided with an arm 15, connected with a spring-diaphragm 16, which acts to hold the reed-bar in position while allowing freedom of motion and also serves the added purpose of absorbing any false vibration that may be set up either by the acting parts of the instrument itself or by false rise or fall of potential transmitted by any cause from the electric circuit. 17 is a tension-spring rigidly secured upon a supporting-bearing 18, a tension-adjusting screw 19 being provided and a smaller screw 20 at the free end adapted to bear with varying force upon arm 15. Adjustment of these devices has the following effects: First, it operates in conjunction with the diaphragm to respond and coact with the varying rates of vibration imparted to the reed-bar by varying rates in frequency; second, it operates when properly adjusted to counteract to a certain extent the time effect or that factor of a lengthening of the true wave of potential which is caused by leading or lagging currents generally found to be superimposed on a regular current in a system, acting in this respect somewhat as a condenser placed in alternating circuits will act to neutralize the effect of lagging currents caused by self-induction of the system; third, in its adjustment it acts in conjunction with the distance of the magnet-poles of the armature to properly regulate the amplitude of vibration of the reed-bar.

In Figs. 9 and 10 I have shown a modified construction of the mounting of the reed-bar employing thin spring-blades 21, projecting into one or both sides of the bearing-base, thereby providing a very sensitive support subject to the magnetic influence described. In the construction shown in Fig. 2 a single such blade is used at one side only. The reeds 6 are preferably constructed of tempered steel or other suitable material. Difference in the vibratory reeds to which they are tuned is such as to insure a proper degree of accuracy in the reading, and there are many other factors other than that of mere natural rate of vibration which must be taken into consideration in the construction and proper proportioning of the reeds—for instance, as to sensitiveness or that property of the reed vibrating in harmony with an imposed force, whereby it will cease or stop such vibration on a certain slight difference between its own rate and that of the imposed force. Thus the reed can be so constructed, proportioned, and mounted that it will vibrate actively in allowing itself to be forced into active vibration even when the difference between its natural rate and that of the imposed force is two or even three or more vibrations per second, while it can also be constructed so that it will start or stop vibrating on so slight a difference as one vibration in eight or ten seconds between its own rate and that of the imposed force with which it is designed to vibrate in harmony. These properties depend upon the length, disposition of the weight, the material, and the condition thereof of which the reed is constructed and also upon the weight, shape, material, and disposition of the weight of the bar which supports the reeds, upon the adjusting-spring, size of the diaphragm 16, and position of the coil. The bar of reeds having been tuned to the varying rates of vibration and properly adjusted as to sensitiveness and amplitude of vibration, the visual effect upon a continuous variation of rate of alternation when connected with the circuit will be in the case of change from a lower to a higher rate to produce a wave of vibrations moving from left to right on the tips 7 of the vibrating reed opposite the scale. The rapidity of vibration is such that the effect on the eye is a mere lengthening of the reed-tip, which will be plainly discernible opposite the graduated scale. As various modifications of the reed-tip may be employed I do not desire to be limited to any particular form of construction and in Fig. 8 have illustrated a reed provided with a small bead or button 22, of white material or any contrasting color adapted to be immediately distinguished by the eye.

In Figs. 6 and 7 I have shown a means for producing luminous rays in which a source of light, as a lamp 23, is inclosed within a suitable casing 24, a ground glass 25 being provided to diffuse the rays evenly, the rays passing outwardly through slots 26, normally covered by the tips 7 of the reeds, but adapted to be uncovered upon vibration, allowing a ray to be projected upwardly against the under side of an inclined reflector 27 and thence outwardly across the indicating-dial. By this construction a visible indication is immediately produced which is readily discernible in the dark. The coils may be adjusted with relation to the armature-bar by means of a set-screw 28, passing through a slot 29 of the coil-base 30, while the reed-bar, the dial-supports, and the various other elements of the device are suitably secured and attached, as shown and described.

In Figs. 9 and 11 I have shown a construction employing a double arrangement of coils 13′, the reed-bar being provided with corresponding double armature-bars 12′, such arrangement being capable of being connected with two generators for the purpose of synchronizing. In this arrangement where two oppositely-mounted coils are used, each of which is connected in its respective circuit, the double armature 12′ acts to impart vibration on coinciding impulses in opposing directions, and in this form of instrument are secured the best results on a two-phase circuit, the generators being connected. On the first and second phase, respectively, in order that the two phases shall be ninety degrees apart and so reinforce, extend, or counteract each other when both are in step, it follows that in order that the vibration of the reed which both rates of alternation affect simultaneously when in step will be increased instead of diminished. To secure the same results, a double-wound single coil may be used, answering the same purpose, but with this difference, that it can be connected with a single-phase multiple machine, the impulses in such case acting in the same direction. Also in cases where the instrument is used on a three or more phase cuit the rates can be and are sometimes necessarily tuned to some one harmonic resulting from the coacting electromotive forces, such being especially the case when three or four phases are reproduced by different windings on the same machine.

While in the various forms of construction which I have shown and described provision has been made for such conditions as usually arise and as I have explained, I do not desire to be limited thereto, as the principle of the invention may be embodied in various other forms in some of which it is better adapted to certain conditions than others, and I desire to include any form or arrangement whereby the frequency of one or more circuits is registered by the arrangement of a bar of reeds, as described, in such relation to the circuit or circuits that they are vibrated by and vibrate in unison with the varying rates of alternation and undulation in cases where the alternating current could be transformed to a flow in one direction by any means.

The invention is not limited to the specific use described, but may be employed for determining the speed of generators where, in conjunction with an alternator, it will when properly graduated show the speed of the directing-pulley of the alternator.

The invention may be employed in connection with any suitable recording mechanism, as, for instance, a traveling band of paper adapted to be visually affected by the passage of a circuit produced by the vibration of the various reeds, as shown in my prior patent, No. 636,685, for weight and pressure recording apparatus

What I claim is—

1. In a frequency-meter, the combination with an armature-bar provided with a series of indicating-reeds and supplemental cushioning mechanism for the bar, of a magnetic coil in operative relation to the bar, and means for establishing a circuit through the coil, substantially as set forth.

2. In a frequency-meter, the combination with an armature-bar mounted on supplemental sensitive supporting-blades and provided with a series of indicating-reeds, of a magnetic coil in operative relation to the bar, and means for establishing a circuit through the coil, substantially as set forth.

3. In a frequency-meter, the combination with a series of indicating-reeds and a supporting-bar therefor, with a base and supplemental means for sensitively supporting the bar, of a magnetic coil in operative relation thereto, and means for establishing a circuit through the coil, substantially as set forth.

4. In a frequency-meter, the combination of an armature-bar provided with a series of vibrating reeds, resiliently mounted adjusting mechanism adapted to control the vibration of the bar, and a magnet in operative relation to the bar, substantially as set forth.

5. In a frequency-meter, the combination of an armature-bar provided with sensitive resilient supporting mechanism and a bearing portion, a diaphragm arranged to support said bearing portion, adjusting mechanism for said bearing portion, a series of indicating-reeds connected with the armature-bar, and a magnet adapted to impart vibration to the bar and reeds, substantially as set forth.

6. In a frequency-meter, the combination of an armature-bar provided with sensitive resilient supporting mechanism and a bearing portion, a diaphragm arranged to support said bearing portion, adjusting mechanism for said bearing portion, a series of indicating-reeds connected with the armature-bar, and

a magnet adapted to impart vibration to the bar and reeds, with means for adjusting the magnet, substantially as set forth.

7. In a frequency-meter, the combination of a registering-dial, an armature-bar provided with sensitive resilient supporting mechanism, means for controlling the vibration of the bar, a series of indicating-reeds connected with the armature-bar and arranged in operative relation to the registering-dial, and a magnet adapted to impart vibration to the bar and reeds, substantially as set forth.

8. The combination with a source of light and apertures therefor, of a series of vibrating reeds adapted to uncover said apertures, substantially as set forth.

9. The combination with a source of light and apertures therefor, of a series of vibrating reeds adapted to uncover said apertures, with a reflecting device and a dial-plate, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

EDWARD McGARVEY.

Witnesses:

W. C. CARMAN,

G. GREENWOOD.