

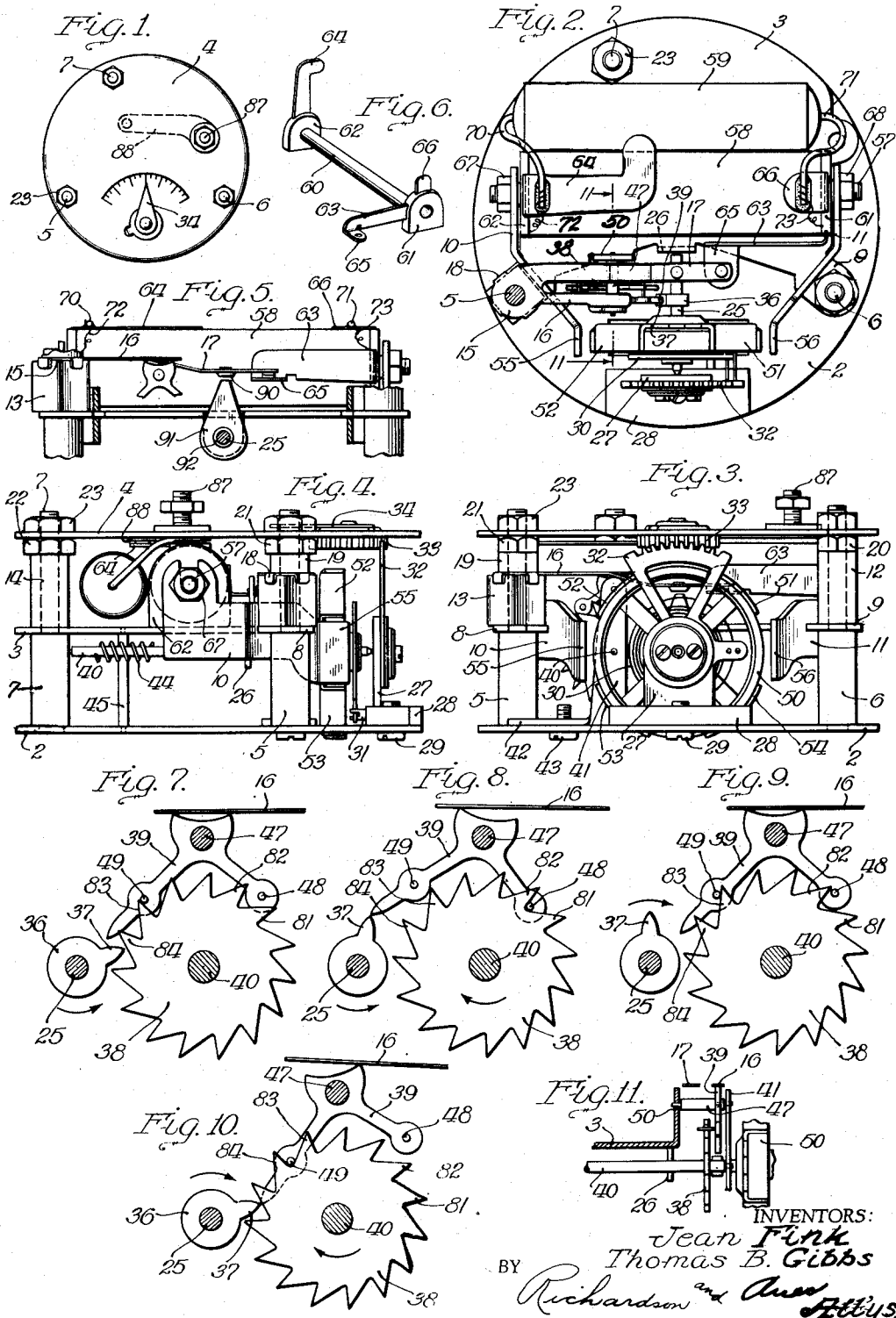
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J. FINK ET AL

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ELECTRIC CLOCK

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## UNITED STATES PATENT OFFICE

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## ELECTRIC CLOCK

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The present invention relates in general to electric clocks, and more in particular to clocks of the type in which the mainspring is omitted and an electromagnet is employed to maintain the balance in oscillating condition, the magnet being intermittently energized under control of the balance. Clocks of this type are well adapted for use in automobiles, and the object of the invention may therefore be considered to be the provision of a new and improved automobile clock, although certain features of the invention are not necessarily so limited and are adapted for use in other types of clocks.

A feature of the invention is a new and improved drive mechanism by means of which the oscillatory motion of the balance is converted into a unidirectional motion of the clock train with a minimum of interference with the free motion of the balance.

A further feature relates to the construction of the electromagnet. The two pole pieces of the electromagnet are assembled with the frame to which they are rigidly secured, while the core of the electromagnet, its winding, the associated condenser, and suitable terminals are constructed as a detachable unit.

A still further feature has to do with the contact spring for controlling the circuit of the electromagnet and provides an arrangement by which this spring may be readily assembled and accurately secured in the proper position.

The foregoing and other features will be described in detail hereinafter, reference being had to the accompanying drawing, in which—

Fig. 1 is a rear view of a clock constructed in accordance with the invention;

Fig. 2 is another rear view of the clock, on a larger scale, and with the back frame plate removed;

Fig. 3 is a side view looking toward the balance as seen in Fig. 2;

Fig. 4 is another side view taken from the left as the clock is seen in Fig. 3;

Fig. 5 is a fragmentary view showing details of the contact device for controlling the circuit of the electro-magnet;

Fig. 6 is a perspective view of the electromagnet spool and terminals before winding;

Figs. 7, 8, 9 and 10 are diagrammatic views showing the essential parts of the drive mechanism in the different positions which they assume during the oscillation of the balance; and

Fig. 11 is a fragmentary sectional view taken on the line 11 in Fig. 2.

Referring to the drawing, the various parts of

the clock are mounted on a frame which comprises the front plate 2, the plate 3, and the three posts 5, 6 and 7. The front plate 2 may be circular in shape and has the three posts secured to it by a riveting or staking operation, as indicated in Figs. 3 and 4 of the drawing. Each post is reduced in diameter for about half its length, as shown by the dotted lines, and the ends of these reduced portions are threaded. The shape of the plate 3 can be seen from Fig. 2, which indicates that in the vicinity of posts 5 and 6 the outline of the plate conforms to the inner surfaces of the pole pieces 10 and 11, except for the two ears 8 and 9, which pass through slots in the pole pieces and are drilled to receive the reduced portions of the posts. Plate 3 is also drilled at a point corresponding to the location of the post 7.

The two pole pieces 10 and 11 are forced on to the ears 8 and 9, respectively, of the frame plate 3 before the latter is assembled and are retained by the press fit. The plate 3 may then be placed in position against the shoulders on posts 5, 6 and 7, after which the tubular spacers 12 and 14 are assembled on posts 6 and 7, respectively, and a short square spacer 13 on post 5. One side of the spacer 13 fits closely against the outer surface of the pole piece 11. The spring unit 15 may then be placed in position on post 5, above the square spacer 13. This spring unit comprises a spring 16 for controlling the pallet lever and a contact spring 17 for controlling the magnet circuit, formed integrally with one another. The common portion of the spring unit is provided with three ears 18 which preferably grip the sides of the spacer 13 tightly when the spring unit is placed in position, the latter being forced down until it rests on top of the spacer. A short spacer 19 is now added, whereupon the assembly may be firmly secured together by means of nuts 20, 21 and 22. It will be understood that other parts of the clock may have to be placed in position before the plate 3 is assembled.

The described construction involving the square spacer 13 cooperating with the pole piece 11 and the ears 18 on spring unit 15 is of considerable advantage in that it enables the nut 21 to be tightened up without any special precaution being taken against rotating the spring unit on post 5. This spring unit is automatically positioned when it is assembled and its position cannot be disturbed when the nut 21 is drawn down.

The back plate 4 may be regarded as part of the frame, although it is readily removable. It has holes drilled to correspond to the locations of

posts 5, 6 and 7, and is clamped in position against the nuts 20, 21 and 22, by three nuts such as 23.

The balance comprises a ring 50, of brass or other suitable material, and a four pole armature which also functions as a support for the ring. The armature is a sheet metal stamping of high grade magnetic material and is shaped as shown in Figs. 2, 3 and 4. The four pole pieces are indicated at 51, 52, 53 and 54, and are connected to a central hub section by means of spokes formed integrally therewith as shown. The ends of the poles are bent at right angles on arcs of a circle of the same diameter as the outer periphery of the ring 50, thus forming a partial enclosure for the ring, which may be held in position by a press fit, or in any suitable manner.

The balance is mounted on an arbor 25, which has a jeweled bearing at one end in the down turned portion 26 of frame plate 3, as shown in Fig. 2. At the other end the arbor 25 has a plain jeweled bearing and also a thrust bearing, which are supported on the balance cock 27 in known manner. The thrust bearing is required because the clock is intended to be mounted with the balance arbor in a vertical position. The balance cock is provided with a base 28, which is secured to the frame plate 2 by means of screw 29. It will be noticed that the bearings for the balance arbor are located so close to the frame plate 2 that the rim of the balance projects slightly beyond the face of the plate, the latter having an opening therein, as shown in Fig. 2, in which the balance oscillates. The purpose of this construction is to enable the oscillating balance to be observed from the front of the clock, it being understood that the dial will be provided with a similar opening.

The usual hairspring is indicated at 30 and has one end secured to the balance arbor and the other end secured to a stud 31 which projects from the base 28 of the balance cock. A regulating mechanism is also provided, as shown, and includes a toothed sector 32 which is rotatably mounted on the balance cock in known manner. The sector 32 is in mesh with a gear 33 which is mounted on the under side of plate 4 and may be rotated by means of a pointer 34. These parts are of the usual construction and require no detailed description. It will suffice to say that rotation of pointer 34 rotates the gear 33 and sector 32 and that the latter moves the regulating pins along the hairspring to change the effective length thereof.

Extending parallel to the balance arbor 25 there is an arbor 40, on which is mounted the escape wheel 38, as seen in Figs. 2 and 11. The arbor 40 has a bearing at one end in the post 7, as seen in Fig. 4. At the other end, the arbor 40 has a bearing in the member 41 which forms part of a bracket including the base 42, Fig. 3. The bracket is secured to the frame plate 2 by means of a screw 43. The arbor 40 drives the clock movement by means of worm 44 and a gear in mesh therewith which is mounted on the shaft 45. The rest of the gear train may be of known construction and has been omitted in order to avoid confusing the drawing.

The escape wheel 38 is rotated by means of a pallet lever 39, the shape of which is seen best in Figs. 7 to 10, inclusive, and the two pallets 48 and 49, which may be hardened steel pins. The pallet lever 39 is supported on a short shaft 47 which has a bearing at one end in the bracket member 41 and at the other end in a raised portion 50 of the frame plate 3, as shown in Figs. 2 and 11. The spring 16 cooperates with the

pallet lever 39 and tends to maintain it in the position in which it is shown in Fig. 7. For actuation of the pallet lever by the oscillating balance, a pinion 36 is provided on the balance arbor 25, the said pinion having a single tooth 37 adapted to engage the end of the pallet lever.

The electromagnet comprises a core 57, a winding 58, and a spool and terminal assembly which is shown in perspective in Fig. 6. The spool comprises a hollow body portion 60 and the two heads 61 and 62, and is preferably molded from some suitable plastic material. The terminal members 63 and 64 are embedded in the heads 61 and 62, respectively, and the terminal member 63 is provided with a soldering lug 66 formed integrally therewith and projecting from the head 61. The core 57 is inserted in the spool, which may be reamed out if necessary, and should fit closely therein. After the core has been inserted the winding 58 and its cover are put on in known manner. The terminal members 63 and 64 and lug 66 are then bent back along the winding to the positions in which these parts are shown in Figs. 2 and 5.

The reference numeral 59 indicates a condenser, which has two heavy terminal conductors 70 and 71. These terminal conductors are cut off to the proper length and are then formed as shown in Fig. 2. The ends 72 and 73 of the winding 58 are wrapped around conductors 70 and 71, respectively, and the latter are then soldered to terminal member 64 and lug 66, respectively, as shown in Fig. 2.

Assuming that the back plate 4 has not yet been assembled, the electromagnet assembly may be placed in its proper position, with the core 57 in the slots of the pole pieces 10 and 11 and the flat sides of the spool heads 62 and 61 resting on the frame plate 3. The nuts 67 and 68 serve to clamp the pole pieces 10 and 11 to the core 57, which is preferably provided with shoulders in line with the ends of the spool. It will be seen from the foregoing that the magnet assembly is made as a separate unit, which is incorporated in the clock at a convenient stage in its manufacture, preferably after assembly of the mechanical parts has been completed. This is of considerable advantage for obvious reasons. The described construction also facilitates repairs in case of a defective condenser or magnet winding.

The contact device for controlling the electromagnet is best seen in Fig. 5. As previously explained the spring unit 15 is clamped above the square spacer 13 on the frame post 5 and includes the contact spring 17. This contact spring cooperates with a contact member 65 which is formed integrally with the terminal member 63. Spring 17 is tensioned in an upward direction, as seen in Fig. 5, so that it tends to break contact with the contact member 65. The spring is operated to close the contact by means of an armature 90, secured to the spring, and a small permanent magnet 91, which is mounted on the balance arbor. The magnet 91 is preferably made of Alnico and has an opening in which there is fitted a bushing 92, which has a press fit on the arbor 25. The poles of the magnet are at the opposite ends thereof, and the magnet is eccentrically mounted on the arbor so that during the oscillation of the balance one of the poles comes much closer to the armature than the other pole. The distances are so proportioned to the strength of the magnet that the armature can be attracted only by the pole which comes the closest to it. Fig. 5 shows the armature 90 in attracted posi-

tion, the contact between spring 17 and contact member 65 being closed. When the arbor 25 and magnet 91 are rotated in either direction, the armature is released and the contact is opened. Rotation of the magnet through 180 degrees will not close the contact because the pole at the rounded end of the magnet passes the armature at too great a distance for it to be operatively attracted.

The magnet 91 is so located as regards its angular position on the arbor 25 that a line passing centrally through the poles of the magnet and the arbor will bisect the angle formed by the spokes which support the poles 51 and 52 of the balance armature. This relation can be seen from Fig. 3, which also shows that when the balance is symmetrically located with respect to poles 55 and 56, with pole 56 midway between armature poles 51 and 54, the operative pole of magnet 91 is in alignment with the armature 90.

The circuit connections for the electromagnet 58 may now be described. There is a binding post 87 mounted on the back of frame plate 4, which is provided with a spring clip 88 beneath the frame plate. When the frame plate 4 is in assembled position, the clip 88 presses against the terminal member 64, as seen in Fig. 4. Assuming that the clock is used in an automobile, the ungrounded pole of the storage battery is connected to the binding post 87. The complete circuit for the electromagnet may then be traced from the ungrounded pole of the storage battery by way of the binding post 87, clip 88, terminal 64, conductor 72, winding 58 of the electromagnet, conductor 73, soldering lug 66, terminal member 63, contact member 65, spring 17 (armature 90 being in attracted position), and through said spring to the frame of the clock. Since the frame of the clock is grounded on the car, the circuit is completed by way of the chassis of the car to the grounded pole of the battery. This circuit is closed intermittently during oscillation of the balance by means of the magnet 91, armature 90, and spring 17. The condenser 59 is included in the circuit in parallel with the magnet winding 58 and prevents sparking at the contact between spring 17 and contact member 65 when the circuit is broken. It will be understood also that these parts are equipped with suitable contact points of non-corrosive metal as indicated in Fig. 5.

The construction of the clock and the various parts thereof having been described, the operation of the clock may be explained briefly.

The hairspring 30 is so assembled and adjusted with respect to the balance that when the battery is disconnected the hairspring will tend to return the balance to the position in which it is shown in Fig. 3. In this position the poles 55 and 56 are midway between the adjacent armature poles on the balance, and the operative pole of magnet 91 is adjacent to armature 90. The adjustment of the hairspring is not at all critical, since the attraction between the magnet 91 and the armature 90 will rotate the balance to the position in which it is shown, provided the hairspring adjustment is approximately correct. In other words, the magnet 91 will pull itself in, if brought within range of armature 90 by the hairspring, and will maintain the circuit of the electromagnet 58 closed inside the clock at the contact spring 17.

When the battery is connected, a flow of current over the previously traced circuit is established and the electromagnet 58 is energized.

The resulting magnetic field passes through the armature and the balance is thus placed in a condition of unstable equilibrium. The rotative forces tending to rotate the balance in opposite directions will not be exactly equal, for various reasons, and the balance will start to rotate in one direction or the other. It may be remarked at this point that when the balance is in the position of Fig. 3 the tooth 37 on pinion 36 is in engagement with the pallet lever 39 on one side or the other thereof and consequently the tension in spring 16 will insure a slightly unsymmetrical location of the balance armature with respect to the poles 55 and 56.

As soon as rotation of the balance begins, the torque rapidly increases, for one pair of armature poles will be approaching the magnet poles while the other pair is receding therefrom. Thus the balance is given a substantial rotative impulse before the magnet 91 has traveled far enough to release armature 90 and break the circuit. The rotation of the balance tensions the hairspring 30 and the direction of rotation is shortly reversed, with the result that the circuit of the electromagnet is again closed when the magnet 91 comes within operating distance of the armature 90. Thus the balance is given another rotative impulse, but in the opposite direction. The operation continues in this manner and in a very short time the balance will attain its normal amplitude, a power impulse being received during each oscillation or beat, when the operative pole of magnet 91 passes the armature 90.

In further explanation it may be pointed out that notwithstanding the symmetrical arrangement of the magnet and armature poles and the magnet 91, the closure of the circuit by the magnet 91 during each beat produces effective rotative impulses applied to the balance which initiate and sustain its oscillations as stated. This is due to the fact that the building up and collapse of the magnetic field is delayed by several factors, including the capacity of the condenser 59 and the inductance of the magnet winding 58, whereby the successive energizations of the electromagnet are caused to occur at times when the balance armature is in such positions with respect to the magnet poles that the impulses received are preponderantly effective in the direction in which the balance is moving. In other words, the delay in the establishment and decay of the magnetic field causes the major portion of the flux to be established each time after the balance has passed dead center and when one pair of poles is approaching and entering between the magnet poles.

The oscillation of the balance drives the clock movement through the medium of the pallet lever 39 and the escape wheel 38, the latter being fixed to the arbor 40 carrying the worm 44, which is the first element of the gear train. The manner in which the drive mechanism operates can best be explained in connection with Figs. 7 to 10, inclusive, which show the essential parts on an enlarged scale and with the several views unobstructed by other parts. The figures show the parts as viewed from the left in Fig. 3.

The normal position of the pallet lever 39 is as shown in Fig. 7 or Fig. 9. The position of the pallet lever is the same in these figures but the relation between the pallets and the teeth of the escape wheel is different, as will be presently explained. Figs. 8 and 10 show the pallet lever fully actuated in its two directions of movement,

respectively. When the clock is not running the tooth 37 of pinion 36 will be in engagement with the end of the pallet lever 39 on one side or the other, depending on chance, for the hairspring 30 and magnet 91 tend to bring the balance in such a position that the radius of tooth 37 is in alignment with the pallet lever, as has already been mentioned. When the clock is running, however, the pinion tooth 37 is out of engagement with the pallet lever at all times except when the balance is passing through its mid position. This insures that the motion of the balance is free and unimpeded except for very brief periods, which correspond approximately to the periods during which power impulses are supplied to the balance.

Considering Fig. 7 now, it is assumed that the balance arbor 25 and pinion 36 are rotating in the direction shown by the arrow. When the tooth 37 engages the end of the pallet lever 39, the lever and shaft 47 are started to rotate in a clockwise direction, and the continued rotation results in the pallet or pin 49 being raised from in front of tooth 83. Shortly after the pallet 49 clears the end of the tooth 83, the pallet 48 engages the tooth 81 and starts to rotate the escape wheel 38. The rotation continues until the pallet lever reaches the extreme position shown in Fig. 8, when the tooth 37 slips off the end of the pallet lever and the latter is instantly restored by spring 16 to the position in which it is shown in Fig. 9. Examination of Figs. 8 and 9 will show that the escape wheel has been advanced by the described operation of the pallet lever, and it will be seen from Fig. 9 that the pallet 49 is now behind tooth 83 instead of in front of it as in Fig. 7. It will be noted also that both pallets 48 and 49 are within the circle defined by the extremities of the teeth of the escape wheel and that pallet 48 in particular is just in front of tooth 82 where it can prevent any tendency of the escape wheel to overrun.

After the pinion tooth 37 has released the pallet lever, the pinion and arbor 25 continue to rotate in the direction of the arrow in Fig. 8 until the balance stops and reverses its direction of motion under the influence of the hairspring. Rotating now in the direction shown by the arrow in Fig. 9, the pinion tooth 37 again approaches the end of the pallet lever and eventually engages it as before, but on the opposite side. The pallet lever and shaft 47 are therefore now rotated in a counterclockwise direction. As the result of this movement the pallet or pin 48 is lifted from in front of tooth 82 of the escape wheel and the wheel is advanced by the engagement of the pallet 49 with tooth 83. The rotation of the pallet lever continues until it reaches the extreme position shown in Fig. 10, which shows the parts in the positions they occupy just before the pinion tooth 37 slips off the end of the pallet lever. When this occurs the pallet lever is restored by spring 16 as before and assumes the position in which it is shown in Fig. 7. Consideration of Fig. 10, however, will show that the pallet 49 is now just in front of tooth 84 instead of tooth 83, and that the escape wheel has been advanced an angular distance of one full tooth. The escape wheel 38 is again locked against overrun, this time by pallet 49 cooperating with tooth 84.

The foregoing describes one complete cycle of operation, during which the balance wheel performs an oscillation or beat in each direction. The cycle repeats itself indefinitely as long as the clock continues to run and the escape wheel

is thus intermittently advanced always in the same direction to drive the clock train in the proper manner.

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:

We claim:

1. In a clock, a frame, an oscillating armature supported on said frame, a magnet core and winding therefor, two members of magnetic material secured to said frame, said members having poles at one end for cooperation with said armature and slotted angularly disposed extensions at the other end for receiving the ends of said magnet core, and means for securing said members to said core after the same has been positioned in the slots in said extensions.

2. In a clock, means including an electromagnet for driving the balance, a circuit for said magnet, a switch for controlling said circuit, said switch comprising a fixed contact member supported on said magnet and a movable contact member, a spring carrying said movable contact member at one end and having its other end rigidly supported on the frame of the clock, and means oscillating with said balance for closing said switch during each beat of said balance.

3. In a clock, means including an electromagnet for driving the balance, said magnet including a winding and a spool of insulating material on which said winding is wound, a circuit including said winding, a switch for controlling said circuit, said switch comprising a fixed contact member secured to one head of said spool and a movable contact member supported on the frame of the clock, and means oscillating with said balance for closing said switch during each beat of said balance.

4. In a clock of the electromagnetically driven balance type, a removable unit including an electromagnet, a contact member included in said unit, a second contact member supported on the frame of the clock and cooperating with said first contact member when said unit is in the clock to control the circuit of said electromagnet, and means oscillating with said balance for closing said contact members together momentarily during each beat of the balance.

5. In a clock of the electromagnetically driven balance type, a removable unit including an electromagnet, contact members supported on the frame of the clock, other contact members forming part of said unit and adapted to engage said first mentioned members, respectively, when the unit is assembled in the clock, a circuit for said electromagnet including said members, and means oscillating with said balance for actuating one of said members to close and open said circuit.

6. In a clock of the electromagnetically driven balance type, a removable unit including an electromagnet and a condenser, contact members included in said unit and constituting terminals of said electromagnet and condenser, contact members supported on the frame of said clock and adapted to be engaged by said first mentioned contact members, respectively, when the unit is assembled in the clock, a circuit for said electromagnet and condenser including said contact members, and means supported on the balance arbor for moving one of said contact members to open and close said circuit.

7. In a clock of the electromagnetically driven

balance type, a removable magnet assembly comprising a core, a spool of molded insulating material, and a winding on said spool, terminal members for the said winding embedded in the heads of said spool, contact members supported on the frame of the clock and adapted to be engaged by said terminal members when the magnet assembly is incorporated in the clock and to be automatically disengaged when the magnet assembly is removed, and means oscillating with the balance for operating one of said contact members to cause the same to intermittently disengage the associated terminal member.

8. In a clock of the electromagnetically driven balance type, a removable magnet assembly comprising a magnet core, a spool of molded insulating material, and a winding on said spool, a terminal member for one end of said winding embedded in one of the spool heads, a contact member terminating the other end of said winding and embedded in the other spool head, and a binding post and contact spring supported on the frame of said clock and adapted to be engaged by said terminal member and contact member, respectively, when the magnet assembly is incorporated in the clock.

9. In a clock, a frame including a post, an electromagnet, a switch including a contact spring for controlling the circuit of said magnet, and means for mounting said spring on said post comprising a shoulder on said post, a spacer on said post above said shoulder having a flat side which prevents said spacer from turning on the post by cooperation with said frame, ears on said spring adapted to grip said spacer, and a nut for clamping said spring and spacer against said shoulder.

10. In a clock, means including an electromagnet for driving the balance, means including a pallet lever intermittently operated by motion of the balance for driving the clock train, and a compound spring formed from one piece of material and comprising a spring member for controlling the circuit of said electromagnet and a second spring member for restoring said pallet lever to normal position after each operation thereof.

11. In a clock of the electromagnetically driven balance type, pole pieces secured to the frame

of the clock for cooperation with the balance, a unit including an electromagnet removably secured between said pole pieces, a contact member included in said unit and constituting one terminal of said electromagnet, a second contact member supported on the frame of the clock and cooperating with said first contact member when said unit is assembled in the clock to control the circuit of said electromagnet, and means oscillating with the balance for causing said second contact member to engage and disengage said first contact member.

12. In a clock of the electromagnetically driven balance type, a removable unit including an electromagnet, means for removably securing said unit to the frame of the clock, a contact spring having one end secured to the frame of the clock at a point near one end of said electromagnet, said spring extending parallel to the magnet core toward the other end thereof, a contact member supported on said unit at the said other end of the magnet core and extending back parallel to the core to meet and overlap the said contact spring, and means oscillating with the balance for operating said contact spring to cause the same to engage and disengage said contact member.

13. In a clock of the electromagnetically driven balance type, a frame including a flat plate, a contact spring having one end fixed to said frame, an electromagnet including a spool for the winding thereof, said spool having heads which are flattened on one side, a contact member mounted on the electromagnet at one of the spool heads, means for mounting said electromagnet on said frame with the said contact member in position to cooperate with the free end of said contact spring and with the flattened sides of the spool heads resting against said flat plate of the frame, the cooperation between the spool heads and the frame plate being effective to properly locate the said contact member relative to the contact spring, and means oscillating with the balance for operating said contact spring to cause the same to engage and disengage said contact member.

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