UNITED STATES PATENT OFFICE.

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ELECTRIC-CLOCK SYSTEM.

1,283,431. Specification of Letters Patent. Patented Oct. 29, 1918.

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To all whom it may concern:

Be it known that I, Henry E. Warren, a citizen of the United States, and a resident of Ashland, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Electric-Clock Systems, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to a novel means, whereby time indications may be distributed by means of an alternating current system.

The invention is especially applicable for use with existing commercial alternating current systems, whereby the individual users of the current supplied by said systems for lighting, power or other purposes, may also be provided with clocks which are operated by the same current and which indicate the correct time and which are simultaneously regulated from a station of the alternating current system.

To this end I employ a synchronously driven clock, preferably having a motor provided with a rotary magnetic field, which is maintained by the alternating current, and which field is magnetically coupled to the time movement of the clock, and I adjust the frequency of the alternations of the said current, so as to compensate for a difference in time between said clock and means for indicating standard time.

The motor referred to may and preferably will be of novel construction as will be described.

The means for indicating standard time may be a standard clock located in a station of the alternating current system, and I prefer to locate in said station a duplicate of the electrically driven clocks included in the system outside of the said station, which duplicate clock may be designated a comparison clock.

The electrically driven clocks referred to are constructed to be driven at a rate proportionate to the frequency or alternations of the current, so that, if the frequency of the current is correct or of a predetermined number per minute, the clocks in the system will keep accurate time.

If the frequency of the alternating current should vary, then the clocks become inaccurate, and the frequency or alternations of the current employed to drive the clocks is adjusted or varied to correct the inaccuracy, which may be accomplished by adjusting the speed of the prime mover or movers in the station, so as to gradually wipe out any excess or deficiency in the sum of the alternations, which has caused the electrically driven clocks to gain or lose slightly with relation to the standard clock.

The speed of the prime mover may be varied by means of speed controllers, such as now commonly provided for the governors of large engines or turbines, and this adjustment may be effected manually or automatically.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a diagrammatic view of a sufficient portion of an alternating current system capable of distributing time indications in accordance with this invention to enable the latter to be understood.

Fig. 2, a plan view of a clock of novel construction, which is employed in the alternating current system.

Fig. 3, a front elevation with parts broken away of the clock shown in Fig. 2.

Fig. 4, a side elevation with parts in section of the clock shown in Fig. 3 looking toward the left, and

Fig. 5, a detail of the clock shown in Figs. 2, 3 and 4 to be referred to.

It is believed that the invention will be more clearly and easily comprehended by first describing in detail the construction of the electrically driven clock preferred by me and which is shown in Figs. 2 to 5 inclusive.

Referring to Figs. 2, 3 and 4, 10 represents a bipolar field magnet for an alternating current motor *a*, and 12, 13, are opposite poles of said magnets, each of which poles is divided so as to produce a rotating field by means of the shading coils 14, 15, which latter cause the magnetism in the pole faces 16, 17, to lag somewhat behind the magnetism in the pole faces 18, 19. In the space inclosed by the poles 12, 13, wherein the magnetic field revolves, there is a rotor, preferably made as a disk 20 of hardened steel and without windings or slots, and preferably of the proportions as will be described.

I have found that with such a rotor, the magnetic remanence produces a strong starting torque and a very marked tendency to run in exact synchronism, because the magnetic lines through the mass of the rotor tend strongly to remain fixed, and after synchronism has been reached to cause the rotor to act as if it were polarized. This synchronous motor is arranged with a driving shaft 21 for the rotor 20 vertically arranged, and with the rotor 20 sufficiently below the middle of the pole faces so as to rise, when in action, and thus take the entire weight of the rotor and its shaft off of its bearings, and thus eliminate all end thrust friction.

Upon the shaft 21 is cut a worm thread 23, which engages a worm gear 24, having its shaft 25 provided with a worm 26, which drives a worm gear 27. The double reduction just described, provides a reduction in speed from that of the rotor 20, revolving for example, 3600 revolutions per minute in the case of a 60 cycle circuit, to 1 revolution per minute on the shaft 28 of the worm gear 27.

The shaft 28 may therefore carry the second hand, not shown, of a clock.

For the purpose of reducing friction and wear and eliminating external interference, the rotor 20 of the motor and the reduction gearing described are inclosed in a nearly air-tight case 29, containing fine lubricating oil, which is distributed by the motion of the shafts and gears over all the surfaces in contact, thus insuring efficient lubrication.

From the shaft 28, revolving once per minute, connection is made by suitable gearing 30, 31, 32, (see Fig. 4) to the minute hand gear 33, which latter is provided with a driving pawl or dog 34, which is capable of driving in one direction a disk 35, which through the usual friction washer 36 drives the shaft 37 on which the minute hand 38 of the clock is mounted. The sleeve 39 on which the hour hand 40 is mounted is driven in the conventional way by back gears 41.

In order to provide against accidental failure of the alternating current supply, provision is made for mechanically driving the clock, and to this end I mount an auxiliary clock movement 45, (see Fig. 4), which may be either spring or weight driven, so as to be capable of driving the disk 35 through a pawl or dog 46, and I also provide means for normally rendering the auxiliary clock movement 45 inoperative.

This result may be effected by means of a magnetizable member 50 or some similar no-voltage device, which will permit the auxiliary movement to run when no current is passing through the coil 47 of the motor *a*, but which will be attracted by the magnetism of the motor when the current is passing through the coil thereof, and will then stop the auxiliary movement 45 by interfering with the motion of the escapement lever 51 or otherwise.

In the present instance, (see Fig. 3), the magnetizable member 50 is shown as carried by a lever 52, which has its arm 53 adapted to be engaged with the escapement lever 51, when the member is in its attracted position, thereby stopping the auxiliary movement. The arm 53 of the lever 52 is disengaged from the escapement lever 51 by a spring 54, when the current ceases to flow through the motor *a*.

It will thus be seen, that as long as the alternating current is on, the clock hands will be electrically driven at a rate proportionate to the frequency of the current, and if the frequency is correct, the clock will keep accurate time, while if the current fails the auxiliary movement will instantly begin to drive the clock hands and will continue to do so until the current is restored to the circuit.

Such a clock provides ideal means for indicating time in all centers of population where alternating current is distributed, and enables existing commercial alternating current systems to provide the individual users of such current for lighting, power and other purposes, with accurate time, inasmuch as said clocks can be connected in the alternating current systems as now installed, without the necessity of special wiring, as it is only necessary to connect the motor *a* with the socket of an incandescent lamp, or with any other socket included in the system.

The user of the alternating current for lighting, power or other purposes, can thus be furnished with a clock which requires no winding or batteries to be renewed and which can be operated at very slight expense.

Provision must be made however for insuring that the time indicated by the clocks in the alternate current system is accurate or substantially so, and to this end, means are provided at the central station of the alternating current system, for determining that the integrated alternations are proportional to the elapsed time.

In the present instance, I have shown in Fig. 1, one means for accomplishing this result, which consists of a standard clock *b* of any known or reliable make, and alongside of it for easy observation, a synchronously driven clock *c*, which is of the construction above described and illustrated in Figs. 2 to 5. The clock *c* has its motor *a* connected by the wires 60, 61, with the main line circuit of an alternating current system, which main line circuit is represented by the wires 62, 63, 64, which are supplied with current by an alternating current generator 65, represented as a three-phase generator, which is operated by a prime mover 66 of any suitable construction, such as now commonly employed, but which is herein represented as a reciprocating engine.

The central station is represented by the lines 67, and the main line circuit 62, 63, 64, is extended outside thereof and has connected with it electric lamps 68, clocks like the clock *c*, but which to facilitate description of the operation of the method of time distribution are marked *d*.

The main line circuit is also shown as furnishing current to a motor 70 for power or other purpose.

The clocks *d* may be located in the offices, factories, or other places where are located the individual customers of the company operating the alternating current system.

The standard clock *b* may be regulated every day by means of signals from Washington or other center of standard time, and therefore can be depended upon to indicate the correct time, while the indication of the clock *c* depends upon the integrated alternations.

It is obvious that all the clocks *d*, which may be designated the secondary clocks in the system, will always show the same time as the comparison clock *c*, consequently if the speed of the prime mover 66 in the central station is corrected from time to time, so as to gradually wipe out any excess or deficiency in the sum of the alternations, which has caused the comparison clock to gain or lose slightly with respect to the standard clock *b*, the same action will correct simultaneously all the secondary clocks *c* in the system.

This adjustment of speed of the prime movers can be accomplished by means of speed controllers, which are commonly provided for the governors of prime movers, such as large engines or turbines.

In the present instance, I have conventionally represented in Fig. 1, a speed controller for the engine or prime mover 66, which consists of an electric motor 80 connected in circuit with the main line wires 62, 63, and with circuit controllers represented as push buttons 81, 82, which are marked F and S to represent fast and slow.

The motor 80 is operatively connected through suitable gearing 83 with the governor 84 for the prime mover.

As represented in Fig. 1, the push buttons 81 82, are connected with the motor 80 by wires 85, 86, and with the line wire 62 by wire 87, and the motor 80 is connected with the line wire 63 by the wire 88.

It will thus be seen, that the operator at the central station can operate the motor 80 to adjust the governor 84 and thereby regulate the speed of the prime mover 66, by manipulating the push button 81 or 82 to cause the motor 80 to revolve so as to move the governor to increase or reduce the amount of steam supplied to the prime mover, according to whether it is desired to speed up the prime mover or to slow down the same.

Temporary variations in speed due to changes in load will be found to produce no appreciable errors in the electrically driven clocks, for the reason that these temporary variations in speed are equally liable to be positive or negative and thus neutralize each other, while in all cases they are brief and have little effect upon the integrated alternations. The ordinary engine or turbine governors are designed to automatically take care of these temporary variations in speed. In a large power station it is unusual, where for example, the normal frequency is 60 cycles to have this fall below 59 cycles or rise above 61 cycles, and such a deviation would not usually last more than 15 or 20 seconds. Even if the frequency should fall one cycle and remain low for five minutes the accumulated error in the secondary clocks would only be five seconds. As soon as the station attendant noticed a difference between the second-hand of the comparison clock and the second-hand of the standard clock, he would make a slight adjustment of the speed controller of the turbines, and within the next ten or fifteen minutes the error would disappear. Such adjustments of the speed controllers would not need to be made oftener than two or three times an hour, in order to maintain the secondary clocks always correct within a very few seconds, and this would be scarcely more arduous than the present method of regulating the speed by observing a frequency indicator, which is a comparatively crude and inaccurate method as compared with the present method.

In the present instance, I have illustrated one system or arrangement of apparatus by means of which the difference in time between the comparison clock and the standard clock is made by the eye of the operator comparing the two clocks, but it is not desired to limit the invention in this respect.

In the present instance, I have shown and described one embodiment of the invention, which has been selected on account of its simplicity to enable the invention to be readily understood, but it is not desired to limit the invention to the particular system herein shown.

By reference again to Figs. 2, 3 and 4, it will be observed that a rotary magnetic field is produced by the current flowing through the motor *a*, and that this rotary magnetic field has a definite time value and is magnetically coupled with the hands of the clock to produce rotary movement thereof.

The synchronous motor may and preferably will be provided with an air gap between its poles and its rotor, of a width which is at least equal to and preferably greater than the axial thickness of the rotor, and excellent results have been obtained with a motor having a field whose polar diameter is ten-sixteenths of an inch, and having its rotor of a diameter of seven-sixteenths of an inch and a thickness of less than one-sixteenth of an inch.

Claims:

1. A system for distributing time indications, consisting of a commercial alternating current system, a standard clock and a comparison clock driven synchronously with the alternations through suitable gearing to run at the rate of the standard clock when the frequency is normal, means to correct accumulated errors in the integrated alternations, secondary clocks driven by synchronous motors through suitable gearing to indicate the same time as the comparison clock, and auxiliary means to drive the secondary clocks if the alternating current fails.

2. A system for distributing time, comprising an alternating current circuit supplied with an alternating current whose frequency is sufficiently high to be used for commercial lighting, a clock having a time element driven by self-starting synchronous motor included in said circuit and capable of remaining in exact synchronism with the alternations of the current flowing through said circuit, and a standard time with which said clock may be compared.

3. A system for distributing time, comprising an alternating current circuit supplied with an alternating current whose frequency is sufficiently high to be used for commercial lighting, a clock having a time element magnetically coupled by a self-starting rotor inherently capable of revolving in exact synchronism with a rotating magnetic field maintained by the said current, and means for providing for a definite relation between the rotations of said field and elasped time.

4. The method of distributing time indications whereby the length of time that an alternating current is flowing through an electric circuit may be accurately ascertained irrespective of the number of interruptions in the flow of said current, which consists in including in said circuit a clock driven by a self-starting synchronous motor capable of running in absolute synchronism with the alternations of said current and adjusting the frequency of the alternations of said current for any difference between said clock and means indicating standard time.

In testimony whereof, I have signed my name to this specification.

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ELECTRIC CLOCK SYSTEM.
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1,283,431.

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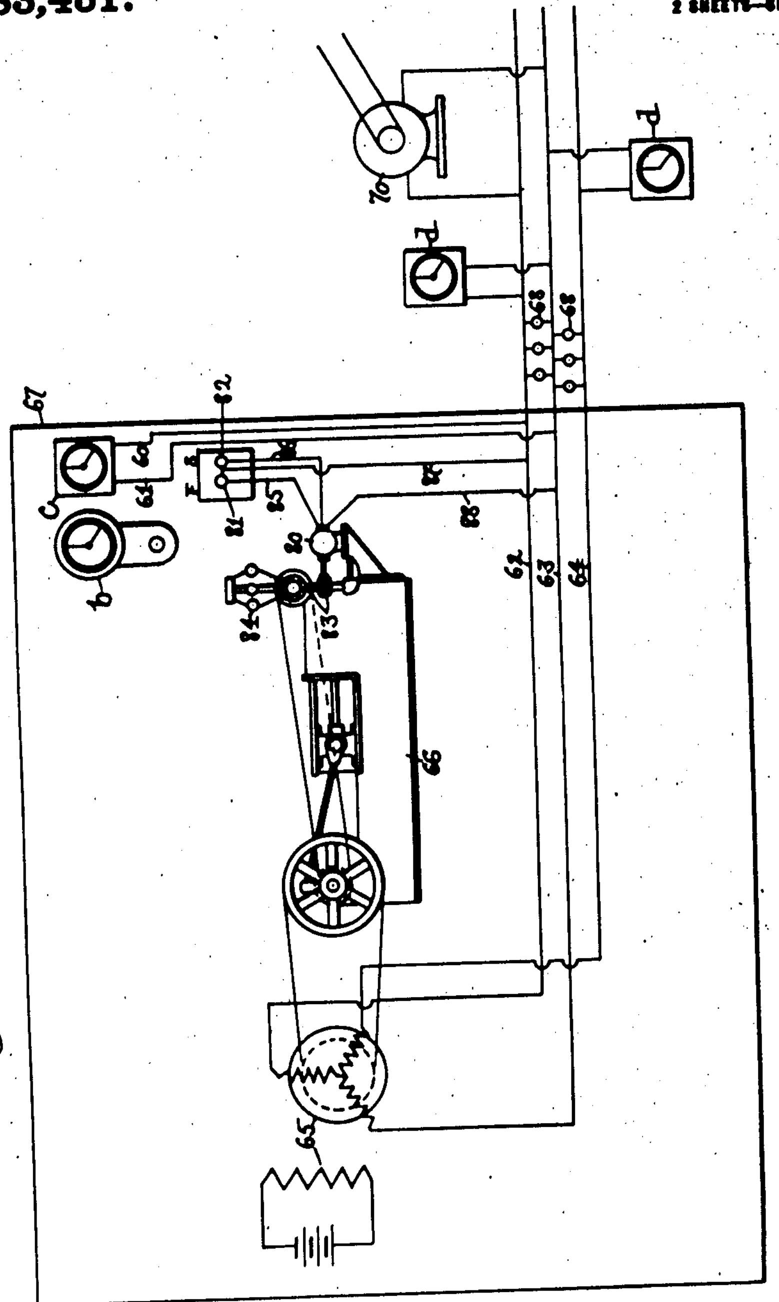
2 SHEETS—SHEET 1.

Fig. 1



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elements of
the basic system
"A 60" clock

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2 SHEETS—SHEET 2.

Fig. 2.

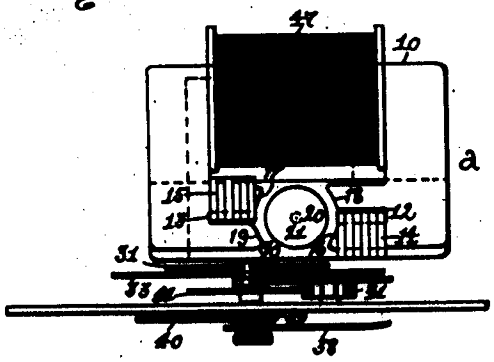


Fig. 5.

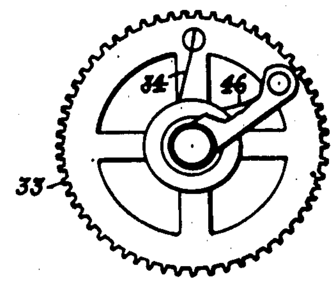


Fig. 3.

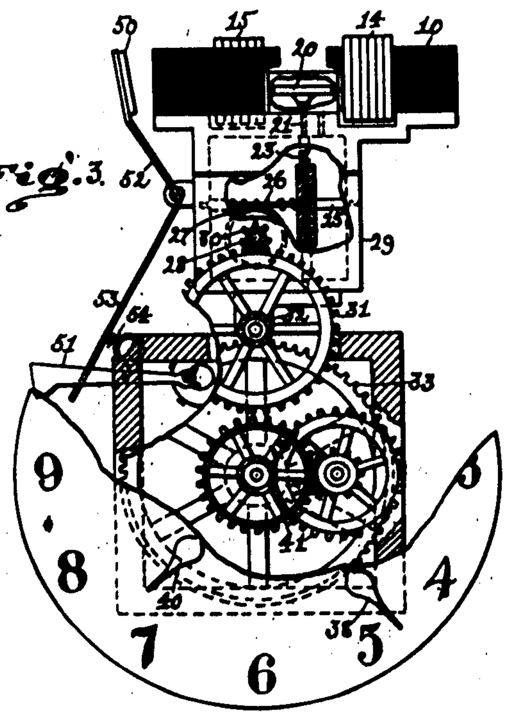
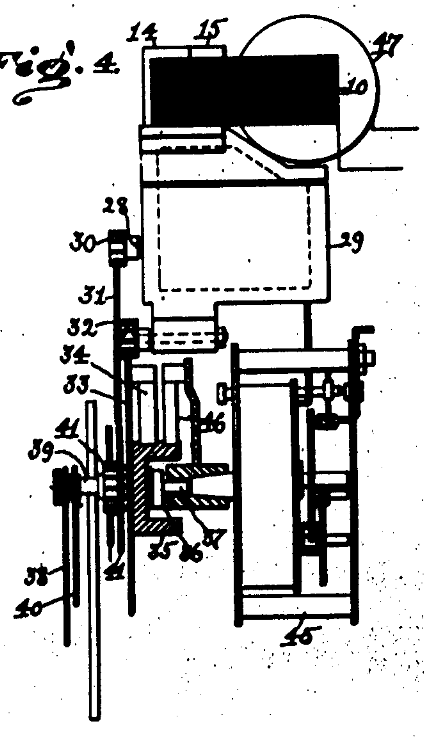


Fig. 4.



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