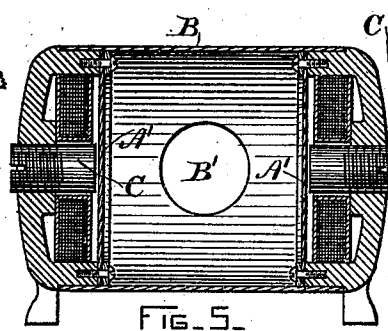
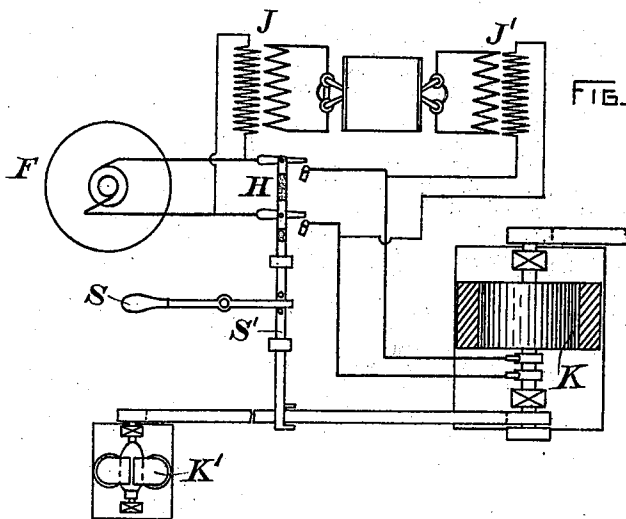
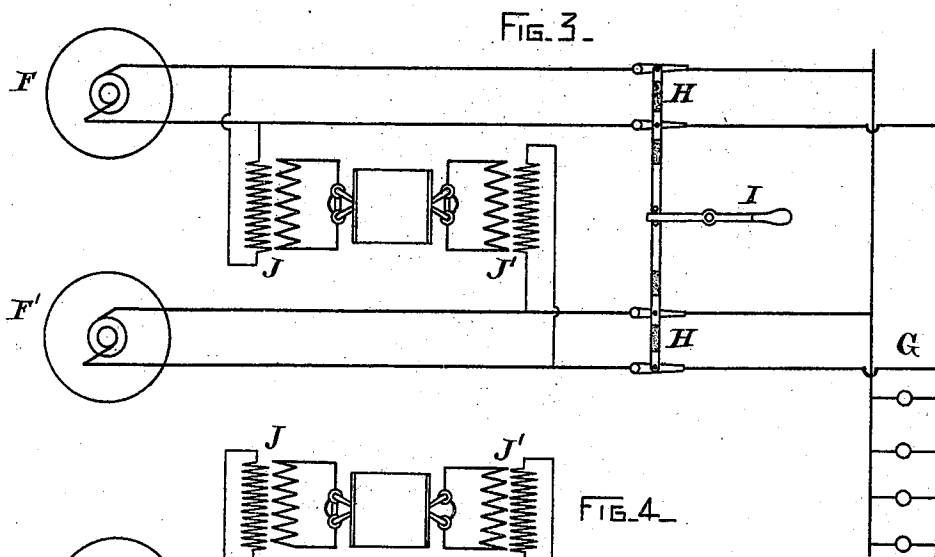
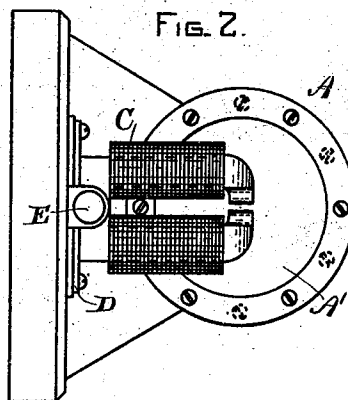
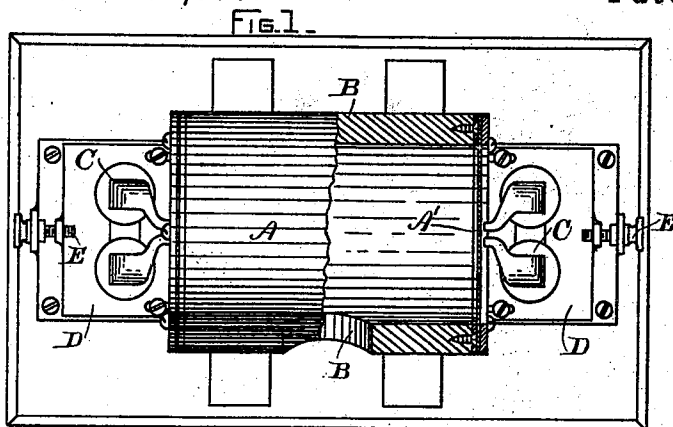


(No Model.)

L. BELL.
SYNCHRONISM INDICATOR.

No. 502,695.

Patented Aug. 8, 1893.



WITNESSES.
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UNITED STATES PATENT OFFICE.

LOUIS BELL, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF NEW YORK.

SYNCHRONISM-INDICATOR.

SPECIFICATION forming part of Letters Patent No. 502,695, dated August 8, 1893.

Application filed December 24, 1892. Serial No. 456,236. (No model.)

To all whom it may concern:

Be it known that I, LOUIS BELL, a citizen of the United States, residing at Boston, county of Suffolk, State of Massachusetts, have invented a certain new and useful Improvement in Synchronism-Indicators, of which the following is a specification.

It is already well known to those skilled in running dynamo electric machines that whenever two or more machines of the alternating current type are to be coupled up together, as for example, when two dynamos connected in multiple are to feed a common circuit, or one dynamo is to drive another as a motor, it is necessary to bring the machines to synchronism before they are thrown into circuit with one another, else they will not work properly. Hence it is a necessary adjunct of an installation of this character to have some means by which the attendant can readily detect when the machines are running at the same speed, or synchronously as it is called, for though synchronism properly implies, both, equal periodicity of current wavelengths resulting from equality of speed, and harmony in phase as well, yet the term as here used refers more particularly to equality in speed, as the essential thing from a practical standpoint is that the wavelengths have equal periods, for then any lack of harmony in phase will right itself even if exact harmony does not at first exist. Phase lamps and other devices have been heretofore used to detect the presence or absence of this necessary synchronism.

My present invention comprises another and radically different method of accomplishing this same result which I prefer to use, and which gives the desired indication to the ear rather than to the eye. To this end I make use of the analogy and analogous action between sound waves in the science of acoustics and current waves in electricity. The periodicity of the waves of current delivered by an alternating machine depends of course upon its speed of running. And if a diaphragm is set in vibration at a speed keeping time with the current periods, sound waves are produced whose periods tally exactly with the current periods. By this transposition of

ing periodicity a tone of distinctive pitch can be secured for any given machine when running at a given speed. When dealing with two or more machines this reproduction in sound waves of the current waves of the machines enables the ready detection of any departure from equal periodicity for, as is well known, the combined effects of two such series of sound waves are to give rise to a steady tone if the sound periods are equal, but if unequal the interference of the waves causes sudden swellings or reinforcements of sound at regular intervals known as "beats."

In my present invention lack of synchronism is detected by the presence of sound beats. As practiced, say, with two machines it consists of setting up a succession of sound waves having periods corresponding to the current periods of the respective machines, which sound waves are free to interfere with one another if of unequal periods and so give rise to beats indicating that the speeds at which the machines are running are not yet equal. When the beats disappear and the tone settles down into a steady note it is because the sound and current waves of the different machines have become of equal periodicity, and the machines may then be coupled together. In the same way harmony in phase may be detected, for though there will be no beats at all times when the periods of the waves are equal, yet the intensity of the resultant tone will be greater or less according to the degree of harmony in phase. The current waves are reproduced in properly corresponding sound waves by the magnetic effects of the current, each current wave imparting a magnetic impulse to a magnet which in turn controls the vibration of the diaphragm.

The drawings illustrate apparatus by which the invention has been put into practice, but it is capable of wide modifications. I have even found that lack of synchronism between two neighboring machines may be detected by the tones given by ordinary reeds set into vibration at speeds respectively proportional to the speeds of the machines.

Figure 1 is a plan view partly broken away of the indicator. Fig. 2 is an end view of the same. Fig. 3 shows in diagram the indicator applied to a circuit where two generators are

coupled in multiple. Fig. 4 shows the indicator arranged to detect when a motor is in synchronism with a generator which is to drive it, and Fig. 5 shows a longitudinal section of a slightly modified form of construction.

The indicator A, as shown, is of a design suitable for use with two machines. It consists of two or more metallic diaphragms or vibrators A', each of which is to be set into vibration so as to give rise to a distinctive series of sound waves corresponding to and representing accurately the current waves of one of the machines tested. The diaphragms are shown fastened to, and closing up the ends of, a sounding chamber B having an opening B'. Magnets C are, in Fig. 1, mounted on plates D outside the sounding chamber with their poles in intimate magnetic relation to the diaphragms, and can be adjusted nearer or farther away from them by set screws E.

How the indicator is coupled up in circuit is shown in Fig. 3. Here F, F' are two alternating current generators. When running they are normally coupled in multiple with a single work circuit G, and switches H, H', which may be controlled by a common lever I, are placed in the connections between the machines and the work circuit. The two magnets C, C, respectively, are included in the secondary circuits of transformers J, J', whose primaries are connected with the different generators F, F'. The magnetic impulses in each magnet, therefore, will correspond rigidly with the current waves of the corresponding machines at any given moment, and these magnets acting upon the respective diaphragms will give rise to series of sound waves, which waves will be equal or unequal in period according as the speeds and current waves of the machines are or are not equal. If unequal the resulting beats are very pronounced and the machines should not be thrown together until a steady resultant tone is given. Until synchronism is attained the circuit of one or both of the machines will be broken at the switches H, H'.

In Fig. 4 F represents an alternating current generator having in its circuit the primary of a transformer J, whose secondary includes, as before, one of the magnets C. K is an alternating current motor which is to be driven with current from dynamo F. The connecting circuit between the two machines passes through a switch H and may be opened or closed thereby. In the circuit of the motor is the primary of a second transformer J', the impulses of current in which affect the second magnet C, and vibrating diaphragm. In order to start these machines into normal operation the dynamo will be brought to speed with the circuit opened at H. The motor K will also be brought to speed by an auxiliary motor K' belted or connected thereto, the motor K meanwhile acting as a dynamo. When synchronism is attained mo-

tor K' will be disconnected, and the circuit connecting the machines F and K closed. If desired these two actions may be effected simultaneously by a common lever S, which works a reciprocating bar S' to which is connected the main circuit switch, and which also controls a belt shifter throwing the motor K' out of gear with K.

When the machines have been brought to synchronism, the transformers and indicator will preferably be cut out of circuit, and will remain cut out, since when once started the machines will continue to run in synchronism, and there is no further need for the indicator.

The construction in Fig. 5 is very similar to that in Fig. 1, except that it is preferred to have, as there shown, the magnets as well as the diaphragm inclosed within and protected by the sounding chamber. The pole pieces of the magnets are screw-threaded and are screwed into the end plates of the sounding chamber so that the magnets are supported and may be readily adjusted toward and away from the diaphragms by turning the magnet cores.

What I claim as new, and desire to secure by Letters Patent, is—

1. The method of indicating synchronism or lack of synchronism between two or more machines of the alternating current type, which consists in setting up sound waves corresponding in periodicity with the current waves of the respective machines, which sound waves are free to interfere with one another and give rise to beats if of unequal periodicity so that the resulting sound beats indicate inequality in speed of the machines, as set forth.

2. The method of indicating synchronism or lack of synchronism between two or more electric machines of the alternating current type, which consists in setting up by the magnetic effects of the currents of such machines distinctive series of sound waves corresponding respectively in periodicity with the current waves of such different machines, which sound waves by their interference, if unequal in period, give rise to beats, and thereby indicate audibly the presence or absence of synchronism, as described.

3. An indicator for indicating synchronism between two or more alternating current electric machines consisting of diaphragms or vibrators in an acoustic medium, and means whereby each machine imparts to a corresponding diaphragm or vibrator, vibrations corresponding in periodicity to the current waves of such machines, for the purpose described.

4. An indicator for indicating synchronism or lack of synchronism between two or more alternating current machines which consists of separate magnets responding respectively to the current waves of the different machines, and a magnetic diaphragm in intimate magnetic relation to each such magnet, whereby equality or inequality in the periods of the

sound waves caused by the diaphragms may be detected by the ear to indicate synchronism of the machines.

5 An indicator for indicating synchronism between two or more alternating current machines consisting of magnetic diaphragms placed opposite one another in a more or less confined sounding chamber, a magnet in intimate magnetic relation to each diaphragm, 10 and circuit connections from the different machines whereby the magnet impulses in the magnets respond accurately to the current waves of the respective machines.

15 6. The combination in an indicator for the purpose described, of transformers the pri-

maries of which respectively are in circuit with the machines, and magnets connected respectively in the secondary circuits thereof, with means for indicating audibly synchronism of the machines, comprising vibrat- 20 ors whose vibrations are caused by and keep time with the magnetic impulses produced in said magnets by reason of their connections with the machines.

In testimony whereof I have hereto set my 25 hand this 20th day of December, 1892.

LOUIS BELL.

Witnesses:

N. F. HAYES,
C. L. HAYNES.