July 10, 1934. C. BATTEGAY 1,965,763

ELECTRIC CLOCK

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Fig. 1

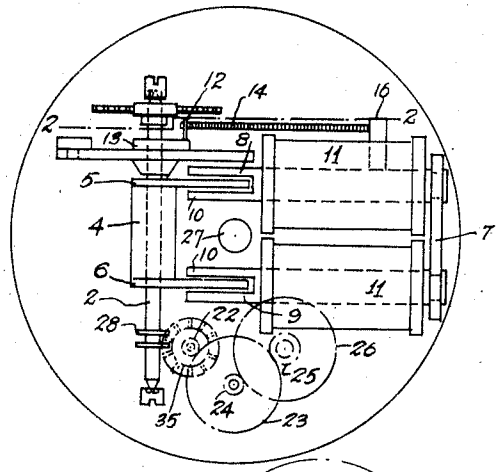


Fig. 3

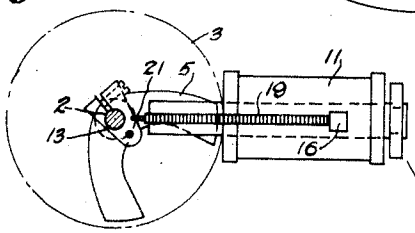
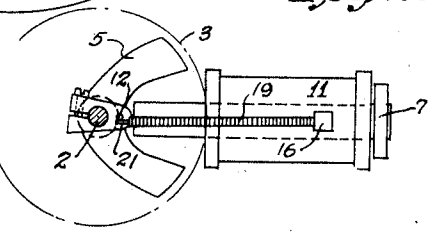


Fig. 2



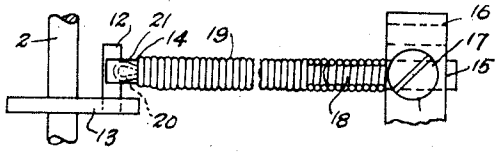


Fig. 9

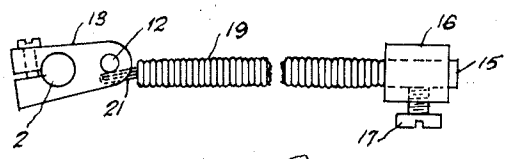


Fig. 8.

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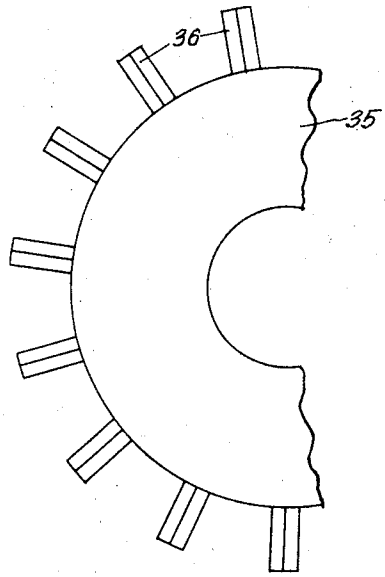
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ELECTRIC CLOCK

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Fig. 4



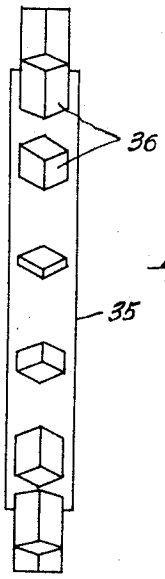


Fig. 5

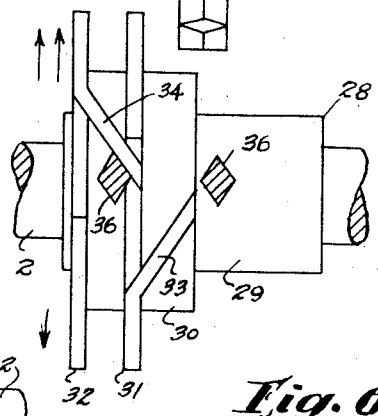


Fig. 6

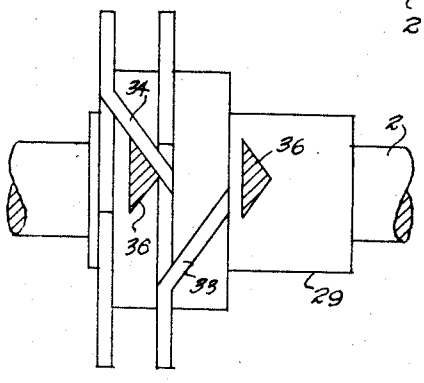


Fig. 7

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ELECTRIC CLOCK

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Fig 10

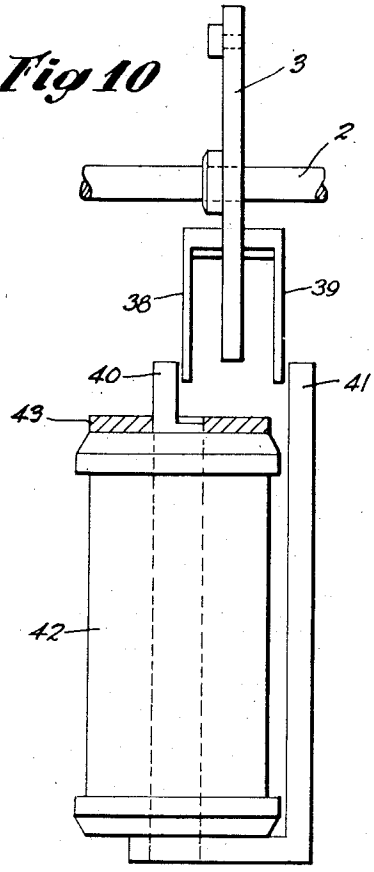


Fig 11

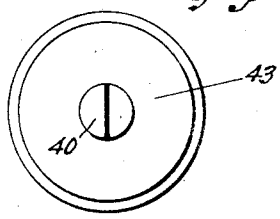
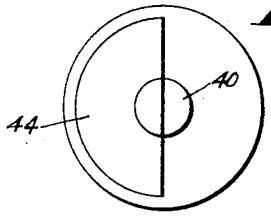
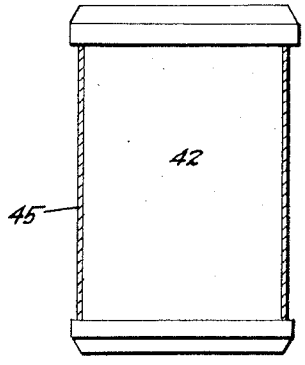


Fig. 12





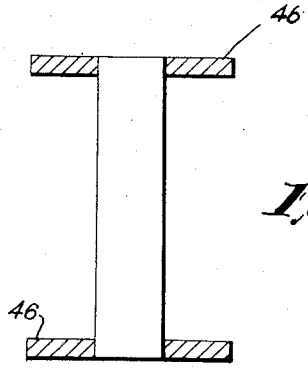


Fig. 14 Fig. 13

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Patented July 10, 1934 1,965,763

UNITED STATES PATENT OFFICE

1,965,763

ELECTRIC CLOCK

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Application March 3, 1931, Serial No. 519,717
In France March 3, 1930

13 Claims. (Cl. 58—28)

This invention relates to electric clocks of the general character described in my prior application, Serial No. 284,297, filed June 11, 1928, (Patent 1,826,719) "Self oscillating electric clocks", and while directed more particularly to independent clocks is adapted for use generally in this art.

Clocks of the character under consideration have a balance wheel which is mounted to be oscillated magnetically. The magnet which causes the movement of the balance wheel operates upon the balance wheel which constitutes an armature and through the cooperation of these parts the balance wheel oscillates back and forth to control the clock movement through an appropriate driving connection.

The object of the present invention is to materially improve upon structures of this class with a view to increasing efficiency of electric clocks and especially those of small dimensions where a very compact construction is desired with absolute accuracy in the keeping of time. This object is obtained through the employment of several novel features which will be hereinafter explained in detail.

For example, a novel arrangement of parts, according to this invention, permits the balance wheel shaft to occupy a vertical position with the armature quite separate and apart from the wheel and mounted upon the shaft. This armature preferably is so formed as to constitute in effect a double armature which is adapted to cooperate simultaneously with both poles of an associated electromagnet and said poles are cut out or bifurcated so as to allow the armature parts to pass through the cut-outs or slots in the poles of the magnet. There is thus obtained a relatively large surface area with a maximum flow of magnetic flux. This construction insures relatively great magnetic power in the operation of the balance wheel through the employment of a relatively small magnet, thus adapting a clock of the present invention to be effectually operated from dry cells. Furthermore the arrangement described materially decreases friction and at the same time provides for the passage of the central shaft of the clock movement directly through the center of the case thereby materially simplifying the construction and permitting the movement to be housed within a relatively small case.

A further feature of the invention relates to novel electrical contact structures to insure periodic flow of current through the energizing magnet; while another feature of the invention resides in novel and efficient mechanism susceptible of that high degree of accuracy in operation essential in small movements.

An important advantage in the novel driving mechanism of this invention resides in the fact that the structure is so constituted as to make it practically impossible for the parts of the mechanism to engage in other than operative relation.

Features of the invention, other than those specified, will be apparent from the hereinafter detailed description and claims, when read in conjunction with the accompanying drawings.

The accompanying drawings illustrate different practical embodiments of the invention, but the constructions therein shown are to be understood as illustrative, only, and not as defining the limits of the invention.

Figure 1 is a front view of electric clock mechanism embodying the present invention.

Figure 2 is a section taken on the line 2—2 of Figure 1, showing the armature in a position corresponding to a position of equilibrium of the pendulum.

Figure 3 is a view similar to Fig. 2, but illustrating the armature in one of its positions of attraction.

Figure 4 is a fragmental face view of the balance wheel of the movement.

Figure 5 is an edge view of said wheel.

Figure 6 is a side elevation of the balance wheel and armature shaft.

Figure 7 is a like view showing a modified form of balance wheel tooth coacting with a driving member.

Figure 8 is a plan view of contact mechanism forming part of this invention.

Figure 9 is an enlargement of part of the structure shown in Figure 1.

Figure 10 is a fragmental view showing a modified form of the invention with which is associated an additional feature also forming part of this invention.

Figure 11 is a plan view of the magnet shown in Figure 10 having associated with the top thereof a ring of conductive non-magnetic metal for purposes hereinafter stated.

Figure 12 is a view similar to Figure 11, but showing a semi-ring of such metal.

Figure 13 shows a covered magnet coil included within a casing or sleeve of conductive non-magnetic metal.

Figure 14 shows a magnet core of magnetic metal with non-magnetic good conducting metal at the ends thereof.

The clock structures of this invention is preferably mounted between two plates, one of which

is indicated at 1. These two plates are spaced apart in parallel planes by suitable posts, not shown, as is common in the clock art. The armature and balance wheel shaft is designated 2 and is mounted to oscillate in suitable supports (Fig. 1) which may be jeweled if desired. The supports are so located in contradistinction to prior practice that the shaft 2 is positioned with its axis vertical, in order to materially decrease friction and to obviate the necessity of counterbalancing. Upon the shaft 2 is fixed the balance wheel 3 and also fixed on said shaft is a sleeve or fixed collar 4 at the opposite ends of which are formed substantially U-shaped armature members 5 and 6. These armature members are rigid with the sleeve 4 and both the members and the sleeve are formed of magnetic material. Furthermore, the U-shaped armature members 5 and 6 are positioned in the same angular relation with respect to the shaft 2 and said armature members and sleeve constitute in effect a double armature as will be readily understood.

The electromagnet 7 is mounted rigidly in position with respect to the plates 1 and its poles 8 and 9 extend in a direction radially of the shaft 2 and to a point fairly adjacent said shaft and said poles are bifurcated or cut away as indicated at 10 to provide slots through which the armature members 5 and 6 may oscillate. The slots 10 are made to fit the armature members fairly closely, but with adequate clearance to preclude actual contact. This arrangement permits of a relatively large surface of air gap for in the fully attracted position of the armature members, one arm of each member substantially fills the gap, so as to provide a substantially closed magnetic flux circuit adapted to exert considerable magnetic force upon the pendulum shaft, even though the coils 11 of the magnet are energized by relatively weak current.

Attached to the shaft 2 or directly to the balance wheel 3 is a suitable contact which is movable with said shaft. This contact is designated 12 in the drawings and is shown as secured to a yoke 13, seen best in Figs. 8 and 9 and adjustably mounted upon the shaft 2. Said contact is preferably positioned on a radius which bisects the angle of the arms of the U-shaped armature member as clearly appears from Figs. 2 and 3 and with this contact is adapted to cooperate a resilient contact arm 14. This contact arm may be of different constructions without departing from this invention, but a very satisfactory form of structure is illustrated in detail in Figs. 8 and 9. In these views, a pin 15 extends through an appropriate rigid support 16 and is adapted to be locked in desired adjustment by means of a set screw 17. The outer end of the pin is threaded at 18 and on this threaded portion is screwed a closely coiled metallic spring 19. The opposite end of the spring is provided with a loop 20 which is housed within or covered by a suitable metal contact piece 21 which is adapted to coact with the contact pin 12.

With this construction, the coil spring 19 constitutes a highly flexible member with sufficient flexibility to permit it to be flexed or bent as the contact pin 12 sweeps the contact piece 21, but with sufficient resiliency and stiffness to cause it to return to its normal straight or neutral position. Experience has shown that a contact of this sort is particularly advantageous because it does not materially impede the operations of the balance wheel, but at the same time assures a proper wiping contact for the passage of electrical current.

The drive of the clockwork from the shaft 2 is accomplished through mechanism including the pinions and gears 22, 23, 24, 25, 26, etc. I have not considered it necessary to show the entire gear train of clockwork as this may be conventional. It is to be noted, however, that with the structure shown, it is possible to mount the central shaft, indicated at 27, in the exact center of the case. This is a highly important feature from a practical standpoint and materially assists in producing a compact arrangement of the parts.

The mechanism through which the drive of the clockwork is accomplished will now be described in detail. It is of the same general arrangement as disclosed in my said prior application, but embodies novel structural peculiarities which render the same highly efficient in the performance of its intended functions. The driving member of the balance wheel shaft is mounted directly upon said shaft and is designated 28. It comprises a fixed collar 29 having thereon a hub 30. Extending about this hub are two annular flanges 31 and 32. These flanges are spaced apart equidistantly for a greater portion of the circumference of the hub. However, in adjacent points in each flange a portion of the flange is cut away and deflected laterally as clearly shown in Fig. 6. Thus the flange 31 is provided with a laterally deflected portion 33 forming a ramp or cam-like surface, whereas the flange 32 is similarly cut away and deflected laterally as indicated at 34 to form a similar ramp or cam-like surface. It is to be noted that these two ramps extend in the same direction axially, but in opposite directions circumferentially with respect to the shaft 2, and that the free ends of the ramps are substantially in the same radial plane of the shaft.

The driving member 28 is adapted to cooperate with a toothed wheel, such, for example, as illustrated in Figs. 4 and 5. This wheel designated 35 is provided with radial teeth 36, which are shown in Figs. 4 and 5 as substantially diamond shaped in cross section. The wheel 35 is mounted with its axis substantially perpendicular with respect to the axis of the shaft 2, so that the teeth 36 will cooperate with the member 28 as indicated in Fig. 6. The pitch of the teeth and the spacing of the flanges 31 and 32 of the driving member are so worked out that the lead of the ramps collectively is in excess of the pitch of the teeth. As a result of this construction, it will be apparent that the oscillation of the shaft 2 from the position shown in Fig. 6 in the direction of the single arrow in this figure will cause the ramp 34 to act upon the associated tooth 36 for the purpose of advancing the tooth in a direction to the left in this figure. The other tooth shown in this figure will be advanced accordingly so that by the time the ramp 34 has moved the tooth 36 to the exterior face of the flange 32, the other tooth 36 will be well within the path of return movement of the ramp 33. Thus when the driving member moves on its return oscillation in the retrograde direction indicated by the double arrow, the ramp 33 will engage with this latter tooth and again advance the wheel 35 until the latter tooth is brought within the path of return movement of the ramp 34. Accordingly, as the escapement member is oscillated back and forth through the oscillations of the shaft 2 as will hereinafter be more fully explained, the wheel 35 is advanced step by step as the successive teeth

of the wheel consecutively cooperate with the ramps 33 and 34.

Particular attention, however, is directed to the diamond shaping of the teeth 36 and to the keen edged termini of the ramps. Experience has shown that when the parts are shaped as described, there will be no possibility of the ends of the ramps engaging the faces of the teeth in a manner to stop the movement. The structure is such that it is absolutely positive in its operation, gives minimum friction and possesses the maximum capacity to withstand wear. The diamond shape to which I have referred constitutes the preferred form of tooth shape. An alternate construction, however, is indicated in Fig. 7, wherein the teeth 36 are shown as of triangular cross section.

It is felt that because of the disclosure of my prior application, a detailed description of the operation of the armatures under the impulse of the magnet, is unnecessary, and that it will be thoroughly understood by those skilled in the art. It may be noted, however, that with the arrangement shown in the drawings, the balance wheel will normally stop in a position wherein the armatures will be in a substantially symmetrical position with reference to the electromagnet as shown in Fig. 2 with the contact piece 21 in engagement with the contact pin 12, so that when the electric circuit through the magnet is closed, the arms of the armature nearest the pole pieces of the magnet will be immediately retracted and the parts will thereupon start to oscillate in a manner that will be clearly understood.

My experience with structures of the character described has demonstrated the marked efficiency of the structure. The vertical disposition of the shaft materially adds to this efficiency. The diminishing of friction and the use of a double armature embodying U-shaped elements and cooperating with the bifurcated pole pieces gives the mechanical power to the movement with a minimum expenditure of current draw and practice has proven that the consumption of electrical energy is sufficiently small to render the clock of this invention well adapted for operation by dry batteries through prolonged periods.

In Figure 10, I have shown another embodiment of the invention. Here the balance wheel 3 carries the armature members 38 and 39 which act between the poles 40 and 41 of the magnet, the pole 40 being cut away as shown, so that the members 38 and 39 overlap the poles 40 and 41 for an appreciable extent for the reasons hereinbefore stated. About the pole 40 is a coil 42 by means of which the magnet is energized as will be understood.

This structure is particularly adapted although not exclusively intended to be operated from a storage battery such as might be used on a vehicle. It is well understood that the voltage of such batteries may vary considerably, so that a battery of six volts may rise to eight volts when it is charged or dropped to less than four volts at other times. With such a condition, there is always a risk of improper operation on the part of the clock due to relatively wide variations in voltage.

I have found that this may be overcome by associating with the magnet a good conducting non-magnetic metal, so disposed as to oppose the magnetic flux in a manner to smooth out the operation of the magnet under all conditions through a retardation action. This non-magnetic high conducting metal may be disposed in various ways with respect to the magnet. For example, as shown in Fig. 10, a ring of metal 43 is positioned at one end of the coil. In practice, this metal may vary without departing from this invention, so that it is non-magnetic and a good conductor. I have found copper or silver to give very satisfactory results. In Figs. 10 and 11, the part 43 is shown in the form of a ring or disk, whereas in Figure 12, it is shown as a half a ring or disk and is designated 44. Good results may also be had by enclosing the covered magnet coil 42 within a tubular sleeve 45 of such metal as shown in Fig. 13 or by making both ends of the magnet spool of such metal as indicated at 46 in Fig. 14.

My experience with the several arrangements which I have described and which utilize the non-magnetic coil as stated is that the magnetism of the magnet poles is opposed by currents set up in the non-magnetic metal, which serves to retard the magnetic flux circuit in a way to smooth out its operation even though appreciable voltage changes occur in the current which is energizing the magnet. In the absence of this feature of the invention, a great increase in voltage brings about a marked increase in amplitude of the armatures, whereas when this feature of the invention is employed, I find that the current induced into the non-magnetic metal is retained long enough to oppose to a large extent the magnetization of the pole pieces. The attraction of the pole pieces for the armatures 38 and 39 therefore thus diminishes and the amplitude of the armatures increases only slightly with such an increase in voltage. In practice, I have found that the clock movement designed to function under an average of approximately six volts functions in substantially the same manner and does not take on an exaggerated amplitude for voltages which are much higher. The induced currents of the rupture of the contact produced in the non-magnetic member absorb in part the electro magnetic energy accumulated in the iron of the core. When utilizing this phase of the invention, I preferably make the winding of the magnet somewhat stronger than heretofore as I find that this gives the best result.

The foregoing detailed description sets forth the invention in its preferred practical form, and the invention is to be understood as fully commensurate with the appended claims.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. In an electric clock, a shaft mounted to oscillate, a balance element fixed on said shaft, an armature member also rigid with said shaft and comprising a pair of relatively rigid fork-shaped armature elements arranged in spaced apart relation to one another axially of the shaft, a double pole electromagnet, the poles of which extend radially of said shaft and are slotted to provide for the passage of the armature elements therethrough, a circuit including said electromagnet, a contact member carried by said shaft, and another contact member adapted to cooperate with the contact member of the shaft and connected to close the circuit through the electromagnet.

2. In an electric clock, a vertical shaft mounted to oscillate on a vertical axis, a balance element fixed on said shaft, an armature member also rigid with said shaft and comprising a pair of relatively rigid armature elements, each having forked portions arranged in angular relation to one another, a double pole electromagnet, the

poles of which extend radially of said shaft and each having a U-shaped slot to provide for the passage of the armature elements therethrough, a circuit including said electromagnet, a contact member carried by said shaft, and another contact member connected to cooperate with the contact member of the shaft to make and break said circuit.

3. In an electric clock, an armature shaft supported in vertical position for oscillation on a vertical axis, a balance member secured to said shaft, a pair of armature elements rigid with said shaft and spaced apart axially thereof, a double pole electromagnet, both of the poles of which extend radially of the shaft at the same side thereof and each of which is slotted for the passage of the respective armature elements therethrough, a circuit including said electromagnet, and a pair of contacts, one of which is mounted on a support which is rigid with respect to the electromagnet and the other of which is carried by the armature shaft to control said circuit.

4. In an electric clock, an armature shaft supported in vertical position for oscillation on a vertical axis, a balance member secured to said shaft, a pair of armature elements rigid with said shaft and spaced apart axially thereof, a double pole electromagnet, the poles of which extend radially from the same side of the shaft and are slotted for the passage of the respective armature elements therethrough, a circuit including said electromagnet, a pair of contacts, one of which is mounted on a support which is rigid with respect to the electromagnet and the other of which is carried by the armature shaft connected to control the circuit, a central shaft extending in a direction perpendicular to a plane including the axis of both poles of the electromagnet, said central shaft extending through said plane between the poles of the magnet and between the electromagnet and the armature shaft, and driving connections between the armature shaft and said central shaft.

5. In an electric clock, an armature shaft mounted to oscillate, a balance wheel fixed on said shaft, a pair of armature elements rigid with said shaft and spaced apart axially thereof, and a double pole electromagnet, the poles of which extend radially from the same side of the armature shaft and overlap the respective armature elements for the purpose of providing air gaps of considerable area between the poles of the magnet and the double armature.

6. In an electric clock, an armature shaft mounted to oscillate, a balance wheel fixed on said shaft, a double armature composed of elements rigid with said shaft and spaced apart axially thereof, a double pole electromagnet, the poles of which extend radially from the same side of the armature shaft and overlap the respective armature elements for the purpose of providing air gaps of substantial area between the poles of the magnet and the armature elements, a central shaft extending through the space between the poles of the magnet and between the magnet and the armature shaft, and driving connections between the armature shaft and said central shaft.

7. In an electric clock, an armature shaft mounted to oscillate, a balance wheel supported on said shaft, an armature member also supported on said shaft and rigid with respect to the balance wheel, said armature being of magnetic material and provided with a plurality of spaced magnetic portions perpendicular to the shaft, each of which is of substantially U-shape, a double pole electromagnet, the poles of which extend radially of said shaft, and radially overlap for an appreciable distance the path of movement of the magnetic portions of the armature, a circuit including said electromagnet, a contact carried by the shaft, and a resilient contact supported on a firm anchorage and adapted to resiliently cooperate with the contact on the shaft to make and break said circuit.

8. In an electric clock, an armature shaft mounted to oscillate on a vertical axis, a balance wheel supported on said shaft, an armature member also supported on said shaft and rigid with respect to the balance wheel, said armature being of magnetic material and provided with a plurality of cross axially disposed magnetic portions, each of which is of substantially U-shape, a double pole electromagnet, the poles of which extend in the direction of said shaft, and radially overlap for an appreciable extent the path of movement of the cross axial magnetic portions of the armature, a circuit including said electromagnet, a contact carried by the shaft, and a resilient contact supported on a firm anchorage and adapted to resiliently cooperate with the contact on the shaft to make and break said circuit.

9. In an electric clock, an armature shaft mounted to oscillate, a balance wheel supported on said shaft, an armature member also supported on said shaft and rigid with respect to the balance wheel, said armature being of magnetic material and provided with a plurality of cross axially disposed magnetic portions, each of which is of substantially U-shape, a double pole electromagnet, the poles of which extend radially toward said shaft and radially overlap for an appreciable extent the path of movement of the cross axial magnetic portions of the armature, a circuit including said electromagnet, a contact carried by the shaft, a resilient contact supported on a firm anchorage and adapted to resiliently cooperate with the contact on the shaft to make and break said circuit, said resilient contact comprising a coil spring, one end of which is supported at said firm anchorage and the other end of which is provided with a rigid projection adapted to directly coact with the contact on the shaft.

10. In an electric clock, an armature shaft mounted to oscillate, a balance wheel fixed on said shaft, a double armature also rigid with said shaft, and a double pole electromagnet, a circuit including said electromagnet, the poles of said electromagnet extending radially of the armature shaft and overlapping the path of movement of the double armature for the purpose of providing air gaps of large area between the poles of the magnet and the double armature, and a body of good conducting non-magnetic metal associated with at least one pole of the electromagnet to produce retarding effect in the magnetizing thereof to compensate for variations in current intensities.

11. In an electric clock, an armature shaft mounted to oscillate, a balance wheel fixed on said shaft, a double armature also rigid with said shaft, and a double pole electromagnet, a circuit including said electromagnet, the poles of said electromagnet extending radially of the armature shaft and overlapping the path of movement of the double armature for the purpose of providing air gaps of large area between the poles of the magnet and the double armature, and a retarding member of good conducting

non-magnetic metal positioned in the flux circuit to produce a retardation action in said circuit to compensate for variations in current intensities.

12. In an electric clock, an armature shaft mounted to oscillate, a balance wheel fixed on said shaft, a double armature also rigid with said shaft, and a double pole electromagnet, a source of direct current, current controlling means for periodically energizing said electromagnet from said source, the poles of said electromagnet extending radially of the armature shaft and overlapping the path of movement of the double armature for the purpose of providing air gaps of substantial area between the poles of the magnet and the double armature, and a copper ring mounted on one of said poles to delay the magnetizing and thereupon delay the attraction of the armature and compensate for variations in current intensities for the purpose of producing uniformity of operation.

13. In an electric clock, a shaft mounted to oscillate, a balance element fixed on the shaft, an electromagnet having a pair of poles at one and the same side of the shaft and spaced apart axially of the shaft, armature members movable with the balance element and spaced apart axially of the shaft to cooperate with the respective poles of the electromagnet, a contact member movable with the shaft, a relatively fixed contact member adapted to cooperate with the contact member of the shaft, and an electrical circuit including both contact members and the electromagnet.

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