

Jan. 29, 1935.

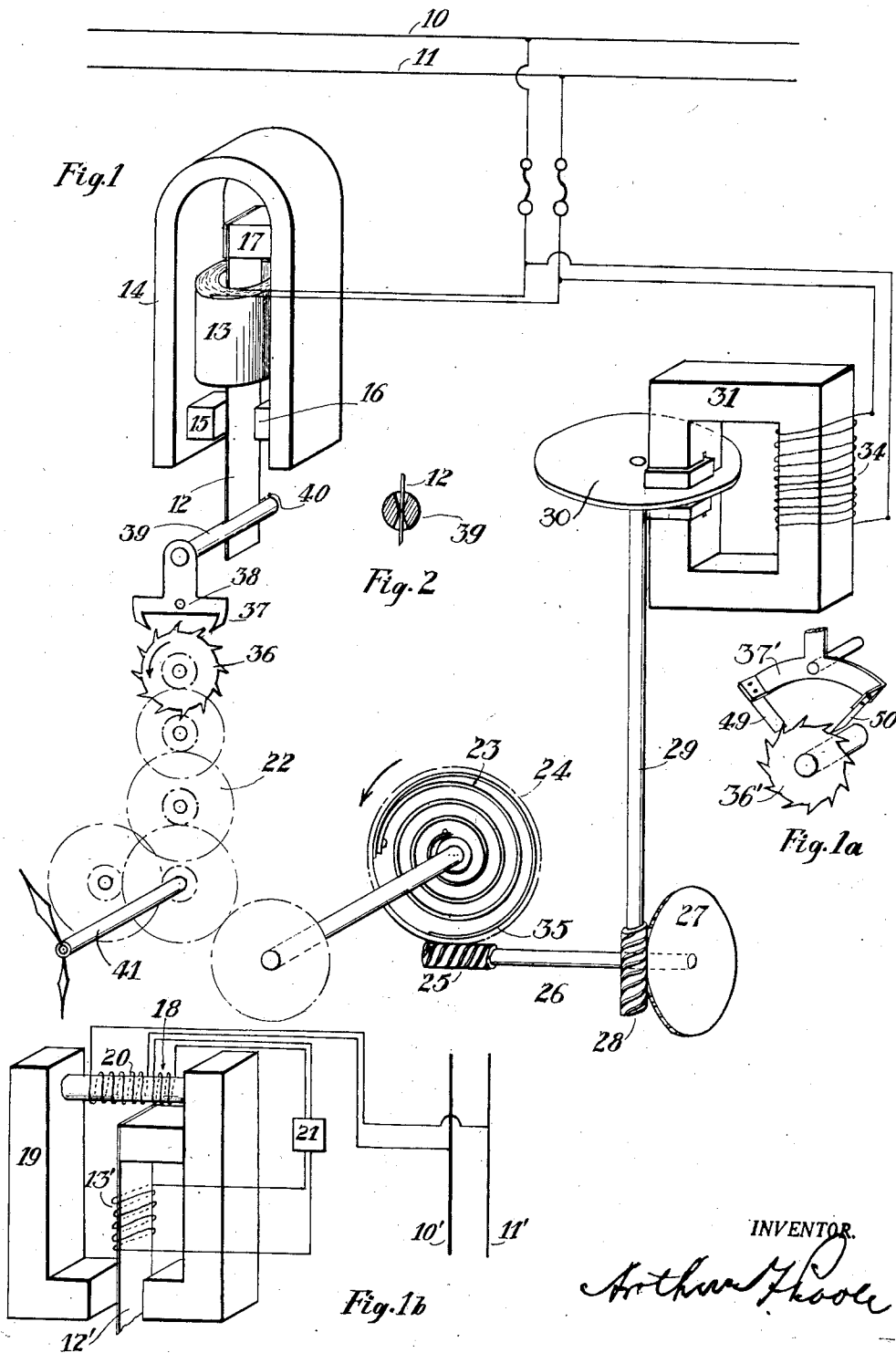
A. F. POOLE

1,989,604

ELECTRIC CLOCK

Filed Nov. 12, 1930

2 Sheets-Sheet 1



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Fig. 3

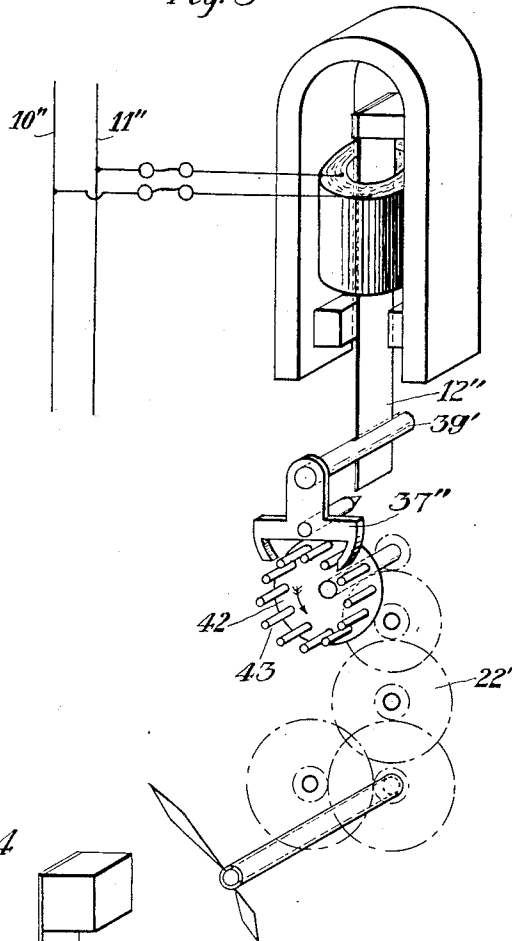


Fig. 3a

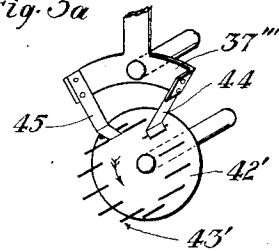
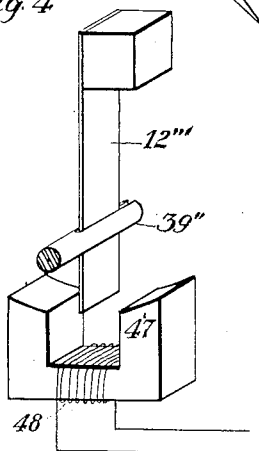


Fig. 4



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ELECTRIC CLOCK

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1 Claim. (Cl. 58—26)

An object of my invention is to provide a new and improved method and corresponding apparatus for governing a clock from a synchronized alternating current. By a synchronized alternating current I mean an alternating current of a power and light distribution system which is controlled by a master clock so that its frequency is held accurately at a definite number of cycles per second, sixty or twenty-five or whatever the case may be. Another object of my invention is to provide for the operation of such a clock by the application of the current to constrain an element to vibrate at a simply related frequency as compared with the frequency of the applied current. For example, the said simply related frequency may be a sub-multiple of the current frequency or the same as the current frequency. Another object is to provide a complete clock that will operate from a local source of power, and with an element having a natural periodic motion at approximately a sub-multiple frequency to which the synchronized current may be applied to hold it in step exactly at the sub-multiple frequency. Another object is to provide a clock with a tuned reed whose natural frequency is approximately a sub-multiple of the synchronized current frequency, and to apply such current to the reed through an electromagnet and thereby hold the reed exactly in step at the sub-multiple frequency. All these objects and other objects of my invention will become apparent on consideration of a limited number of specific embodiments thereof which I have chosen to present in this specification by way of example. It will be understood that the following disclosure relates specifically to these particular embodiments of the invention, and that the scope of the invention will be indicated in the appended claim.

Referring to the drawings, Figure 1 is a diagram showing apparatus by which my invention may be practiced; Figure 1a shows a modification of the pallet; Figure 1b shows a modification of the vibratory reed and associated elements; Figure 2 is a detail cross-section showing the connection of the reed and the stud carried by the pallet in Figure 1; Figure 3 shows a modification in which the clock train is driven by the vibrating reed instead of by a local clock-spring as in Figure 1; Figure 3a shows a modified pallet and escape wheel for the system of Figure 3; and Figure 4 shows a modified disposition of the reed and its associated alternating current magnet.

Referring to Figure 1, the conductors 10 and

11 carry synchronized alternating current of moderate voltage which may be derived through a transformer from a high tension distribution system. By branch conductors from 10 and 11 current goes through the coil 13 and the stator winding 34 of the induction motor 31—30. This consists of the shaded pole stator 31 and the associated rotor 30 constituting a self-starting motor. Through the shaft 29, worm 28, worm-wheel 27, shaft 26, worm 25, and worm-wheel 24, a constant torque in the direction of the arrow is put on the drum within the worm-wheel 24. Being loosely mounted on its co-axial shaft this drum rotates continuously. Within it is the spiral clock spring 23 with its inner end connected to the shaft, and its outer end carrying a shoe 35 having frictional engagement with the interior of the drum. Thus a constant torque in the direction of the arrow is put on the shaft, and through the clock-train 22 a constant torque is transmitted to the escape wheel 36.

Returning to the coil 13 this surrounds the vibratory soft iron reed 12 which is mechanically tuned to a frequency that is closely approximate to some convenient sub-multiple of the alternating current frequency in the coil 13. Thus, for example, if the current in coil 13 is of the frequency of sixty cycles per second, the reed may have the frequency of approximately 12 cycles per second. The permanent magnet 14 carries the pole-pieces 15 and 16 between which lies the reed 12 supported from the block 17. I have established that when the reed 12 is thus exposed to the periodic magnetic field due to the current in the coil 13, it may be set into vibration and may continue to vibrate at the exact sub-multiple frequency to which it is approximately tuned. The clock-train 22, pallet 37 and associated parts should all be made very light so as not to interfere with the vibration of the reed 12.

Whereas I have suggested that with 60 cycle current the reed may properly be tuned to approximately 12 cycles per second, this is largely a matter of mechanical convenience. With 25 cycle current it may be practicable to make the reed vibrate at 25 cycles per second. The frequency of the reed may be related to the frequency of the current in the relation of simple small integer numbers, for example, it may be a multiple, or the same, or a sub-multiple. With 60 cycles it may be inconvenient to have a mechanical element tuned at so high a frequency as a multiple or the same frequency, and a sub-multiple frequency such as 12 cycles may be best.

The reed 12 engages the stud 39 by means of the slot 40, which has the shape shown in Figure 2. Thus an oscillatory movement about the shaft 38 is imparted to the pallet 37 which carries the stud 39, and thus the escape wheel 36 is permitted to turn step by step under the torque to which it is subjected from the spring 23 as described heretofore. The clock train 22 carries the usual time indicating hands on the co-axial shafts 41. Thus these hands move at a rate determined precisely by the frequency of the synchronized current derived from the conductors 10 and 11, and this precise relation is dependent on the fact that the reed 12 can be made to vibrate exactly at a frequency that is a definite sub-multiple of the said current frequency, provided the reed is mechanically tuned to approximately that sub-multiple frequency.

The design of the gear train 22 is such that in normal operation the worm 24 turns in the direction of the arrow somewhat faster than its shaft is permitted to turn by the escape mechanism 36—37. Thus the spring 23 is kept wound from its outer end to a considerable extent, and the shoe 25 acts as a clutch to prevent unwinding at that end.

To set the clock in operation initially, the current may be turned on and enough alternating magnetic attraction will be applied to the reed 12 to start and build up a vibration therein, so that the clock will be self-starting in this sense. But this clock will be like ordinary pendulum and balance-wheel clocks in that the construction of the clock will determine whether the torque of its main-spring 23 transmitted to the escape wheel 36 will ordinarily suffice to start the clock in the absence of current in the coil 13. The clock may or may not be self-starting in this sense.

If the current goes off during normal operation, the clock will continue to run at a rate determined by the actual mechanical tuned frequency of the reed 12, which is made as nearly as practicable the same as the chosen sub-multiple frequency in relation to the current frequency. Then when the current comes on again, the clock goes on at the exact sub-multiple frequency. Most current interruptions on electric distribution lines are of very short duration, so that any departure of the clock from true time due to its interim operation at the natural frequency of the reed 12 will be very small. Of course, if the current stays off long enough, the spring 23 will run down and the clock will stop, unless the spring is wound by hand, which can easily be done. When the current goes off, of course the torque in the spring will manifest itself at both ends, but the spring cannot unwind at its outer end, because of the irreversible character of the worm and worm-wheel connection between the motor 31—30 and the worm-wheel drum 24. Whenever the current comes on after an interruption, the motor 31—30 starts up and winds up the spring to the point of slipping at the shoe 35.

To reduce noise and make the operation smoother, the modification shown in Figure 1a may be employed. Here the pallets 49 and 50 are made as thin leaf springs, thus giving quieter and smoother operation.

Another modification is shown in Figure 1b.

Here an alternating current magnet 19 of soft iron is used, energized by the synchronized alternating current in the winding 20. On the same core with winding 20 is another winding 18 which functions as the secondary of a transformer stepping down the voltage to the input side of the rectifier 21, from which the rectified current goes to the coil 13' around the reed 12'. The rectifier 21 may preferably be of the dry plate type, and more specifically, of the kind that passes both half-waves of the alternating current. Thus the reed 12' will be energized by a current that is direct, though somewhat pulsatory, while the magnet 19 will be energized by synchronized alternating current; accordingly the reed 12' will be started and sustained in vibration at a sub-multiple frequency to the alternating current frequency, provided the reed is tuned naturally to approximately the said sub-multiple frequency. The reed 12' and associated electromagnetic system of Figure 1b take the place of the reed 12 and its associated electromagnetic system of Figure 1; and the system modified thus operates otherwise as described for Figure 1.

In the embodiment of my invention shown in Figure 3, the reed 12'' is controlled from the synchronized alternating current conductors 10'' and 11'' as the reed 12 is controlled from conductors 10 and 11 in Figure 1. But here the clock train 22' is driven from the reed 12' instead of merely limiting its movement as in Figure 1. In Figure 3 the escape wheel 42 has its teeth in the form of round pins 43, and the pallets 37'' are beveled so that as they are oscillated by the vibrating reed 12'', they push the escape wheel 42 around, and through it drive the gear train 22' and the clock hands. For quietness and smoothness of operation the pallets may be modified by making them as thin flexible leaf springs; this corresponds to the modification of Figure 1 that is shown in Figure 1a. With the modification of Figure 3 or Figure 3a, the clock train must be made very light and the clock dial must be rather small. Obviously this clock will stop when the current goes off, but will start when the current comes on, and will operate in synchronism as long as the current stays on.

In either Figure 1 or Figure 3, the reed and its associated electromagnetic system may be replaced by the corresponding parts shown in Figure 4. Here the reed 12''' is of tempered steel so that it will have some residual magnetism. The magnet 47 is energized by synchronized alternating current through the winding 48. Thus a vibration of the reed is set up and sustained at a sub-multiple frequency as described for Figure 1 or Figure 3.

I claim:

In combination, a source of synchronized alternating current of a frequency high enough to be used for light and power; a coil connected thereto, a permanent magnet, a tuned reed associated with the coil and the magnet, the natural frequency of the reed being approximately the quotient of the frequency of the alternating current divided by a small integer number, a clock train whose movement is determined by the vibrations of the reed, and a spring to drive said clock train.

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