Patented July 22, 1924. 1,502,493

UNITED STATES PATENT OFFICE.

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TIME-INDICATING APPARATUS.

Application filed April 15, 1918. Serial No. 228,633.

To all whom it may concern:

Be it known that I, HENRY E. WARREN, a citizen of the United States, residing in Ashland, county of Middlesex, and State of Massachusetts, have invented an Improvement in Time-Indicating Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

My invention relates to clocks or like apparatus, and in one of its aspects relates to clocks designed to compare time indications derived from independent sources; as for instance the time indications given by the standard clock work with those had from a synchronous alternating current motor. The invention has for its general object an improved arrangement of parts affording an accurate, reliable and serviceable apparatus in which such indications may be readily compared and for correcting variations in time indications.

My invention has particular application where it is desired to regulate one of the sources of time indications so that two such independent sources may be made to give substantially the same time indications; for instance where it is desired to regulate the frequency of the alternating current to synchronous motors giving time indications so that their indications are made to agree with those of a standard time piece in the manner disclosed in Letters Patent No. 1,283,431 issued in my name on October 29, 1918.

To give effect to my invention, I have found it expedient to have hands which are impelled separately by the independent sources of time, traverse the same indicating dial. Such an arrangement facilitates the exact visual comparison of the indications, while a concentric arrangement permits the relative angular displacement of the hands being made an index of the error which may exist between the respective time indications given by the two sources.

In further giving effect to my invention, it is desirable that the source which is made the standard of comparison should have very accurate time keeping qualities, and also have means for correcting with great precision any deviations in its time indications from standard Observatory time signals such as are regularly sent out from Washington. To this end I have arranged, in a novel manner, to keep the spring tension in the source, or time keeper serving as the standard of comparison, substantially constant, by having its spring or driving means re-wound constantly by as much as it runs down; the rewinding may be conveniently accomplished by the synchronous motor which gives the other time indications. Also to correct for the deviations in the standard time keeper from the standard time signals I provide my standard time keeper with a device for accelerating or decelerating at will the movement of the timing element or pendulum, in my time keeper.

Such device is preferably an electro-magnetic one and is made with advantage, to function in two ways, one by applying a constant correction continuously to the movement of the timing element, the other by applying a definite correction to such movement for a limited time only.

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

Fig. 1 is a front elevation of a time indicating apparatus embodying the invention.

Fig. 2, a side elevation of the apparatus shown in Fig. 1.

Fig. 3, a diagram illustrating one form of mechanism for regulating or setting the apparatus shown in Figs. 1 and 2,

Fig. 4, a plan of a modified form of time indicating apparatus and

Fig. 5, a front elevation of the apparatus shown in Fig. 4.

Referring to Figs. 1, 2 and 3, 10 and 11 represent the pendulum bob and rod of a clock movement having an escapement 12 and wheel 13, to which power is transmitted from the main spring 14 through gears and pinions 15, 16, 17, 18, 19, 20, 21, 22, in a manner well understood, and motion from the escapement is transmitted by pinion 23 and gear 24 to a sleeve 25, which carries a hand 26, which cooperates with a dial *a* having numerals 1 to 5, which indicate that the hand 26 makes a complete revolution

once in five minutes. The hand 26 constitutes a revolving member or element indicative of standard time.

27 represents a self-starting synchronous motor, which may be such as is shown and described in another application Se. No. 138,763 filed by me Dec. 26, 1916. The motor 27 drives a shaft 29 through a slip coupling 28, and motion is transmitted from the shaft 29 by pinion 30, gears 31, 32, and pinion 33 to shaft 34 upon which is fastened the hand 35. The shaft 34 extends through the sleeve 25 and the hand 35 is thus concentrically mounted with respect to the hand 26 and constitutes a time element driven by the synchronous motor 27, and the ratio of the gears connecting the motor 27 with the hand 35 is such that the latter revolves at precisely the same rate as the hand 26 and cooperates with the dial *a*.

Energy is also transmitted from the gear 31 through pinion 36, gear 37, pinion 38 and gear 39, pawl 41 and ratchet wheel 42 to shaft 40, to which the inner end of the clock spring 14 is fastened, the outer end of which spring is fastened to the gear 15.

The ratio of the gears from 31 to 39 is such, that normally the spring 14 will be wound by the motor 27 exactly as fast as the pendulum permits it to be unwound. It will thus be seen that variation in the frequency of the alternating current which operates the synchronous motor 27, influences the rate at which the hand 35 is revolved over the dial *a*, and consequently variation in the frequency of the current is made known to the operator at the power station in which the master clock is located by noting the position of the hand 35 with relation to the hand 26.

Provision is made for regulating the rate of the pendulum with great convenience and precision, which is accomplished as herein shown by providing the pendulum 10 at its lower end with a permanent steel bar magnet 50, which cooperates with and swings across flat coils of insulated wire 51 and 52, so that the magnetic lines preceding from the magnet 50 are constantly cutting the conductors in these coils. By means of a battery of two or more cells 53, I apply constant potential across the terminals of two potentiometers 54 and 55, of known construction, and by means of sliding contacts 56 and 57, the position of which is indicated by means of scales 58 and 59, current at plus or minus potential is taken from the resistances 60 or 61. Contact 56 is connected by the wire 62, contact maker 63 and 64, and conductor 65 at one end of coil 52, the other end of which is connected with the middle point of the batteries 53, so that if contact maker 63 and 64 is closed by pushing down on the knob 66, current will flow in either one direction or the other through coil 52, according to the position of sliding contact 56, which will be indicated on the scale 58.

Current from potentiometer 55 flows through conductor 67 to one end of coil 51 and thus, by connection 68 which is common to both coils 51 and 52, back to the middle point of the battery 53. Consequently current may flow in either direction from the coil 51 according to the indication of the sliding contact 57 on the scale 59. Graduations on the scales 58 and 59 are preferably made in seconds. The knob 66 may be held down after being depressed by catch 69, which is released once in every twelve hours by the pin 70 in the hour hand gear 71 of the clock. Consequently the circuit through coil 52 which includes potentiometer 54 can only be left closed for somewhat less than twelve hours. The effect of current passing through either of coils 51 or 52 is to accelerate or retard motion of the pendulum 10 according to the direction of the current through these coils, and the amount of acceleration or retardation will depend upon the strength of the current. This is determined by the potentiometers 54 and 55. If the sliding contacts 56 and 57 are in their mid position there will be zero potential across the terminals of the coils and consequently no current will flow. On deviation of the sliding contacts in one direction, the effect of the current will be to make the clock run faster, and the deviation of the sliding contact in the other direction will make the clock run slower.

The scale graduations 59 are preferably such as will correspond to the acceleration or retardation of the clock of one second in twenty-four hours, and the scale graduations 58 correspond preferably with acceleration or retardation of one second in somewhat less than twelve hours. As a result of this arrangement, the clock may be set by means of potentiometer 54, by depressing the knob 66 and sliding the contactor 56 so that the other end which passes over the scale will correspond with the number of seconds which the clock should gain or lose. This operation of setting must be performed just after the pin 70 has permitted the arm 72 to drop so that the catch 69 may become effective, and it is usually arranged so that this result will take place about noon or mid-night when clocks are normally set.

The retardation or acceleration produced through potentiometer 54 will be effective for the next twelve hours only, so that the clock will not gain nor lose after the catch 69 has been released. The potentiometer 55 however, on the other hand remains in circuit constantly, and consequently produces a constant effect through coil 51 on the pendulum 10. Therefore by means of

this latter potentiometer, the rate of the clock may be permanently accelerated or retarded.

The operation of the duplex master clock shown in Fig. 1 may be briefly described as follows: The dials are so arranged that they can be seen readily by the switch board operator in an electric power station. The synchronous motor 27 is connected to the bus bars so as to respond to the frequency of the alternating current being generated. The spring 14 is wound at the point 43 and the pendulum is started. The hands 35, 26 of the clock are then set to correspond with the true time, being exactly over each other. The operator is instructed to adjust the frequency so as to maintain these hands together. He can do this very easily by observing the clock occasionally, say at half hour intervals and knowing whether the hand 35 has a tendency to gain or lose in respect to hand 26. If he finds that the hand 35 is gaining he will slow down the speed governors of the turbines, or speed them up if he finds that the hand 35 is losing.

Experience has demonstrated that in large power stations it is very easy to keep the hands together within two or three seconds, by comparatively infrequent adjustment of the speed governors. Each day, at noontime preferably, the reading of the hand 26 should be compared with the true time received by wireless from Washington or otherwise determined, and then the rate of the clock should be corrected by means of potentiometer 55 and the error of the clock should be corrected by potentiometer 54. A clock made in this manner, will run normally with an error less than one second per day. The motor 27, which is running constantly will keep the spring 14 which drives the pendulum, always wound at exactly the same tension.

In Fig. 1, the standard time keeper is shown as provided with a main spring and controlled by a pendulum, but it is not desired to limit the invention in this respect, as a duplex master clock may be provided in which the standard time keeper may be otherwise driven as for instance by a synchronous motor M as shown in Figs. 4 and 5, so that its rate is controlled by the frequency of the current which is supplied to the motor M.

The master clock shown in Figs. 4 and 5, may be used in the power house of an isolated plant and the alternating current for the motor M may come from a large power station which is provided with a pendulum master clock shown in Fig. 1, and the current supplied to the second synchronous motor 27 in Figs. 4 and 5 may be received from the bus bars of the isolated plant, for example, a manufacturing plant which supplies its own power. It will thus be seen that by means of the modified master clock shown in Figs. 4 and 5, it is easy for the engineer of the isolated plant to maintain the same average frequency as the large power station without purchasing any electrical energy from the large power station, excepting the insignificant amount necessary to drive the tiny synchronous motor M.

The motor M is connected through gears 80, 81, 82, 83 with the hand 26, and the motor 27 through gears 30, 31, 32, 33, with the hand 35. The method of using the clock shown in Figs. 4 and 5 is the same as has been heretofore described. The means for regulating the rate of the pendulum of the standard time keeper is not herein claimed as it forms the subject-matter of a divisional application Serial Number 390,014 filed by me on June 18, 1920.

Claims:

1. In an instrument of the character described, a standard clock, a synchronous motor, two hands mounted concentrically, connections between one hand and the standard clock and between the other hand and the synchronous motor, so proportioned that both hands revolve normally at the same rate, and connections between the synchronous motor and the driving mechanism of the standard clock whereby the spring of the latter is kept constantly wound.

2. In an instrument of the character described, a clock movement provided with a main spring and with a time element rotatable thereby, a second time element concentrically mounted with relation to the first mentioned time element, a synchronous motor, gearing connecting said motor with said second time element, and gearing connecting said synchronous motor with the main spring of the clock to wind up the same.

3. In an instrument of the character described, a clock movement provided with a main spring, a time element, and gearing connecting said time element with said main spring to be continuously rotated thereby, a second time element concentrically mounted with relation to the first-mentioned time element, a synchronous motor, and gearing connecting the second time element with the synchronous motor to be continuously driven thereby, and so proportioned with relation to the gearing of the clock movement as to normally rotate the second time element at the same rate as the first-mentioned time element whereby variations in the synchronism of the two motors are instantly visualized.

4. In an instrument of the character described, a time element, a clock movement provided with gearing connected with said time element to rotate the latter, a second time element concentrically mounted with relation to the first-mentioned time element,

a synchronous motor, and gearing connecting the second time element with the synchronous motor to be continuously driven thereby, and so proportioned with relation to the gearing of the clock movement as to normally rotate the second time element at the same rate as the first-mentioned time element, whereby variations in the synchronism of the clock-movement and of the synchronous motor are instantly visualized.

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

HENRY E. WARREN.

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TIME INDICATING APPARATUS

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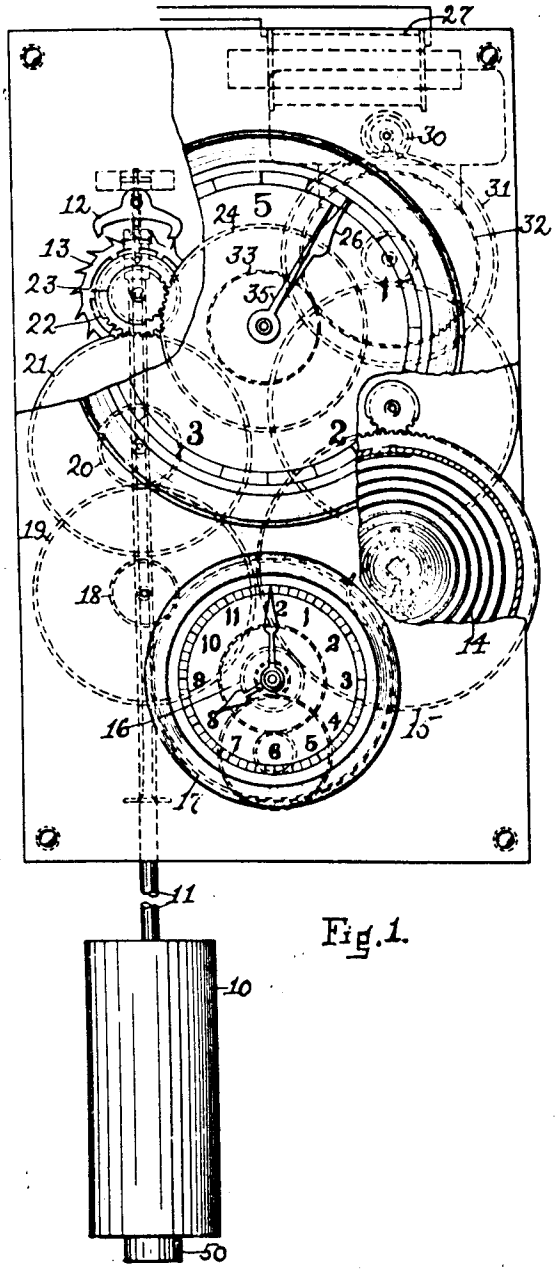

Fig. 1.

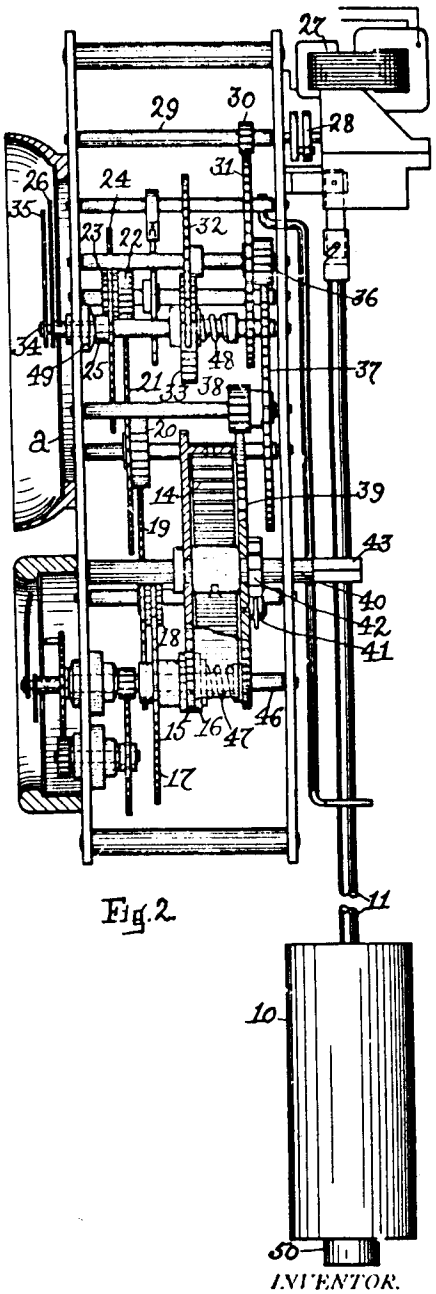

Fig. 2.

"A" clock

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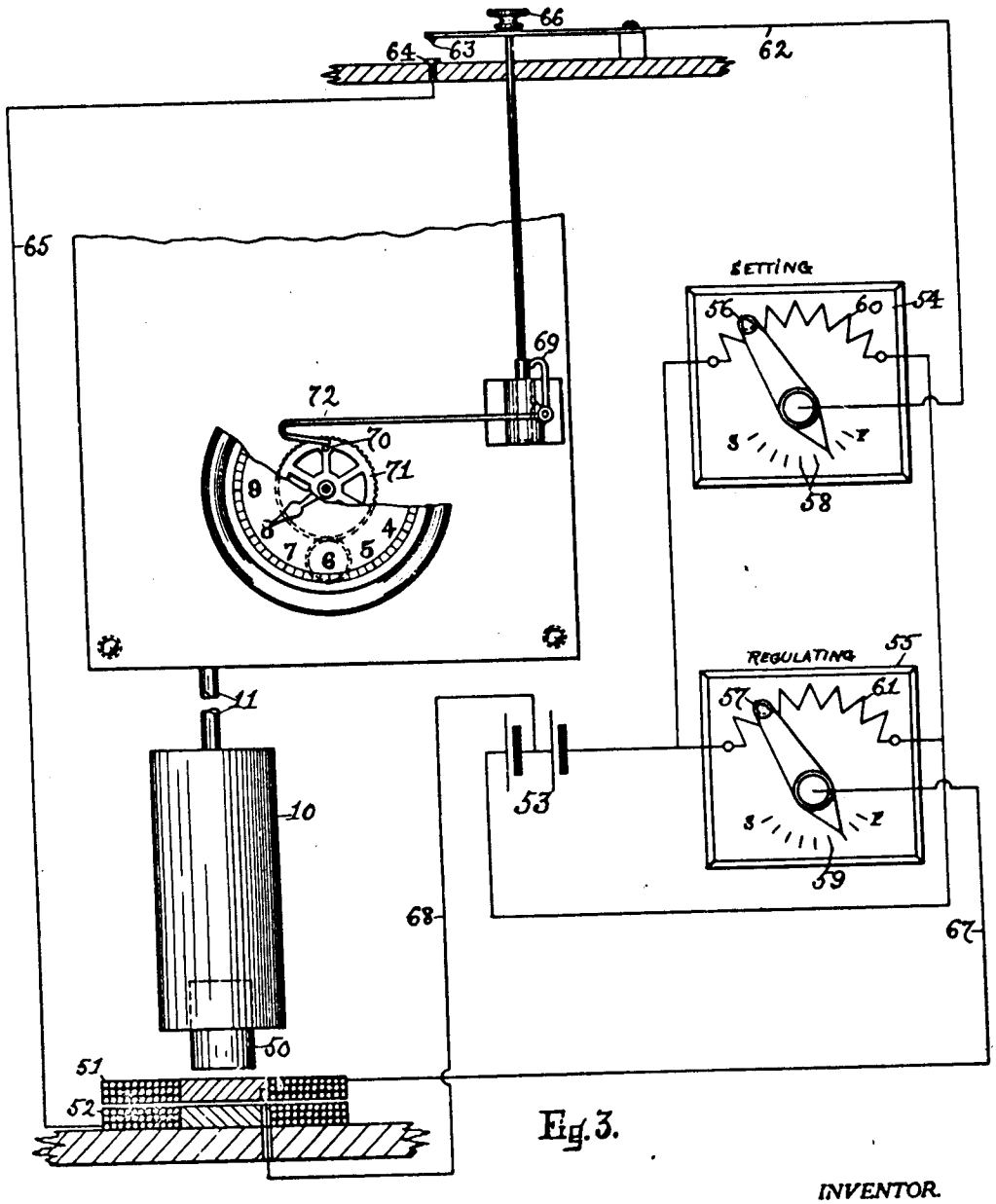

Fig. 3.

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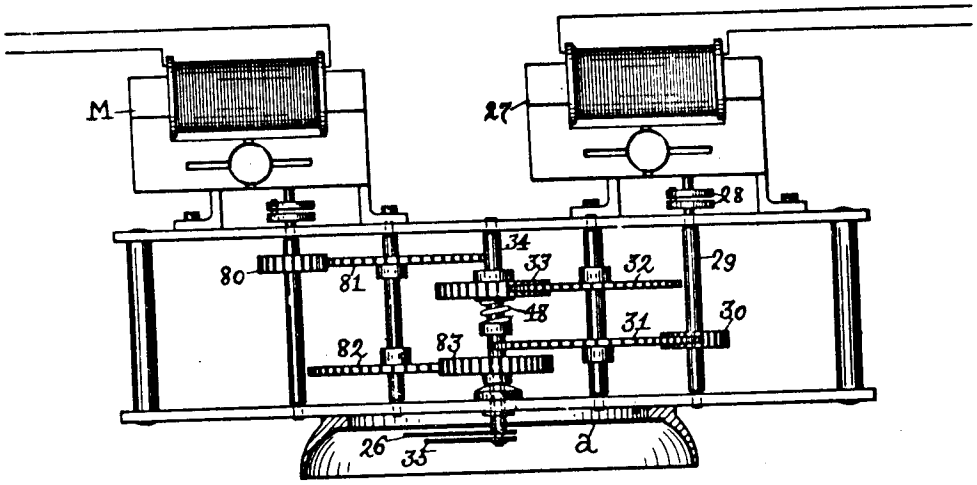

Fig. 4.

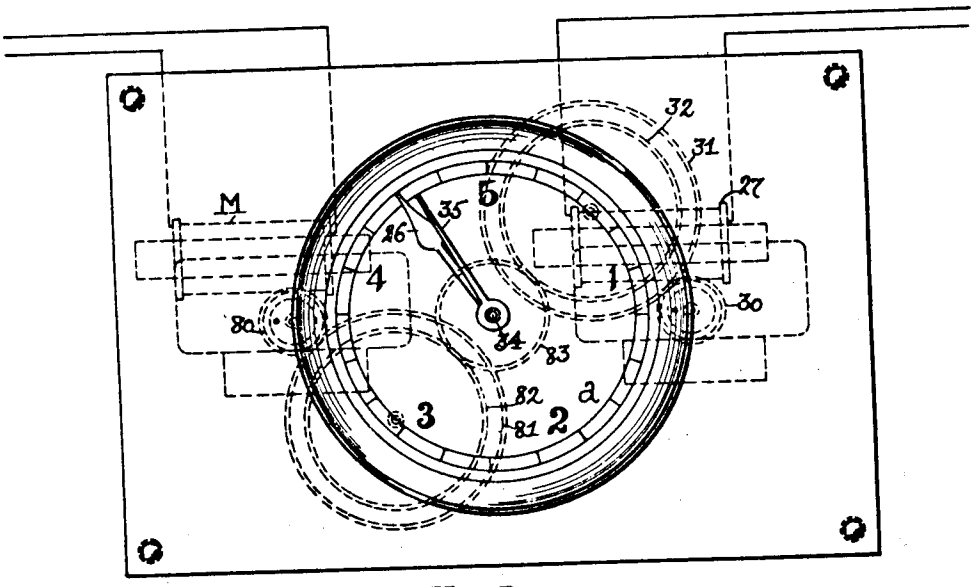

Fig. 5.

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