March 13, 1945. J. FINK 2,371,387

ELECTRIC CLOCK

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Fig. 1.

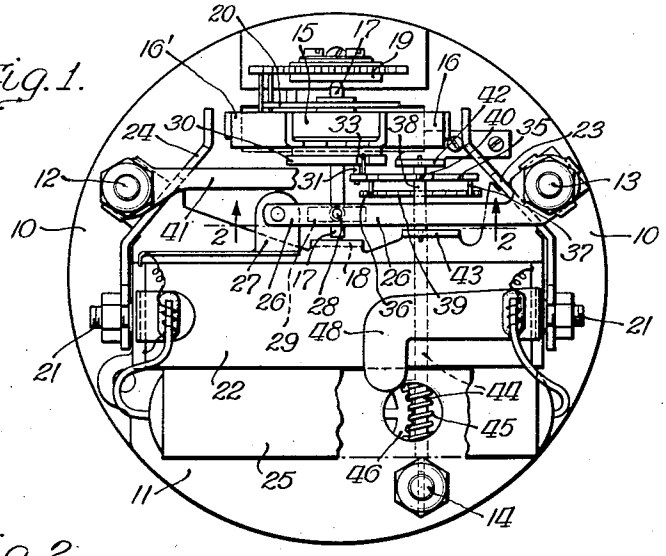
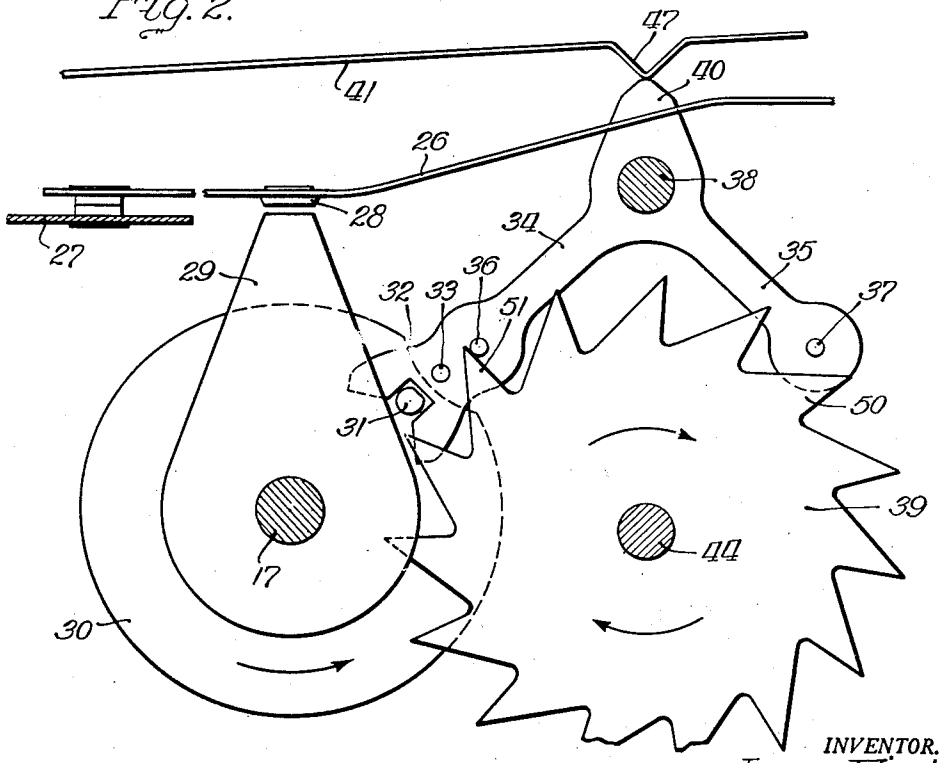


Fig. 2.



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ELECTRIC CLOCK

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7 Claims. (Cl. 58—28)

The present invention relates in general to electric clocks, and more in particular to electric clocks of the type in which an oscillating balance drives the clock train and in which the balance is maintained in oscillating condition by means of an electromagnet which is intermittently energized under control of the balance.

The object of the invention is the improvement of a clock of the foregoing type by the provision of a new and improved drive mechanism through the medium of which the oscillatory motion of the balance is converted into the unidirectional motion of the clock train.

A special object is a self-starting drive mechanism having features which insure reliable starting of the clock under all conditions.

The invention will be described in detail hereinafter, reference being made to the accompanying drawing, in which—

Fig. 1 shows the essential parts of a clock embodying the invention; and

Fig. 2 is a section on the line 2—2, Fig. 1, showing the improved drive mechanism.

The invention may be employed in any electric clock of the general type hereinabove described. For a complete disclosure of a suitable clock of this type reference is made to United States Patent No. 2,356,983, granted August 29, 1944. In view of the description in said patent, it will not be necessary to explain in detail the construction and operation of the whole clock, and the description will be limited, therefore, to the improved drive mechanism, except for such brief explanation of other parts as may be desirable for an understanding of the invention.

Referring to Fig. 1, the various parts of the clock are mounted on a frame which comprises the front plate 10, the plate 11, and the three posts 12, 13 and 14. The front plate 10 may be circular in shape, as shown, and has the three posts secured to it by a riveting or staking operation. The plate 11 is of irregular shape and rests on shoulders formed on the posts 12, 13 and 14, whereby it is maintained in the proper spaced relation to plate 10. The posts 12, 13 and 14 are threaded above the shoulders and nuts are used to clamp plate 11 in position.

The balance comprises a ring 15, of brass or other suitable material, and a four-pole armature which also functions as a support for the ring. Two of the armature poles are indicated at 16 and 16'. The armature is a sheet metal stamping of high grade magnetic material and is mounted in suitable manner on the balance arbor 17. The balance arbor has a bearing at one end in the down-turned portion 18 of the frame plate 11 and at the other end has a bearing supported on the balance cock 19. Associated with the balance is the usual hairspring, indicated at 20.

The electromagnet for oscillating the balance includes a core 21, a winding 22, and the pole pieces 23 and 24. The pole pieces are supported on the frame plate 11, and for this purpose are provided with slots whereby they may be forced on to the two ears by means of which the frame plate is supported on posts 12 and 13. The pole pieces are assembled to the frame plate before the latter is assembled on the posts. The pole pieces extend inwardly past the posts 12 and 13, whereby their respective free ends are brought into operative relation with the four-pole armature which forms part of the balance. The opposite ends of the pole pieces, extending upward from the plate 11, are bifurcated to receive the core 21, and engage shoulders formed near the ends of the core, against which they are clamped by nuts, as shown. The parts are so proportioned that the heads of the spool on which the winding 22 is carried rest on the frame plate 11. The reference character 25 indicates a condenser which is connected in parallel with the winding 22.

The circuit of the electromagnet is controlled by means of a pair of contact members 26 and 27. The contact member 26 is a flexible spring and is supported in suitable manner on the post 13. The contact member 27 is the fixed member of the pair and is supported on one of the heads of the magnet spool. The contact spring 26 is normally out of engagement with the contact member 27; that is, spring 26 is tensioned in the proper direction to break the contact. During oscillations of the balance the spring 26 is actuated periodically into engagement with contact member 27 by means of an armature 28 secured to the spring and a small permanent magnet 29 mounted on the balance arbor 17. The magnet 29 also functions, with the initial aid of the hairspring, to restore the parts and maintain them in a definite normal position as shown in Fig. 2, whenever the clock stops due to the current supply being disconnected. In this position of the parts the contact between the spring 26 and contact member 27 is closed.

The oscillating balance operates the clock train by means of drive mechanism which will now be described, reference being had to Figs. 1 and 2 of the drawing.

Mounted on the balance arbor 17 adjacent the four-pole armature of the balance there is a roller 30, having the pin 31 projecting from the side thereof. The pin 31 may be of hardened steel or other suitable material, and lies in the fork which is provided at the end of arm 34 of the pallet lever. The latter part is shaped as shown in Fig. 2 and comprises the integrally formed arms 34 and 35 and the short tapered upright arm 40. The pallet lever is mounted on the shaft 38 which has a bearing at one end in

the bracket 42 and at the other end in the upturned portion 43 of the plate 11. The arm 34 of the pallet lever carries a guard pin 33, which is located within the recess 32 in the roller 30 when the parts are in the position shown. The bracket 42 extends upward from the frame plate 10, to which it is secured by screws, as indicated.

The pallet lever is provided with the two pallets 36 and 37, which may be hardened steel pins, by means of which the so-called escape wheel 39 is rotated. The escape wheel is mounted on an arbor 44, which has a bearing at one end in the bracket 42 and at the other end in the post 14. Only a part of the arbor 44 can be seen in Fig. 1, since it is located below frame plate 11 and directly underneath the arbor 38. The arbor 44 drives the clock train by means of the worm 45, which engages the gear wheel 46, the latter being the first wheel of the train. The remainder of the clock train is not shown, but is of the usual and known construction.

The reference character 41 indicates a light spring which is mounted on post 12. The spring 41 is formed near the end so as to provide a V-shaped projection 47 which bears on the tapered end of the arm 40 of the pallet lever. Spring 41 is tensioned downward, but applies no rotative force to the pallet lever because the latter is on dead center.

The complete clock includes a back plate (not shown) which is mounted on posts 12, 13 and 14 in spaced relation to plate 11. For this purpose suitable tubular spacers may be placed on the threaded portions of the posts above the nuts shown, and the back plate may be held in place by additional nuts. The details of this construction are immaterial to the invention but are fully disclosed in the patent previously referred to. The back plate is provided with an insulated terminal to which one pole of the battery or other current source is connected. This terminal extends through the back plate and engages the coil terminal 48 mounted on one of the heads of the magnet spool. The spool may be of molded construction, in which case the coil terminal 48 and the contact member 27 are embedded in the two spool heads, respectively.

From the foregoing the circuit of the electromagnet will be readily understood. It extends from one pole of the battery to the back plate terminal, and thence by way of the coil terminal 48, winding 22 of the electromagnet, contact member 27, and contact spring 26 to the frame of the clock, which is connected in any suitable manner to the other pole of the battery.

The operation of the clock will now be explained, with special attention to the functioning of the drive mechanism.

It will be assumed to start with that the battery or other source of current is disconnected, which means of course that the clock has stopped. When the clock is not running the various parts of the drive mechanism are in the position in which they appear in Fig. 2, as previously mentioned. The contact 26—27 is closed, and the pallet lever is in its mid-position, with the spring 41 under tension.

When the battery is connected a flow of current over the previously traced circuit is established and the electromagnet is energized. The resulting magnetic field passes through the armature which forms part of the balance, and a rotative force is thus applied to the balance which tends to rotate it in one direction or the other. The rotation of the balance tensions the hairspring and also brings about the release of armature 28 and the opening of the circuit of the electromagnet by the disengagement of contact spring 26 and contact member 27. The balance then rotates in the opposite direction and as the magnet 29 passes the armature 28 the latter is attracted and the circuit of the electromagnet is again closed. The electromagnet thus receives another impulse of current, and the operation continues in this way until in a few seconds the balance is oscillating with its normal amplitude, the electromagnet being energized momentarily during each beat as the magnet attracts armature 28 to close the circuit.

The starting of the clock is facilitated by the action of spring 41. As the balance starts to rotate, the roller 30 rotates also and the pin 31 rotates the pallet lever. As soon as the latter has moved off dead center its rotation is accelerated by the spring 41, due to the V-shaped projection 47 engaging one of the tapered sides of arm 40. Thus the pallet lever delivers a secondary impulse to the roller 30 by means of the forked arm 34 and pin 31, which tends to augment the initial swing of the balance. The power for the secondary impulse is stored in the spring 41 by the magnet 29, when it brings the parts to rest in the position shown in Fig. 2. When the clock is running the spring 41 is tensioned during the first half of each beat, the power being supplied by the osciliating balance, and during the last half of each beat the spring 41 assists in rotation of the clock train, thus returning the power to the system.

The pallet lever is shown in the intermediate position, in which it stands when the clock is stopped. When the clock is running the pallet lever oscillates between two extreme positions in which the pin 31 on the roller 30 is clear of the fork and the motion of the balance is not impeded by the drive mechanism. The drive is effected as the balance passes through a short range of movement at the middle of each beat, and at times when it receives impulses from the electromagnet. The driving operation may now be considered more in detail.

It may be assumed that the balance and roller 30 are rotating in the direction shown by the arrow associated with the roller, having completed one-half of the beat in this direction. The pin 31 has entered the fork on arm 34 of the pallet lever and has rotated the pallet lever to the position shown, tensioning the spring 41. As the rotation of the roller 30 continues, the pin 31 continues to rotate the pallet lever and very shortly the pallet pin 37 engages the tooth 50 of the escape wheel 39. The continued rotation of the pallet lever now rotates the escape wheel, the power stored in spring 41 being of assistance in the rotation, as previously mentioned. When the pallet 37 arrives nearly at the bottom of the notch between tooth 50 and the next adjacent tooth, the pin 31 on roller 30 leaves the fork and the balance and roller continue their excursion in a counter-clockwise direction. The escape wheel has been advanced an angular distance equal to one-half the tooth spacing.

During the motion of the roller and pallet lever just described the guard pin 33 on arm 34 of the pallet lever moves away from the balance arbor 17 and as the pin 31 leaves the fork the distance between the guard pin 33 and the center of arbor 17 is slightly greater than the radius of the roller; that is, the pin 33 has moved far enough so that it does not bear on the periphery of the roller.

The pallet lever is held in this position, with guard pin 33 clear of the roller, by the spring 41. The guard pin is provided to prevent any displacement of the pallet lever, such as might be caused by an accidental shock, which would prevent the pin 31 from properly entering the fork on the return movement of the balance; but in the normal operation of the clock the guard pin is held just clear of the roller, which eliminates the drag that would otherwise be present.

The rotation of the balance and roller 30 in the direction indicated is stopped by the hairspring in the usual manner and the rotation in the opposite direction begins. As the balance approaches the middle of its beat the pin 31 enters the fork on arm 34 of the pallet lever and rotates it also. Shortly after the pallet lever passes its mid-position, in which it is shown in Fig. 2, the pallet pin 36 engages the sloping face of tooth 51 of the escape wheel 39 and the continued movement of the pallet lever rotates the wheel in the same direction as before and through the same angular distance. As the pallet 36 arrives nearly at the bottom of the notch between tooth 51 and the next adjacent tooth the pin 31 leaves the fork and the balance and roller continue their rotation. The pallet lever is held in this position by the spring 41, until the pin 31 again enters the fork upon the next beat of the balance.

The operation continues in this manner as long as power is supplied to the clock. When the battery is disconnected, as by opening of the battery circuit at some point outside the clock, the balance continues to oscillate, but with gradually decreasing amplitude, until eventually the mutual attraction between the magnet 29 and the armature 28 is sufficient to overcome the inertia of the balance and the parts are brought to rest in the position in which they are shown. In this connection it should be noted that the rotative force due to the attraction between magnet 29 and armature 28 is considerably greater than the force which can be applied to the pallet lever by spring 41, which insures that the pallet lever will be brought to mid-position each time the clock stops.

The invention having been described, that which is believed to be new and for which the protection of Letters Patent is desired will be pointed out in the appended claims.

I claim:

1. In a drive mechanism for a clock, a toothed wheel, a pallet lever for rotating said wheel responsive to oscillation of the lever, means including a balance for oscillating said lever, a spring acting on said lever and tending to rotate the same except when the lever is in mid-position, and means including a permanent magnet for returning said pallet lever to mid-position against the tension of said spring whenever the balance comes to rest.

2. In a drive mechanism for a clock, a balance supported on an arbor and adapted to oscillate, a pallet lever adapted to be oscillated responsive to oscillation of said balance, a toothed wheel adapted to be rotated by said pallet lever, a spring acting on said pallet lever and tending to rotate the same to one or the other of the extreme positions which the pallet lever assumes during oscillation, said spring and lever being so arranged that the spring exerts no rotative force on the lever when the latter is in a position midway between said extreme positions, and a permanent magnet on the balance arbor cooperating with an armature fixed against angular motion around said arbor to maintain said pallet lever in mid-position until said balance starts oscillating.

3. In a drive mechanism for a clock, a toothed wheel included in the clock train, a pivoted pallet lever for rotating said wheel responsive to oscillation of the lever, means for oscillating said lever on its pivot, a spring acting on said pallet lever and tensioned during the first part of an oscillation of the pallet lever in one direction, said spring being effective during the latter part of said oscillation to apply force to the pallet lever to assist in driving said wheel, and means effective when the clock stops for partly oscillating said lever to tension said spring.

4. In a drive mechanism for a clock, a toothed wheel for driving the clock train, a pivoted pallet lever for rotating said wheel responsive to oscillation of the lever, the said lever being ineffective to drive said wheel until the lever has passed the halfway point in each oscillation, means including a balance for oscillating said lever, a spring acting on said lever during the last half of each oscillation to aid the balance in completing such oscillation, said spring being tensioned by said balance and lever during the first half of each oscillation of the lever, and means effective to complete a half oscillation of said lever and tension said spring if the balance stops oscillating.

5. In a drive mechanism for a clock, a toothed wheel for driving the clock train, a pivoted pallet lever for rotating said wheel responsive to oscillation of the lever, the said lever being effective to drive said wheel only during the last half of each oscillation, means including a balance for oscillating said lever, a spring associated with said lever for receiving and storing power from the balance during the first half of each oscillation which is applied to said lever to aid in driving said wheel during the last half of each oscillation, and means for insuring that said lever comes to rest in mid position with said spring under tension when the clock stops.

6. In a self-starting clock having a balance, means including an electromagnet for causing the balance to oscillate, drive mechanism responsive to oscillation of the balance for advancing the clock train, means for starting and stopping the clock by closing and opening the circuit of said electromagnet, and means associated with said drive mechanism for storing power when the clock stops and for applying at least a part of such power to the balance when the clock is started again.

7. In a self-starting clock, a balance supported on an arbor, an electromagnet, a permanent magnet on the balance arbor controlling the circuit of said electromagnet to cause the balance to oscillate, drive mechanism responsive to oscillation of said balance for advancing the clock train, means for starting and stopping the clock by closing and opening the circuit of said electromagnet at a point outside the clock, said permanent magnet being effective whenever the clock is stopped to bring the balance and a part of said drive mechanism to predetermined positions, and means associated with said drive mechanism and responsive to movement of said part thereof to said position to store power which is applied to the balance when the clock is started.

JEAN FINK.